

Moving Out of the Meeting Room

Exploring support for mobile meetings

Jens Bergqvist, Per Dahlberg and Fredrik Ljungberg
Viktoria Institute, Gothenburg, Sweden

Steinar Kristoffersen

Norwegian Computing Centre, Oslo, Norway

“The structuring properties of the interaction order in real-time settings such as meetings have enormous (and as yet largely ignored) consequences for the overall structuring of organizations. Caught in a meeting and connected through a series of interactions across time and space are the people, ideas, decisions, and outcomes that *make* the organization.”

(Boden 1994, p 106)

Recent research in CSCW shows that people become mobile in order to meet. Such meetings take place everywhere. Therefore, they are difficult to conduct using traditional meeting support. In this paper, we empirically examine mobility in face-to-face meetings. The objective is to characterise such encounters and suggest meeting support beyond the meeting room. We have identified four dimensions of such mobile meetings: establishing meetings, multiple threads, briefings, and technology. The implications from this study complement existing research with guidelines for mobile meetings.

1 Introduction

Within the field of CSCW considerable attention has been paid to information technology (IT) support for meetings. One strand of this research has focused on meetings between co-located people. Research efforts in this category involves

technological contributions, e.g., the design of meeting rooms (Nunamaker *et al.* 1991), roomware (Streitz *et al.* 1997), advanced meeting technologies (Elrod *et al.* 1992), and software applications (Pedersen *et al.* 1993), but also empirical contributions, e.g., studies of the ways in which people make meetings happen (Mantei 1989; Moran *et al.* 1996). Clearly, these contributions have been very important to the field.

One issue that has not been so much addressed in the research on meeting support is mobility. In fact, mobility has until recently been largely overlooked in the CSCW literature (Luff and Heath 1998). Some recent empirical accounts on the topic have shown that people are often mobile to meet each other and solve problems (Bellotti and Bly 1996; Kristoffersen and Rodden 1996). Such meetings can occur in many different places, which makes them difficult to assist by means of traditional meeting support (e.g., electronic whiteboards), which tend to be static and tied to dedicated places. By meeting support we understand any IT designed to assist collaboration between people who have “come together” to deal with work-related issues (see, Nunamaker *et al.* 1992). Related to but yet different is support for informal communication, which seeks to assist unarranged, unscheduled, and less goal-oriented engagements with random participants (Fish *et al.* 1990, Kraut *et al.* 1990). The empirical research on informal communication has involved studies of interaction between co-located people (Whittaker *et al.* 1994), however the technological contributions have exclusively supported remote interaction (Fish *et al.* 1993).

The objective of our research is to explore meeting support beyond the context of the meeting room, i.e., assist people who come together in face-to-face meetings in other places. The purpose of the study reported in this paper is to begin to investigate work in real settings in a systematic way, with a particular objective to inform the design of such meeting support. The study explores the work of staff at the central IT department of the city of Gothenburg, Sweden. By reporting the fieldwork and elicit implications for the design of support for mobile meetings, we seek to add to and extend the emerging CSCW literature that investigates mobility for the purpose of design.

We start the paper by summarising the research on meeting support and mobility (Section 2), and describe the research context of the study (Section 3). In section 4, we report the results of the empirical study, and in section 5 we discuss the findings in relation to existing research, and the implications the results may have for design. In section 6, we conclude the paper.

2 Related work

There are two areas of related work to the research presented in this paper. These are the CSCW research on meeting support and mobility.

One strand of research on meeting support for co-located people has focused

on equipping meeting rooms with IT support (Nunamaker *et al.* 1991). These rooms often involve expensive and special-purpose hardware, which makes them static and tied to dedicated places. Related to this research is what recently has been called roomware, i.e., the combination of information devices and physical objects in a room, e.g., walls, chairs and tables (Streitz *et al.* 1997). The research on roomware tends to go beyond the context of the meeting.¹ Research on meeting support also explores advanced hardware technologies, e.g., electronic whiteboards (Elrod *et al.* 1992), and software applications with which these could be equipped, e.g., the Tivoli application (e.g., Pedersen *et al.* 1993). Software for meeting support running on light weight technologies like PDAs (Personal Digital Assistant) has been explored as well (Myers *et al.* 1998). Research also investigates the integration of meetings along the dimensions of time and space (Inoue *et al.* 1997), as well the integration of meetings and other group activities (Mark *et al.* 1995). Another strand of research conducts empirical studies of meetings. The studies evaluate meeting support and inform design (e.g., Mantei 1989; Olson *et al.* 1992).

Most research on mobility can be characterised as empirical studies (but see Kristoffersen and Ljungberg (1998) for an exception). Most of these concern mobility as a *consequence* of an interest in another topic, e.g., informal workplace communication (Whittaker *et al.* 1994), the effects of video technology in banking (Kristoffersen and Rodden 1996), co-operation and IT use in a dispersed design team (Bellotti and Bly 1996), and the practice of photocopier technicians (Orr 1991). As far as we are aware, Luff and Heath (Luff and Heath 1998) is the only contribution in CSCW that explicitly investigates mobility for the purpose of design. Luff and Heath reconsider three empirical studies from the point of view of mobility. The focus is not personal mobility only, but also the mobility of artefacts, called micro mobility. The analysis involves three cases with three different focuses on mobility. These are micro mobility in medical consultation, remote mobility at a construction site, and remote and local mobility in the London Underground.

In this paper, we seek to bring together meeting support and mobility, and in doing so, address an issue that has not been previously explored: meeting support for mobile settings.

3 Research site and method

The research was conducted at an IT company owned by the local government of Gothenburg, Sweden. The company has a wide range of responsibilities. The most important are: consultation, design, installation and support of software,

¹ See for example the conference on "Cooperative Buildings" (Streitz *et al.* 1998) and the panel on "Roomware for cooperative buildings" at the CSCW'98 conference

installation and support of hardware, and maintenance of the local government's servers. The clients are distributed all over the city. The company employs 300 personnel, and the annual turnover is approximately 280 million SEK (approximately \$30 million).

The department we investigated has about 25 employees. The main task is to design, install, and support Lotus Notes applications and databases. Many employees both work as project leaders and developers. The manager of the department (Bonnie²) has her own office. Everybody else either shares office or works in the office landscape.

We spent approximately 70 man-hours doing close participant observations (or, shadowing), i.e., following every single move of a particular person. Everybody was aware of the research and its purpose, and field notes were taken continually. The analysis of the empirical data aims to "make sense of massive amounts of data, reduce the volume of information, identify significant patterns, and construct a framework for communicating the essence of what the data reveal" (Patton 1990, p. 371-372). Having transcribed the field notes, we started the coding of the empirical data. This meant going through the data carefully, making notes and labelling data that seemed to capture underlying patterns. In the analysis, we used pseudo HTML to tag the field data, e.g., meetings in the office, and Perl scripts for processing it, e.g., meetings in the office following a formal meeting. Gradually, the coding process became a matter of interpretation, i.e., "attach significance to what was found..." (Patton 1990, p. 423).

4 Results

In this section, we summarise the results of the empirical study. The analysis is based on the 88 face-to-face meetings we observed. These meetings took place away from the desktop for at least one of the participants (thus, they were considered mobile), and they were clearly related to work. We excluded traditional meetings, e.g., the weekly group meeting.

In table 1, we summarise the meetings observed according to where they took place (away, home and elsewhere) and whether or not IT was involved (IT involved and no IT involved). Home means that the meeting took place in the office of the person shadowed, i.e., someone else (one or more) had been mobile to establish the meeting. Away means that the meeting took place in the office of someone else, i.e., (at least) the person shadowed had been mobile to establish the meeting. Elsewhere means that the meeting did not take place in an office but somewhere else, i.e., all people involved had been mobile to establish the meeting.

As we can see in the table, the number of meetings were quite equally divided

² The names of the people investigated have been changed for anonymity

between the three categories (28, 24 and 36). Of the 88 meetings, 52 took place in offices, and 36 elsewhere. We can also observe that most of the meetings did not involve IT (74 of 88).

Place	IT involved	No IT involved	Total	%
Away	4	24	28	32%
Home	3	21	24	27%
Elsewhere	7	29	36	41%
	14	74	88	100%

Table 1 Summary of the meetings observed

The purpose of the analysis is to serve as a source from which we can elicit implications for the design of meeting support for mobile workers who engage in face-to-face meetings. We identify four important aspects of the ways in which such meetings take place. These are.

- establishing meetings,
- multiple threads,
- briefings, and
- technology.

4.1 Establishing meetings

The focus of the analysis is meetings in mobile settings, i.e., meetings that take place away from the desktop of at least one participant. This means that all meetings we report here were preceded by at least one person being mobile. In most cases (52 of 88), the person who wanted to establish the meeting simply walks to the office of the person with whom she wants to interact. When arriving there, one of the persons would typically indicate the presence of herself or the other party (one or several). For example, the arriving person could ask “Do you have a minute?” or “Have you read the email I sent you this morning?”.

However, this does not always happen. For example, consider the excerpt below. Previous to this situation, Ursula and Bonnie have been discussing a contract.

[Bonnie is engaged in a meeting with Henry in her office] Ursula enters the office She says nothing but leaves a document on top of Bonnie’s keyboard. Bonnie and Henry continue to talk as if nothing had happened [.] Henry leaves Ursula returns and points at the document she left earlier

What seems to happen in this situation is that neither Henry, Bonnie nor Ursula think it would be appropriate to interrupt the ongoing meeting. Bonnie and Henry just continue their conversation, and in doing so, they indicate to each other, and Ursula that it makes sense to continue the meeting. Because Ursula says nothing, but leaves immediately after having placed the document on the keyboard, she seems to agree. Accordingly, for all three people involved, it seems to make sense

not to establish a new conversation when Ursula shows up, and therefore a new meeting does not happen. We made several similar observations during the study.

Of the 88 meetings, 36 took place elsewhere, i.e., in another place than the office of a person involved. One reason why is that the person who wants to establish the meeting encounters the person(s) with whom she wants to interact on the way to her office. For example:

[Bonnie and Ursula have previous today been discussing a contract] Bonnie reads the contract After a while, she walks towards the door of the office "to check something with Ursula " But Ursula is just passing by in the hallway [] A new discussion follows

In other cases, the person who wants to establish the meeting does not find the person with whom she wants to interact with (typically she is out of the office). She continues to seek for her and finds her somewhere else. For example:

Arriving at his desktop after the lunch break, Errol finds a PostIt note on his desktop written by Amanda. Amanda writes that she wants to talk to him Errol walks away towards Amanda's office, but she's not there Errol finds her in the printer room from which they head towards Amanda's office

Quite frequently, meeting participants want to invite more people in to the discussion To do so, they could go to the person (one or several) in question, asking her to join the meeting. For example:

Annie and Errol are discussing the X SOFTWARE³ application when they realise that they need to invite Ursula into the discussion. Therefore, they simply walk away towards Ursula's office ...

Sometimes this kind of mobility does not aim at a particular person, but a role. For example.

Errol and Annie are engaged in a meeting. They discuss the software licenses of X SOFTWARE [a Lotus Notes based system] Errol says: "It's funny that X SOFTWARE is include in the Y SOFTWARE⁴ package, yet it seems to require new licenses." In order to find out they need to talk to "somebody who knows." However, "since the boss is gone, it may be the best thing to do to talk to Ursula " They decide to go see her

In this situation, Errol and Annie seem to want to talk to anybody who can help them solve the problem ("somebody who knows"). It seems as if they would have asked the boss if she had been there. However, since she is not available at the moment, they decide to see someone else who could help (i.e., Ursula).

4.2 Multiple threads

The meetings typically involve discussions on many different topics. Topics are introduced, suspended, replaced and resumed, and while some are picked up in several meetings others just seem to fade away. Such micro discussions and the ways in which they occur, have been called threads. Because meetings tend to

³ The name of the software package has been changed for anonymity

⁴ The name of the software package has been changed for anonymity

involve many threads, which are not introduced, dealt with and completed in a sequential manner, we will describe the structure of the meetings in terms of multiple threads.

Threads that have been dealt with in previous meetings are sometimes just picked up in later meetings. This would typically happen in meetings with the manager. New threads in a meeting seem to be picked up in many different ways. For example, one person could associate a topic with something that another person said, e.g., “By the way, I also ...”. However, threads do not just pop up, but are introduced and resumed in an intelligible way. In some cases, the topic would be obvious, e.g., someone reporting that she has done what was agreed on in a previous meeting, while in other cases it would have to be explained, e.g., when someone in a discussion says “This reminds me of. ” and introduce a new thread. If someone picks up a thread that does not make sense, then the other people would typically make this obvious. They would do so by hinting that an explanation is expected.

To illustrate the structure of threads during and between meetings, let us briefly describe a typical situation for Bonnie (the manager).

[Bonnie is in her office] Ursula enters the office with a contract. Ursula wants Bonnie to go over it before filing it in the Lotus Notes system. [] Ursula leaves the room []

[Bonnie and Ursula have previous today been discussing a contract] Bonnie reads the contract. After a while, she walks towards the door of the office “to check something with Ursula.” But Ursula is just passing by in the hallway [] A new discussion follows

Henry enters the office and explains that he cannot attend a meeting “Can anyone else attend?” Bonnie calls Ian [on the phone] to check what the meeting is about. Henry leaves the office during the call []

During the conversation [the call] Ursula paces back and forth across the room. She leaves after a minute or two [] Bonnie returns to reading the contract

Ursula returns. Bonnie briefs her about the telephone conversation. They start a long discussion on the issue of software ownership []

Larry arrives. He picks up the discussion about laptop computers []

Henry enters. He wants to discuss a pricing issue []

Ursula enters the office. She says nothing but leaves a document on top of Bonnie’s keyboard. Bonnie and Henry continue to talk as if nothing had happened [] Henry leaves

Ursula returns and points to the document she left earlier [.]

As we can see, the meetings in Bonnie’s office involve several threads. When Ursula first enters the office, she introduces a new thread, the contract. The contract is temporarily suspended when the meeting is over and Ursula leaves the room. Later, Bonnie resumes the contract when inviting Ursula into the office. Then the contract is suspended again. However, it is picked up again when Henry leaves the office and Ursula returns. It is interesting to notice that the contract lasts for several meetings (with several other threads).

4.3 Briefings

Much time during the meetings is spent describing things to each other. Some of these briefings concern what people have done in the past, while others concern what they plan to do in the future.

Briefings about the future could be information about, for instance, a future project or a customer visit. One example is when Amanda informs Errol about the new file structure for the web site.

Amanda [a Lotus Notes administrator] enters Errol's office. She describes to Errol that the file structure of the web server is messy. One reason, she explains, is that "it was not designed for so many documents" [] She continues "It was designed by company X and Paul." Amanda explains that a new server is going to be purchased, and that Chrystal has designed a new structure."

In this situation, Amanda briefs Errol about things that do not concern him primarily, but which are good-to-know. It is interesting to notice that the briefing involves past events as well as future plans.

Briefings about the past can be follow ups on tasks that have been discussed previously. We also observed the ways in which people brief each other for the purpose of making sense of past events. Previous to the excerpt below, the servers at the company had crashed. This was noticed by the employees.

The systems administrator shows up in the corridor. He is in a hurry. When passing by the door to Bonnie's office, he exclaims "Somebody has dropped a plate on a fuse! The server of our company and the tramway had a power failure!"

Here, the systems administrator explains to Bonnie why the servers are down, thus he gives reasons for why the servers had dived.

Briefings could also be people describing what they plan to do. Consider the following example:

Ursula enters Bonnie's office. She brings with her a contract. She says she wants Bonnie to go over it before filing it in the Lotus Notes system. Ursula explains to Bonnie that "the contract partner will probably visit them this evening" [..] Bonnie explains that she "can't access some objects in the project data base from home." She also says that she's "going to convert the document verbal description of the business plan to a word processing file." In addition, she describes that she "plans to work at home tonight," and that she will contact Ursula if she makes any updates.

In this situation, we can observe at least two briefings which seem to play major roles in the interaction. First, Ursula describes to Bonnie that the contract partner will make a visit later. Second, Bonnie says she plans to work at home tonight, but that she will contact Ursula if she makes any updates.

There are also briefings that appear serve the purpose of giving order. For example, consider the following excerpt.

Ursula's cellular phone rings. In the subsequent conversation, she makes an offer [it's a client] "we can do this we can do that." She informs the caller about costs and what is included "education and support." She also says that "Annie will be responsible." When the phone call is finished, Ursula walks to Annie's office. She tells Annie about the call, and the task. She

also describes that it could be good to make some cost calculations Ursula leaves.

Here, Ursula in a descriptive manner explains to Annie what has been said during a phone call with a client. She also describes a task and what ought to be done. Clearly, she does not simply describe the call and the task to Annie, but requests her to assume the responsibility. Since Annie does not express another stand point, she seems to accept the request. We made other similar observations about people briefing each others about what ought to be done in the future.

4.4 Technology

Of the 88 meetings observed 14 involves the use of IT. On these occasions, IT either serves as a resource for face-to-face interaction, or as a means for interaction with remote people.

When people enrol IT (e.g., a PC) in a face-to-face meeting, they typically rearrange the way in which the interaction takes place. In a sense, what often happens is the opposite to the *micro-mobility* observed in the studies by Luff and Heath (Luff and Heath 1998, p. 306), i.e., “the way in which an artefact can be mobilised and manipulated for various purposes around a relatively circumscribed, or at hand, domain.” According to our observations, it is not the artefacts (IT) that are “mobilised and manipulated,” but rather the participants of the meetings (Luff and Heath made similar observations). What typically happens is that people want to check something on the computer network. Therefore, they move to a PC at hand which one of them starts to operate. The other participants would stand behind the operator, glancing over her shoulder.

The way in which the meeting takes place when the PC is enrolled differs significantly from the way it took place previously. When the PC is used, only one person can be in control, if many people are involved it can be difficult for everybody to see what happens on the screen, eye-contact is lost when everybody looks in the same direction, and so on. However, these were the premises on which the PC could be involved in the face-to-face interaction. It is striking how this differs from Luff and Heath’s (Luff and Heath 1998) description of the ways in which medical records were used in medical consultations.

We also made observations of how IT was used in meetings for interaction with remote people. The IT that people use in these situations is the cellular phone. What typically would happen when someone in a meeting starts to use a cellular phone, is that the meeting is suspended (compare threads). Everybody but the person using the phone is quiet. It seems as if they just listen and wait for the call to end.

Making a phone call would typically be a consequence of an emerging need for external contact defined by the meeting participants, e.g., that something needs to be sorted out and a phone call is made accordingly “Let’s call her and find out.” Consider the following excerpt from a meeting

Errol explains that it's not obvious who is going to join the project "Susan and myself know something about the technological issues," he explains. But they would also like to see some more people involved [] Susan picks up the phone to give Bonnie (the manager) a ring "to find out"

As mentioned previously, instead of making a phone call, the entire meeting sometimes moves to persons who needs to be enrolled into the conversation.

Upon finishing the phone call, the caller would typically explain to the other meeting participants what the other party said (in a sense, recapitulate the conversation)

We also observed meetings where a participant received a call. What typically happens then is that the receiver explains to the other meeting participants who was calling, e.g., by saying "Hi Mr X!", but also for the caller that she was in a meeting, e.g., "I'm in a meeting...". For example:

Steve's cellular phone rings. He answers. "Hi there... I'm in a meeting with Bonnie" [] Upon finishing the call, he explains: "It was Amanda"

5 Discussion

The meetings we investigated seem to share features with informal communication and meetings, as described in the CSCW literature. However, as we shall see in the discussion below, there are also important differences. To emphasise these, and highlight in what ways our observations can be distinguished from previous contributions in the field, we introduce the concept of mobile meeting.

5.1 Mobile meetings

Interaction takes place in meetings, but meetings are not simply interaction. Meetings are deliberate efforts to establish organisational order and bring about work. Meetings bracket out people, places, and agendas in such a way that it becomes clear who are the appropriate participants, which topics may be raised, etc. One objective of this paper is to bring the social accomplishments of this bracketing to the fore, and sensitise designers to the practical requirements of attending such meetings. Within a CSCW context, the purpose thereby is to improve technological support for achieving mobile meetings.

A meeting may comprise of formal or informal arrangements for turn-taking, participation and sticking to the agenda. The typical meeting (see, Jay 1993) takes place in a meeting room. It fulfils a specific function, it is scheduled and organised according to an agenda, it is usually attended to by an invited group of people, and it often takes place regularly. Formal meetings are usually understood as officially convened, with fixed membership and agendas. They often occur regularly and have a directed and restricted set of turn-taking mechanisms, which

are managed by a chairperson. Informal meetings, on the other hand, are generally task or decision-oriented. They are clearly distinguished from informal communication, as understood by Kraut *et al.* (Kraut *et al.* 1990), by being convened, albeit often verbally. Informal communication is often positioned as the opposite to meetings. Informal communication is usually not planned or used to articulate formal functions. It can take place anywhere and involve random participants. It may be seen a social event rather than a meeting, nevertheless, it may of course relate to work in other ways.

The issue of participation is crucial. An organisationally defined group attends to a typical meeting. Attendees to mobile meetings were, on the other hand, all closely engaged in the activities of concern to the meeting (compare: establishing meetings). Moreover, we observed that people even left mobile meetings when they did not concern them any longer, which may be considered inappropriate behaviour in typical meetings.⁵ Informal communication, on the other hand, has an open set of participants.

Informal meetings are generally unrecorded, or even explicitly off-the-record (Boden 1994). This is in contrast to mobile meetings, which are often concerned with allocating responsibilities and action points which are recorded, or need to be recounted for an external purpose later (compare: briefings)

Informal meetings, albeit not having a designated chair, usually have a *de facto* responsibility assigned to the most senior person (Boden 1994). The activity of chairing, moreover, is often territorial, inasmuch as the meeting often takes place in the office of the person who takes on the role as chair. According to our observations, mobile meetings often (in our case: 73%) take place away from the office of the initiator, and they tend to be less territorial. In contrast to typical meetings, which are tied to a few dedicated places, mobile meetings and informal communication could take place in almost any places.

We claim that mobile meetings may be informal as well as formal and that they are, indeed, proper meetings, with a expected and accountable set of participants and agenda that needs to be followed - clearly, from our excerpts, alien issues are often simply ignored.

5.2 Establishing mobile meetings

Mobile meetings are established through deliberate efforts involving *physically seeking out* and *negotiating* with potential participants, *bracketing* the subsequent communication and *agreeing on topics*

Some meeting support systems treat the convening and establishing of meetings as detached from the meetings themselves. They usually support requests for participation, and may distribute documents. Some systems also

⁵ As Boden (Boden 1994, p 87) puts it " participation by particular organisational members is expected and accountable "

maintain the shared calendars of participants (Ephrati *et al.* 1994). These designs, therefore, assume that people will be at their workstations well before the meetings, with time set aside to prepare and articulate competing organisational chores

The main implication of our fieldwork is to support locating people, physically as well as virtually, in a highly mobile environment. Supporting negotiation of meetings is a tempting enterprise, but one that we believe may be too obstinate given the formalising nature of technology (see, Kristoffersen and Ljungberg 1999). Leaving the entire process of establishing meetings (locating and establishing) to social protocols, on the other hand, may be too defensive.

Hence, a promising principle for establishing mobile meetings could be affording awareness of the activities (Dourish and Bly 1992) and position of potential participants. Maintaining and managing this type of state information should be a low-overhead activity (Grudin 1994). For the mobile user, calm information appliances (Norman 1998), may support this functionality. Position may be either absolute or relative to other users. Absolute position shows, for instance, at which office a person is located. ParcTab is one system that provides this kind of support (Want *et al.* 1995). However, we find that the relative positioning is equally exciting. Relative positioning is based on proximity, one example of which is the Hummingbird system (Holmquist *et al.* 1998). Hummingbirds give notice when users are nearby.

Establishing meetings is cumbersome (Ephrati *et al.* 1994). Even with simple technologies, such as the telephone, as many as 60% of all calls fail to connect with their intended recipient (Rice and Shook 1990; Whittaker *et al.* 1994). We think that one important lesson to be learned for CSCW is that this is part-and-parcel of organisational life. One novel implication of this paper is that members of organisations conspicuously use mobile meetings as a feature to resolve this problem. Perhaps this is one good explanation of why we found no mobile meetings that were pre-arranged using IT (in contrast to (Fish *et al.* 1993)).

Boden (Boden 1994) claims that meetings cannot start without having a critical mass of members in attendance. We argue that mobile meetings are one way of reaching critical mass, since they take place with fewer participants, topics are dynamically adjusted to the availability of participants, and it may be suspended and resumed when appropriate. The threshold is lower indeed, since one person with a mission seems to be able to pull off a mobile meeting almost regardless.

5.3 Multiple threads

Mobile meetings involve multiple topics. *Threads* relate to topics, and may be seen as their enactment. Mobile meetings have many topics, but usually only one active thread at any time. Threads are not always completed within a meeting, and the pertaining contributions do not always occur sequentially. Threads are,

moreover, sometimes moved between meetings, thus, they tend to be suspended and resumed.

McDaniel *et al.* (McDaniel *et al.* 1996, p. 41) define a thread as "...a stream of conversation in which successive contributions continue a topic, following an initial contribution which introduces a new topic." Whittaker *et al.* (Whittaker *et al.* 1994) on the other hand, reported that informal communication tend to be one long session, that is suspended and resumed over time. We found that threads in mobile meetings do not consist of *sequential* (uninterrupted) contributions, they are not always introduced explicitly, and they can be involved in several meetings.

Considering threads instead of topics as the atomic unit of meetings opens up a new design space, inasmuch as they lend themselves more easily to representations comprising, for instance, participants, documents and place. Thus, a system could conceivably always show the closest thread on top of the mobile user's display. Threads are, in contradistinction to topics, bracketed in actual time and space. In the meetings, threads were shifted frequently and effortlessly. New IT should not make switching more difficult.

5.4 Briefings

Mobile meetings serve as important ways for people to brief each other about past and future events. Because the attendees typically are closely engaged in the activities of concern, briefings are likely to be important for everybody involved.

The PC could be a useful tool for briefings. For example, a project member could perhaps more effectively brief someone else when accessing to the common information space of the project. However, not even a laptop PC seems light weight enough for mobile meetings. Therefore, we suggest the use of calm, ubiquitous devices equipped with features for replication and browsing.

5.5 Technology

Technology in mobile meetings either serves as a resource for face-to-face interaction, or as a means to carry out interaction with remote people. Technology is only used when absolutely needed, and it often makes people rearrange the ways in which they interact, e.g., by trying to use individual IT like the PC as if it was a group technology. When people use the cellular phone in meetings, they typically explain the use context; that they are in a meeting, who the other party is, etc.

Luff and Heath (Luff and Heath 1998) coined micro mobility to describe the ways in which technology (objects-in-interaction) should serve as a flexible resource in interaction. They also reported how people rearrange interaction to cope with technology that does not have this property. Overall, our findings of technology in co-present interaction echo those of Luff and Heath. However, one

novel observation seems to be the ways in which people explain context - who is calling, where they are, etc. - when using technology for remote interaction (cellular phone) within the context of mobile meetings.

Clearly, if technology is to serve as a flexible and augmenting resource in mobile meetings, people need to be able to “mobilise and manipulate” it according to the emergent needs of the group.⁶ One approach would be to make technology group aware, i.e., make it possible to accommodate it to group use. However, this way of integrating functionality into artefacts may make them capable of doing many things, but none of them particularly well (Norman 1998). Another approach would be to design dedicated information appliances for groups (Norman 1998). It is interesting to notice that this suggestion is quite the opposite of what often is argued in the meeting support literature, namely that group support needs to be accompanied with support for the individual (e.g., to protect privacy).

5.6 Design in progress

Based on the empirical study, and the implications derived from the results, we are currently developing a series of applications for mobile meetings. The applications are programmed in C and run on the Palm III platform. The Palm III is the most widely used portable device. In a sense, it could also be described as micro mobile. Let us briefly introduce two applications that are being developed.

The Dynamic to do list runs on a Palm III equipped with a radio transceiver (originally developed for the IPAD project at the Viktoria Institute, see (Holmquist *et al* 1998)). The device scans the environment and give priority to the items of the user's to do list based on the proximity of others. This may support the establishing of mobile meetings, and briefings. We plan to experiment with the same technique on threads.

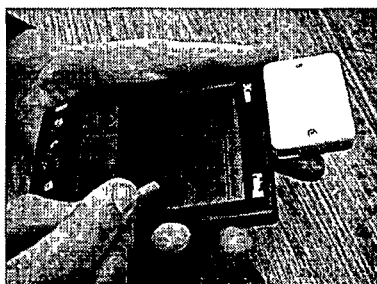


Figure 1 The dynamic to do list runs on a Palm III equipped with a radio transceiver

⁶ Streitz and associates at GMD early articulated the need to integrate “traditional” support for face-to-face interaction with other types of meetings (same time other place, different time same place, different time different place) These ideas have been explored in, among others, the DOLPHIN project (e.g., Streitz *et al* 1994)

The portable project database replicates selected items from a Lotus Notes project database. The idea is to provide users with easy access to information that is potentially relevant in a mobile situation, e.g., to brief someone about the progress of a project.

We plan to evaluate the applications in the organisation investigated in the study.

6 Conclusions

In this paper we have introduced the concept of mobile meeting. We have argued that mobile meetings are different from meetings already discussed in the literature and supported by CSCW systems, among others, by having: a managed set of records and responsibilities, a dynamic agenda which is closely aligned with current topics, and an open yet not arbitrary set of participants. In contrast to informal communication, on the other hand, mobile meetings are clearly bracketed from other organisational activities.

We have introduced four important dimensions of mobile meetings, each of which has design implications for CSCW.

- First, mobile meetings are established through deliberate efforts involving physically seeking out and negotiating with potential participants. CSCW design should take locating participants into account, but perhaps not attempt to support negotiation.
- Second, mobile meetings involve multiple topics, which are enacted by threads. Threads lend themselves more easily (than topics) to representations comprising participants, documents and place. However, it is important that new IT does not make switching between threads more difficult.
- Third, mobile meetings serve as important ways for people to brief each other about past and future events. Support for briefing could be calm and ubiquitous devices equipped with features for replication and browsing of information spaces.
- Fourth, technology in mobile meetings either serves as a resource for face-to-face interaction, or as a means to carry out interaction with remote people. Technology support is currently limited, and should to a larger extent support situated sharing and micro-mobility.

We are currently designing models and prototyping meeting support based on these recommendations. We believe that mobile meetings represent an emerging organisational feature of which the series of interactions across time and space are the people, ideas, decisions, and outcomes really *make* organisations.

7 Acknowledgement

This research is a part of the Mobile Informatics programme, which is funded by the Swedish Information Technology research Institute (SITI).

We would also like to thank our industrial partner Linq Systems AB and the research site company.

8 References

- Bellotti, V and S Bly (1996) "Walking away from the desktop computer Distributed collaboration and mobility in a product design team," In *Proceedings of ACM 1996 Conference on Computer Supported Cooperative Work*, edited by K Ehrlich and C Schmandt, ACM Press, pp 209-218.
- Boden, D (1994) *The business of talk Organizations in action* Cambridge, Polity Press
- Dourish, P and S Bly (1992) "Portholes: Supporting Awareness in a Distributed Work Group," In *Proceedings of ACM 1992 Conference on Human Factors in Computing Systems*, ACM Press, pp 541-547
- Elrod, S, et al (1992). "Liveboard A Large Interactive Display Supporting Group Meetings, Presentations and Remote Collaboration," In *Proceedings of ACM 1992 Conference on Human Factors in Computing Systems*, ACM Press, pp 599-607
- Ephrati, E, G Zlotkin and J Rosenschein (1994). "Meet your destiny. A non-manipulable meeting scheduler," In *Proceedings of ACM 1994 Conference on Computer Supported Cooperative Work*, edited by T W. Malone, ACM Press, pp 359-371.
- Fish, R, R Kraut, R Root and R Rice (1993). "Video as a technology for informal communication" *Communications of the ACM* Vol 36, No 1, pp 48-61
- Fish, R S, R E Kraut and B L Chalfonte (1990) "The VideoWindow system in informal communications," In *Proceedings of ACM 1990 Conference on Computer-Supported Cooperative Work*, edited by T K. Bixson, ACM Press, pp 1-11
- Grudin, J (1994) "Groupware and social dynamics. Eight challenges for developers." *Communications of the ACM* Vol 37, No 1, pp 93-105
- Holmquist, L -E, a Joakim Wigstrom and J. Falk (1998). "The Hummingbird Mobile Support for Group Awareness," Demonstration at *ACM 1998 Conference on Computer Supported Cooperative Work*.
- Inoue, T, K -i Okada and Y. Matsushita (1997) "Integration of face-to-face and video-mediated meetings HERMES," In *Proceedings of International Conference on Supporting Group Work*, ACM Press, pp .
- Jay, A (1993) How to run a meeting In *Readings in Groupware and Computer-Supported Cooperative Work: Assisting human to human collaboration* R Baecker San Francisco, CA, Morgan Kaufmann Publishers Inc. pp 130-144.
- Kraut, R, R Fish, R Root and B Chalfonte (1990). Informal communication in organizations Form, function and technology. In *Readings in Groupware and Computer-Supported Cooperative Work. Assisting human to human collaboration*. R Baecker San Francisco, CA, Morgan Kaufmann Publishers Inc: pp. 287-314
- Kristoffersen, S and F Ljungberg (1998) "MobiCom Networking dispersed groups" *Interacting with Computers* Vol 10, pp 45-65.

- Kristoffersen, S and F Ljungberg (1999) "An Empirical Study of How People Establish Interaction Implications for CSCW Session Management Models," To appear in *Proceedings of ACM 1999 Conference on Human Factors in Computing System*, Pittsburgh, ACM Press
- Kristoffersen, S and T Rodden (1996) "Working by Walking Around Requirements of flexible interaction management in video-supported collaborative work," In *Proceedings of Human Computer Interaction*, edited by B Spence and R Winder, Springer Verlag
- Luff, P and C. Heath (1998). "Mobility in Collaboration," In *Proceedings of ACM 1998 Conference on Computer Supported Cooperative Work*, edited by S Poltrock and J Grudin, ACM Press, pp 305-314
- Mantei, M (1989) Observation of executives using a computer supported meeting environment In *Readings in Groupware and Computer-Supported Cooperative Work. Assisting human to human collaboration* R Baecker San Francisco, CA , Morgan Kaufmann Publishers Inc pp 695 - 708
- Mark, G , J Haake and N. Streitz (1995) "The use of hypermedia in group problem solving An evaluation of the DOLPHIN electronic meeting room environment," In *Proceedings of The Fourth European Conference on Computer-Supported Cooperative Work*, edited by H. Marmolin, Y Sundblad and K Schmidt, Kluwer Academic Publishers, pp 197-213
- McDaniel, S , G Olson and J. Magee (1996). "Identifying and analyzing multiple threads in computer-mediated and face-to-face conversations." In *Proceedings of ACM 1996 Conference on Computer Supported Cooperative Work*, edited by K Ehrlich and C Schmandt, ACM Press, pp 39-47
- Moran, T P , P Chiu, S Harrison, G Kurtenbach, S Minneman and W v Melle (1996) "Evolutionary engagement in an ongoing collaborative work process A case study," In *Proceedings of ACM 1996 Conference on Computer Supported Cooperative Work*, edited by K Ehrlich and C Schmandt, ACM Press, pp 150-159
- Myers, B A , H Stiel and R Gargiulo (1998) "Collaboration using multiple PDAs connected to a PC," In *Proceedings of ACM 1998 Conference on Computer Supported Cooperative Work*, edited by S Poltrock and J Grudin, ACM Press, pp. 285-294
- Norman, D (1998) *The invisible computer* Cambridge, MA , MIT Press
- Nunamaker, J , A Dennis, J Valacich, D Vogel and J. George (1991) "Electronic meeting systems to support group work " *Communications of the ACM* Vol 34, No 7, pp 40-61
- Nunamaker, J F , J F George, J S Valacich, A R Davis and D R. Vigel (1992) Electronic meeting systems to support information systems analysis and design. In *Challenges and strategies for research in systems development* W W Cotterman and J A Senn New York, John Wiley pp
- Olson, J M , G M Olson, M Storosten and M Charter (1992) "How a group-editor changes the character of a design meeting as well as its outcome," In *Proceedings of ACM 1992 Conference on Computer-Supported Cooperative Work*, edited by M Mantei and R Baecker, ACM Press, pp 91-98.
- Orr, J E (1991) Talking about machines An ethnography of a modern job Xerox PARC, Report SSL-9107
- Patton, M Q (1990). *Qualitative Evaluation and Research Methods* New York, Sage
- Pedersen, E R , K. McCall, T P Moran and F G Halasz (1993) "Tivoli. an electronic whiteboard for informal workgroup meetings," In *Proceedings of ACM 1993 Conference on Human Factors in Computing Systems*, ACM Press, pp 391-398

- Rice, R and D E. Shook (1990) Voice messaging, coordination and communication In *Intellectual teamwork. Social and technical foundations of cooperative work*. J Galegher, R Kraut and C Egidio Hillsdale, New Jersey, Lawrence Erlbaum pp 327-350
- Streitz, N, J Geissler, J Haake and J Hol (1994) "DOLPHIN Integrated meeting support across local and remote desktop environments and LiveBoards," In *Proceedings of ACM 1994 Conference on Computer Supported Cooperative Work*, edited by T. W Malone, ACM Press, pp 345-358
- Streitz, N, S Konomi and H Burkardt, Eds (1998). *Cooperative buildings Integrating information, organization and architecture*. Darmstadt, Springer Verlag
- Streitz, N A, P Rexroth and T Holmer (1997). "Does "roomware" matter? In vestigating the role of personal and public information devices and their combination in meeting room collaboration," In *Proceedings of The Fifth European Conference on Computer-Supported Cooperative Work*, edited by J Hughes, W Prinz, T Rodden and K Schmidt, Kluwer Academic Publishers, pp. 297-312.
- Want, R, B N Schilit, N I. Adams, R Gold, K Petersen, D Goldberg, J R Ellis and M Weiser (1995) *The PARCTAB Ubiquitous Computing Experiment* Xerox PARC, Report CSL-95-1.
- Whittaker, S, D Frohlich and O Daly-Jones (1994) "Informal workplace communication What is it like and how might we support it?," In *Proceedings of ACM 1994 Conference on Human Factors in Computing Systems*, edited by B Adelsom, S Dumais and H Olson, ACM Press, pp 131-137.