The Hummingbird as a Support for Mobile Group Awareness
– An Evaluation –

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Sammanfattning

Denna uppsats beskriver en utvärdering av Hummingbird. Hummingbird är ett stöd för ”medvetenhet” (awareness) i mobila grupper. Utvärderingen utfördes på Monter Service, en avdelning på Svenska Mässan i Göteborg. Vi använde etnografi för att bygga en uppfattning om situationen och för att skapa oss en tydlig bild av vad gruppen tyckte om Hummingbirden. Våra observationer koncentrerades kring tre ämnen: medvetenhet, kommunikation och koordination. Resultaten från studien användes för att ge förslag på förbättringar av Hummingbirden detta för att den inte gav det stöd som var menat att den skulle ge. Resultaten har även använts för att formulera hur gruppen själv skulle vilja att ett sådant stöd borde se ut för att fungera i deras situation.

Abstract

This thesis describes an evaluation of the Hummingbird, which is a support for mobile group awareness. This evaluation was performed at Monter Service, a department at the Swedish Exhibition and Congress Centre in Gothenburg. We used ethnography to build an understanding for the situation and to make a clear picture of what the group thought of the device. Our observations were concentrated to the three areas: awareness, communication and coordination. The findings of the study resulted in some suggestions for improvements of the Hummingbird, it did not support the group to the extent that were intended by the developers. We also used the results to formulate how the group would like such a support to be constituted to fit into their situation.

1. Preface

1.1 Acknowledgements

We want to thank our supervisor Lars Erik Holmquist, the originator of the IPAD concept. We also thank Monter Service at the Swedish Exhibition and Congress Centre in Gothenburg, for a nice time and that they wanted to have us hanging around. We especially thank Magnus Bergqvist and Nina Lundberg for fantastic guidance during the writing and the great advice about our method. Last but not least we want to thank our families and friends for their patience and understanding during this time.

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1.2 Keywords

IPAD, Hummingbird, awareness, communication, coordination.

2. Introduction

This thesis was a part of the research project "Innovative Interface Designs for Mobile Devices" of the research group PLAY[1], at the Viktoria research institute. The Swedish Institute for Information Technology, SITI funded the project. The objective of this project was to explore how we could support inter-personal awareness with IT, Information Technology. At the time of writing this thesis the project was in one of the last stages. The project had earlier resulted in a demo at a conference (*PLAY homepage)*, one journal paper *(Holmquist, 1998)* and one master thesis *(Falk, 1999)* focused on the development of the Hummingbird. The Hummingbird is a device sprung from the concept of the IPAD, Inter-Personal Awareness Device, which is supposed to act as a support for mobile group awareness.

Our part of the project was to properly evaluate the Hummingbird as a prototype and IPAD as a concept. The purpose of the thesis was to make a formative evaluation of the Hummingbird in an environment where there was no former experience of the device or of the concept itself. With formative evaluation we mean an evaluation that concentrates on ways to improve the device or concept and primarily how the Hummingbird could be developed to further fit into a work situation of this kind. Another intent with this evaluation was to find out how the Hummingbird supports awareness in the work situation, if this awareness was of any help for the group collaboration. We also wanted to raise a few questions regarding awareness and create a dialogue between the test group and ourselves.

We attempted to achieve this by making an ethnographical field study in an interesting setting. The choice fell on a work group at SECC, the Swedish Exhibition and Congress Centre in Gothenburg. During this study we came to the results that this was not the ideal support for the group. Other results of the field study was an important exchange with the group that gave us a lot of ideas how to change the Hummingbird to better fit into their daily work.

[1] Applied research on art and technology.

We wrote this in mind of a reader with some previous experience of the subject Information Technology. We would also like to make the reader aware of the fact that all names used in this thesis are fictive in consideration of the integrity of the test group members. We have translated all the quotations from the test group, both from the interviews and the observations, from Swedish to English and we might thus have lost some of the original sentiment of the statements.

2.1 Problem area

The work situation of today is very different from what it was ten years ago. Awareness of presence is becoming an important factor at the workplace. The difference is obvious regarding office work, with the increasing practise of distributed work and flexible hours. But there have also been important changes of blue-collar work. An example from our study is the flexibility of working hours when possible. Even though it might be impossible to make ones own schedule it is now more likely for them to have a schedule that changes over time i.e. the schedule changes with the workload, and when possible with the preferences of the workers themselves. This is making the situation more complex than it was some years ago. These changes also affect the need for awareness (see chapter 6).

This complexity brings on a need for support and in the search for such a support the PLAY research group has come up with the concept of IPAD's mentioned in the section above. Our initial intent was to study the usability of the Hummingbird, which is a prototype of an IPAD. We were foremost trying to evaluate the concept and the general idea of IPAD's, rather than the prototype itself. During the empirical stage of the project we found that our project was drifting towards a more formative kind of evaluation. We discovered that the actual test gave rise to new interesting ideas, both from the participants of the test and from us.

Illustrated in this thesis is a small setback for the project, since the opinion was that the Hummingbird was ready for a final evaluation. Since it is difficult to see beyond the shortcomings of a prototype, we were happy that the test group was able to take this point of view. Thus our final purpose of the project was to make a formative evaluation of the Hummingbird in this blue-collar work setting and to propose some improvements of the device to make it fit better into this situation.

2.2 Problem definition

The key question we will answer in this thesis is:

Is the Hummingbird a good tool for supporting awareness in a blue-collar work situation?

From this question we can distil another important concern of this thesis:

How would the ideal support for awareness in this blue-collar work situation be constituted?

2.3 Disposition

We will start by giving the reader a general explanation of the concept of IPAD's and of what the Hummingbird is. We have chosen to also include in this chapter the earlier evaluations made. In the chapter "Related Work" we have decided to describe some related concepts that are relevant to our work. These are ICQ and Active Badge. After this we will move into a description of the method used in this thesis and why we chose it. Following this we will bring up the theoretical framework including the concepts awareness, communication and coordination.

The next chapter is the actual field study. This is a description of what we saw and the results from our observations. The field study is divided into two phases, each one handling different stages of the study. In the first phase we describe the general work situation as it was before we introduced the Hummingbird. The second phase is the actual evaluation and the results from it.

After this we will discuss the results and propose some further research that would be interesting in this project. We will also discuss what we could have done differently. In the last chapter we draw our conclusions and answer the questions posed earlier in this thesis.

3. The IPAD concept

The PLAY research group at the Viktoria Institute has developed a concept, the IPAD, or *Inter-Personal Awareness Device*. This is an Information Technology device designed to support awareness and collaboration between people when they are in the physical presence of other users. The idea with IPAD's is to give the user a sense of the physical distance. This is done by creating a virtual link among the group that serves the purpose to inform the group members of who is in the proximity. The IPAD use the relationship between the other IPAD's and are therefore not dependent on a fixed infrastructure *(Holmquist, 1998)*.

The IPAD is a handheld or wearable device that supplies constant awareness information. It is intended to be a personal device and should be designed to be carried at all times. The IPAD concept is developed to be a *calm technology*.

In Information Technology, calm technology aims to reduce the burden of information overload by letting the user select what information is at the centre of their attention and what information is peripheral. Calm technology is technology that is designed to operate in the periphery and not ask for attention. It is not necessary that all technologies used are calm but it is necessary to be able to command technology without being dominated by it. We must learn to design for the periphery. Calm technology should be both informative and encalming and make our lives and tasks easier *(Weiser and Brown, 1996)*.

3.1 The Hummingbird

From the concept of IPAD's the PLAY research group at the Viktoria Institute developed the Hummingbird. It is a small electronic device designed to be worn or carried at all times. Each member of a group is given their own Hummingbird. The prototype we used in our evaluation was built in the shell of a Game Boy using the display and the serial port already there. The actual programming of the device is done in the cartridge that normally contains the software of the games.

Users bring the Hummingbird with them at all times when they want their presence to be detectable by the rest of the group. Whenever two or more Hummingbirds are within range of each other, they will "hum". The "hum" is a sound that is providing

information that someone is around without demanding the user to pick up the device and look at the Hummingbird. The identities of the other Hummingbirds in the same group will be shown on the devices' display. Here it is shown who is HERE and who is AWAY. The identity of the owner of the Hummingbird and his group identity is also shown on the display *(Figure 3.1*).

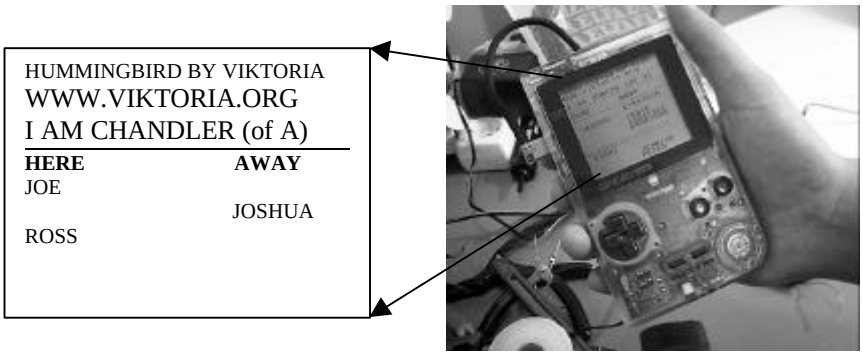

Figure 3.1 The Hummingbird, an example of what it can look like.

The Hummingbird will give users continuous information about which other Hummingbird-equipped group members are close. "Close" in this case is approximate. The range indoors is dependent on how many walls there are interfering with the transmission, and what type of walls these are. The range outdoors or in an open space is within "shouting distance".

Beepers and mobile phones are tools, which can be used regardless of where the user is situated, but these do not provide continuous awareness information. A call via phone or beeper can also be disruptive, since there is no way of knowing what activity the person at the other end is engaged in, and for this reason many people are in some situations wary of using them when not absolutely necessary.

By using the Hummingbird users will get continuous awareness and need not disturb people to get knowledge of their presence. The Hummingbird will only be brought to the foreground of attention when desired or needed, otherwise it will remain in the background. This makes its design related to the principles developed for calm technology *(Holmquist et al., 1999)*.

3.2 Previous evaluations

As mentioned previously the IPAD research project was at this point in time in one of the last stages. During the development of the Hummingbird there have been several evaluations focused on different parts of the concept. We will in this section give the reader a short review of what has been revealed in the earlier tests. We will also bring forward some differences and similarities between the tests already made and our test. Previous evaluations made by the PLAY research group *(Falk, 1999)* has tended to stress how familiar/unfamiliar the environment is for the participants and that people react differently in an unfamiliar situation from a familiar situation. We do not have this aspect partly because it already has been examined and partly because we believe that the nature of the work is equally important for the need of awareness. The foremost reason for this account of previous evaluations was to give an understanding of the state of the art when we began our evaluation.

3.2.1 The Roskilde test

This test took place on a music festival in Roskilde, Denmark 1998. Four Hummingbirds were distributed in the test group. In this case one of the participants of the test group was both the developer and the analyst of the results from the test. *(Falk, 1999)*.

This evaluation was the first in the "real world" and the research group wanted to test the functions and implementation, such as range and rate. But the research group also wanted to learn more about the way in which this technology affects a group.

One *similarity* to our evaluation is that the test took place in the "real world" and both evaluations examine how this technology affects a group. Another similarity was that the sound did not have any function at all.

One *difference* between this test and our evaluation is that the test group in Roskilde was already familiar with the IPAD concept and it was not an everyday situation or work situation. We believe that the fact that some of the users in this test were also the developers and the rest were familiar with the concept made some difference to the test results. We think that the test group was somewhat expecting to feel the awareness and thus did. This does not mean that the test was useless or inadequately performed. At this stage in the process the main point was to explore whether the prototype was working or not. Another difference between the evaluations was that

in our test the participants were familiar with the environment and in the Roskilde test the participants were unfamiliar with the environment.

3.2.2 The ACM conference

This evaluation took place in Orlando, Florida, 1998, on the annual ACM SIGGRAPH conference on computer graphics and interactive techniques which is a combined scientific conference and technical exhibition *(Falk, 1999)*.

This time the test group consisted of three persons, of which two had previous knowledge about the Hummingbird and one had no earlier experience of the device. The Hummingbird was used almost constantly the first few days until the prototypes started to fail.

One *similarity* with our test is that the tests took place in a similar physical environment, an exhibition. Another similarity was that in both evaluations the sound was not used or made no difference.

The *differences* between this test and our evaluation are that the test group at the ACM conference had a technical competence and that the group was on unfamiliar ground.

3.2.3 The Viktoria evaluation

The Viktoria evaluation was performed at the Viktoria Institute in Gothenburg. The test group consisted of four persons, which only carried the Hummingbird for one workday *(Falk, 1999)*. Other awareness support the group had was telephones, e-mail and ICQ, but these tools are all bound to the desktop. This is problematic in a fairly mobile environment when you are on the move a lot.

The purpose of this test was to see if the Hummingbird added to the existing sense of awareness in this situation. They also wanted to see if the Hummingbird was used differently here than in the other test situations.

One *similarity* is that they evaluate the use in everyday work situations rather than in exceptional situations or recreational situations as in the previous tests. Another similarity was that the participants were familiar with the environment. More similarities between our evaluation and the Viktoria evaluation were that the participants did not use the Hummingbirds as actively as in the

earlier evaluations. The participants let the Hummingbird remain in the background attention.

One *difference* between this evaluation and ours is that the group already had some experience about the Hummingbird. Another interesting difference from all the other tests was that the sound did have a function. In the other tests it could not be heard or was turned off because of different reasons.

3.2.4 The ski instructor test

This evaluation took place on a ski trip to Norway, 1999. At this ski trip there were almost two hundred students participating. A student at the University of Linköping conducted the evaluation. The evaluation was part of a forth-coming Master Thesis *(Weilenmann, 1999)*. The test group, which consisted of six people, was chosen from the sixteen ski instructors participating in the trip.

The main objective was first to evaluate the prototype, second to observe if and how an artefact could be a part of a group.

The biggest *similarity* to our evaluation were that the participants or the person that made the evaluation, did not have any knowledge either of the Hummingbird or the IPAD concept it self before the evaluation. Another similarity is the size of the test groups.

The *difference* in this evaluation was that it had more of a social point of view than that of a work situation, even if the ski instructors also were in a work situation but of another type than our test group.

4. Related work

Here we bring up other concepts that are relevant for our thesis. We will try to make the connection between the different research areas and the IPAD concept and the Hummingbird as clear as possible.

4.1 ICQ

ICQ ("I Seek You") is an Internet tool that gives the user information at the computer about who is on-line, and makes it possible to contact them *(ICQ homepage)*. The attempts of contact is indicated for the user as sounds and visual effects, these can be customised to the preferences of the individual user. ICQ will get your entire message across in real time. By using ICQ you are able to chat, send messages, e-mails, URLs or make a file transfer. It is also possible to choose to be invisible to other users. In this mode you can see the other people you are invisible to.

ICQ requires that you use the infrastructure of a computer in access to the Internet. ICQ is therefore immobile and depends on the external services of databases and servers *(Falk, 1999)*.

Like the Hummingbird ICQ support group awareness and is personal. It is an important factor that the support and information is real time distributed. The difference between ICQ and the Hummingbird is the need of an infrastructure and the possibility to communicate through the technology. With the Hummingbird you are not able to receive or send any messages nor are you able to hide from other users other than by turning the device off. But with the device turned off, you are not able to use it for information yourself.

4.2 Active Badge

The Active Badge system was designed and developed at the Olivetti Research Laboratory, Cambridge, England. *(Want et al., 1992)*. The Active Badge is a small personal device and is designed to be worn. The system provides information to the sensors about the location of individuals within a building by determining the location of their Active Badge*)*. The system requires an underlying infrastructure. The sensors are connected together in a network, or rather, a collection of sub-networks, because of the number and shape of the buildings that make up the department.

The sensor passes the identity from the Active Badge and the

identity of the sensor itself to a server, which constantly can be seen on a monitor. The Active Badge does not receive any information from the server or sensors, the Active Badge only sends information.

The Active Badge is similar to the Hummingbird in several ways. Firstly the device is personal and sends information about the identity of the user. It is also a device, which provides information, in real time, about the group wearing the Active Badges. A difference is that the Active Badge demands an underlying infrastructure and does not provide any information at all to the group members wearing them. To receive information from the system you have to look at the monitor of the computer where all information is gathered.

Because of the design both Active Badge and the Hummingbird allows the user to be mobile. Active Badge only allows the user to be mobile in range of the sensors but the Hummingbird does not have this limitation.

5. Method

In this chapter we will describe the methods used to bring us the answers to the questions posed initially. Our problem was to find out how well the Hummingbird fitted into a blue-collar work situation and if there was any need for this kind of technology there. The other of our purposes was to bring out any suggestions on how the Hummingbird should work and how it should be designed.

We wanted to see the results for ourselves rather than being dependent on the arbitrariness that might result from using questionnaires, surveys or any other quantitative method. This caused us to choose a qualitative method of evaluation. The method chosen is ethnographical field study but we have also spent time browsing for literature to support or contradict our findings.

We decided early on in the process of outlining our work that we wanted to use qualitative methods. One of the main reasons for this is the fact that the evaluation is dependent on the environment it is situated in. Thus we have to bring our research to the natural environment of the test group rather than bringing the test group to a laboratory.

Ethnography seemed to be the ideal method for us. The ability to understand the social setting, with emphasis on the collaborative aspects, was the biggest reason for us to go with ethnography rather than any other method. This is also one of the reasons why it has become popular in system development *(Hughes et al., 1994)*. We used Bly's *(1997, page 2)* definition of fieldwork and qualitative methods:

> *"By field work, I mean the use of qualitative methods (interviews, observations, videotaping, interactive analysis) to study the everyday setting and activities of the users environment"*.

By using observations and interviews we intended to get an understanding of the context in which we would evaluate the Hummingbird.

There are some theories about the connection between studying a situation and inflicting change into it *(Easterby-Smith et al., 1991).* When introduced in a situation as a co-worker, observer or something in between, you automatically cause the situation to change. This is one of the fundamentals of action research *(Easterby-Smith et al., 1991)* and action case *(Vidgen and Braa, 1997)* where this is turned into a virtue rather than a problem. We

have taken this into account but we have chosen not to use any of these methods. The reasons for this is that we did not consider our project to be long enough for action research and we wanted to take advantage of the depth we could reach by concentrating on ethnography rather than using a hybrid method such as action case. Still, we were aware of the impact an observer has on a situation.

5.1 Literature review

We have spent considerable time searching for relevant information in the field. We found it necessary to explore what other research had been done in this area. This was done to give us an understanding of the problem area in general.

We have primarily been using the ACM digital library *(ACM homepage)* in the search for relevant papers. The ACM digital library holds journals and proceedings from major conferences in the Computer Science area. The reason for choosing the ACM as a literature resource was that we wanted to be sure of the accuracy of our sources. We were concentrating on finding papers regarding awareness, wearable computers, informal communication, etc. Another fruitful method for finding relevant papers has been to browse the reference list in the papers already written on the subjects Hummingbirds and IPAD's. These two methods resulted in interesting papers concerning Awareness *(Gutwin 1996a, Dourish and Bellotti 1992, Greenberg et al. 1996)* and Ethnography *(Hughes et al. 1994, Blomberg et al. 1993, Hughes et al. 1993)* that we could not have found so easily in another way.

In addition to the methods mentioned above we also looked for relevant literature at the university library. This method was more suitable for finding literature regarding ethnography compared to the other subjects in our interest.

5.2 Ethnographic field studies

Ethnography is originally a research method used within sociology and anthropology, e.g. the study of national communities and foreign cultures. The fundament of ethnography is to reach an understanding of a situation based on observations of how people act. The connection between social sciences and IT in general is becoming very popular. This connection is particularly evident in

the Computer Supported Cooperative Work, CSCW[2] area *(Hughes et al., 1993, Hughes et al., 1994)* where it is important to have an understanding of the groups' dynamics in order to build a support for the group.

One of the criticisms against using this method in system development is that ethnography is too time consuming for this kind of work. When developing a system there is normally a great pressure of time, the system developers are constantly battling against short deadlines. This pressure of time does not fit well with the prolonged ethnographical studies *(Hughes et al., 1994)*. Another criticism is the difficulty of communicating the results of the ethnographic field study to the designers. We were however in a slightly different situation. Our project was not leading to a system design phase but was strictly an evaluation of a prototype and the concept around it. Thus, we did not have to translate the results from ethnography to system design, and although we were under a rather tight schedule we had enough time to make it count as so called "quick and dirty" ethnography *(Hughes et al., 1994)*. This view accepts the impossibility of getting a complete understanding of the setting but settles for a good enough understanding. This means that one can concentrate on the parts of the organisation one is particularly interested in.

The ethnographic method is reaching over a wide area with diverse ways to perform the study. The methods most commonly connected with ethnography are observations and in-depth interviews. These are the methods we have practised during the study.

We have divided our study into two phases. One phase taking part before the actual introduction of the device and the second phase during the testing period itself.

5.2.1 Observations

Observations are an important part of the ethnographic field study. There are several different ways to perform the observation. One is to try to stay invisible to the practitioners, much like a "fly on the wall". Another is to try to become a practitioner oneself working side by side with the observed group. Both the "fly on the wall" approach and the practitioner approach are for different reasons extremely hard to accomplish. Therefore it is more common that the

[2] CSCW is the wide area of designing and developing computer support for collaborating groups.

study is done in a fashion in between these two extremes. It is important for the observer to find a culturally appropriate role that allows him or her to "hang around" observing the situation *(Blomberg et al., 1993)*. If this is not accomplished it is hard to get the inside view of the situation one is after.

Our role in this project was that of participating observers. We have been working together with the group trying to blend in as much as possible. The group was from the beginning informed about the reason for us being there thus knowing that they were being observed. This fact however did not stop the group from accepting us as members of the group. Most group members treated us as "Little helpers" or assistants. Some of the staff was even upset because we "had to work for free".

By observing the group working and interacting one gets a sense of the dynamics in the group. Our goal was to become a part of the group itself in order to receive the best results possible. By understanding the group it gets easier to understand why the group reacts a certain way and this is exactly the kind of understanding we needed in order to draw the right conclusions in the evaluation of the Hummingbird and the IPAD concept.

5.2.2 Interviews

Interviews were used as a complement to the observations we had made. The interviews gave an opportunity to verify the information gathered from our observations. We paid great weight to the information given in the interview situation. Here we had an opportunity to actually hear the participants' point of view.

The interviews took place in both phases of our study. We chose to perform interviews with the three intended key persons in both phases and the rest of the group only in phase two. The first interviews were primarily performed to confirm our observations during phase one. The purpose of the interviews in phase two differed somewhat. Here we tried to find information impossible to gather from the observations. These interviews gave each participant the chance to speak his own mind without any pressure from the work mates.

The interview questions were composed after we had done some hours of observing. We used the observations made to distil the topics we wanted to probe further into. The first set of interview questions we organised into four blocks; organisation, awareness, communication, and coordination. The second set was organised into two blocks; usage of the Hummingbird, and formative questions *(Appendix A)*. The reason to not specify the second sets' questions further was that we did not want to lead the informants to answer the "right way". We have translated the questions from Swedish to English and added these questions as an appendix to this thesis.

6. Theoretical framework

In this chapter we will give the reader an understanding of the theoretical framework we base our discussion upon. These theories are awareness, communication and coordination.

6.1 Awareness

Awareness is a very wide concept and there is a lot of literature on the subject. However we were not interested in all kinds of awareness; we limited ourselves to awareness relevant to cooperation and collaboration. In this section we will introduce the different awareness concepts that we used as a framework for our study. These were collaboration awareness and group awareness. There are many different definitions of awareness and sometimes it seems that each author has his/hers own. Many of these definitions seem to be overlapping and we have thus only chosen to use a few of the concepts we have encountered. We chose the ones we felt were suitable to explain the situation we have studied.

Most papers discussing awareness focus on office work and work situations including a desktop, but awareness is also important in other situations. According to Dourish and Bellotti *(1992, page 107)*

> *"Awareness information is always required to coordinate group activities, whatever the task domain."*

6.1.1 Collaboration awareness

Collaboration awareness is defined as one case of background awareness in which a co-worker is peripherally made aware of the potential for collaboration with a colleague *(Bly, 1997)*. Narine et al *(web site 98-12-30)* discussed the importance of awareness in workgroups. To understand the role awareness plays in collaborative groups Narine et al describe what happens when one co-worker moves to another location. The communication between distant co-workers drops quickly and the reason for this is the weak support for the intent to communicate. There is a lack of *intent stimulus, intent opportunity* and *intent comfort*.

Intent stimulus are the events that stimulate the intent of communication. An example is when you walk down the corridor and see a co-worker available for communication.

Intent opportunity is the probability of making a communication contact once the intent is formulated. In other words it is when you have the opportunity, face-to-face, by phone, via e-mail or any way there might be, to actually engage in conversation with a co-worker.

Intent comfort is the social acceptability of making the communication contact. Co-located people have no trouble with this since they see each other every day in the corridor or lunchroom. For people not in the same location it is harder to know when it is socially acceptable to engage in a conversation.

All the three examples above are a question of awareness. Awareness about who is available and acceptable to talk to at the moment. There is support for preserving this awareness over distance but most of these require extra effort from the co-workers. One example is ICQ where the user has to explicitly tell the others if he is available or not by changing his status.

6.1.2 Group awareness

People who work together maintain awareness of others to help them coordinate activities and to find opportunities to collaborate *(Dourish and Bellotti, 1992)*. This is called group awareness and is part of the glue that allows groups to be more effective than individuals *(Gutwin and Greenberg, 1996, Gutwin et al., 1995)*.

Group awareness can be interpreted as an umbrella term for amongst others *workspace awareness and informal awareness (Gutwin et al., 1996a).*

Workspace awareness applies to situations where the information provided by the shared workspace is used to build awareness of where the others are and what they are doing. Workspace awareness lays its' focus on the role of the workspace in collaborative activity.

Informal awareness can be described as knowledge about who is currently around and what he is doing. Informal awareness is essential to collaborative work *(Gutwin et al., 1996b)*. Informal awareness is built from conversations and overhearing other people talking. This might seem very similar to the above described workspace awareness but the difference lies in the way the information is collected.

6.2 Communication

The Encyclopaedia Britannica *(online, 990505)* defines communication as:

> *"a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior ".*

The communication can be divided into formal or informal communication.

Whittaker, Frohlich and Daly-Jones *(1994)* defines informal communication as the communication taking place synchronously in face-to-face and support a number of different functions: the execution of work-related tasks, coordination of group activity, transmission of office culture, and social functions such as team building. Informal communication is poorly supported by technology. People who are physically co-located are more likely to communicate frequently and informally.

We have made our definition of informal communication a little bit wider than the one stated above. We are in addition including some phone calls, the ones that are unplanned and primarily handling social chat and updates.

Formal communication is when one has a plan for what to say. There is a goal with the conversation and this goal is set before establishing contact.

6.3 Coordination

The Encyclopaedia Britannica *(online, 990505)* defines coordination as:

> *"the harmonious functioning of parts for effective results"*

There is a big selection of definitions of coordination. We have settled for the ones that are limiting themselves to talking about the way people work together to reach a mutual goal. This was the kind of coordination we looked for in our study at the Swedish Exhibition and Congress Centre, in Gothenburg. Below you can read two different definitions from research papers on the subject.

"The goal of coordination is to make components interaction, as derived by there mutually independent activity, result in a coherent behaviour, according to the global system requirements."
(Omicini, 1999, page 175)

" …coordination can be seen as the process of managing dependencies among activities."
(Malone and Crowston, 1994, page 1)

Often there is a complexity in the work situation that is making the coordination difficult. Therefore it might be fruitful to pay some attention to these difficulties and create a support for them.

7. Field study

When starting up our project we very quickly came up with some criteria for the test setting. We wanted to perform this test in an environment where the participants had no former experience of the Hummingbird. The foremost reason for this was that we wanted no interference of preconceived opinions and expectations. We also needed a group of people working in an environment big enough for them to be mobile in, but small enough for us to study.

The choice fell on one of the groups working with the construction of the exhibition cases at SECC, the Swedish Exhibition and Congress Centre, in Gothenburg. We call this group "Monter Service". When starting our study we knew little about the work situation. We knew that the group moved over quite a large area and that they had virtually no computer experience. But this was all the knowledge we had of the situation.

Figure 7.1 Most of the participants of Monter Service having lunch.

We have divided the field study into two phases. *Phase one* in which we were building a picture of the workgroup as a whole and trying to understand the group dynamics. In *phase two* we introduced the device and studied how it was used. We were trying to build as clear a picture as possible of the test groups' opinions.

7.1 Phase one

We started out by spending some time observing the normal work situation. We observed the way the group worked during 53 hours. These 53 hours is the total amount of time the two of us spent there in phase one, and these hours were spread over one week. During this time we focused on the way the group communicated and how the group acquired the collaboration awareness and group awareness they needed.

7.1.1 Awareness

Monter Service has a big workspace. The group works scattered over this space each day. To be able to construct the different exhibition cases they have to move over almost the entire area to the different exhibition halls and the different storage spaces. This makes it hard to maintain an awareness of where other people are. To give an understanding for this complexity we will describe the physical environment for the group.

SECC *(SECC homepage)* is logically divided into several exhibition halls of a total area of 41 000 m^2, from A to K, the I-hall is still to be built. When the storage space of 10 000 m^2 is included there is a total area of 51 000 m^2. Five of the exhibition halls F-K are situated on the second floor *(Figure 7.2)*. This is also the floor where the conference rooms are. The other departments such as the department of economy, sales, personnel administration, etc. are on the upper floors. The other five exhibition halls A to E, the ticket office, Customer Service, the restaurants etc. are located on the entrée floor *(Figure 7.3)*.

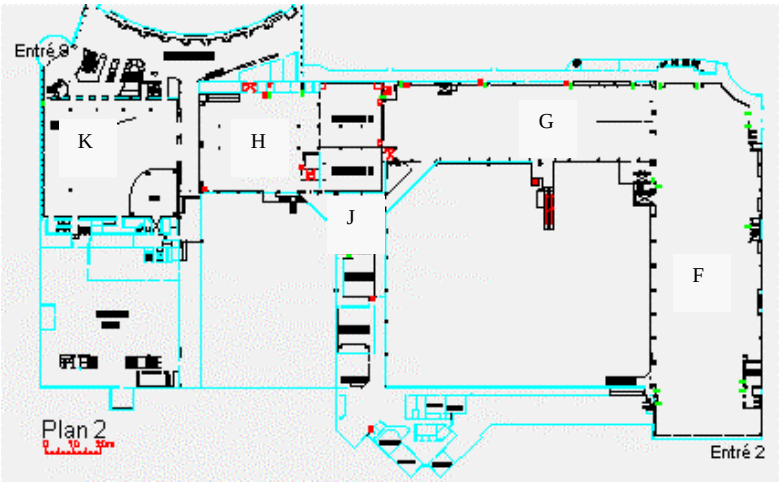

Figure 7.2 A map over SECC in Gothenburg second floor

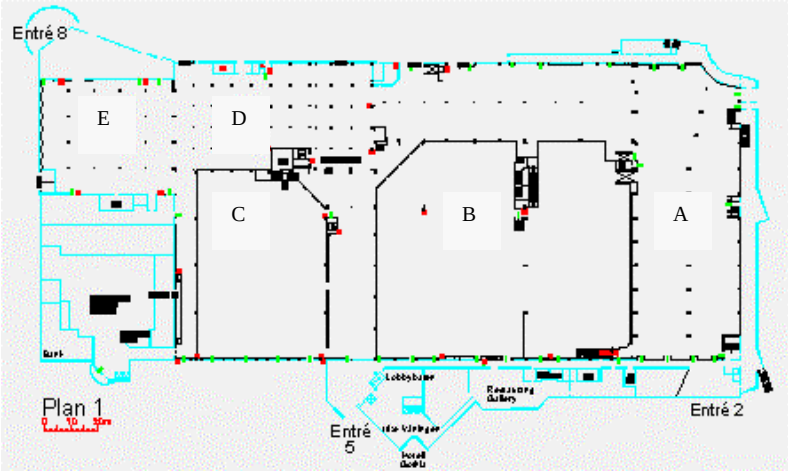

Figure 7.3 A map over SECC in Gothenburg first floor.

In the basement the managers of the different blue-collar working groups have their offices in connection with their departments. The manager of Monter Service, Joshua, has his office beside their storage space, which is called the ALU *(Figure 7.4)*. The ALU is the storage for the aluminium profiles and the wall pieces that most exhibition cases are built of. Almost all the 10 000 m^2 storage space, workshops etc is in the basement. All of the blue-collar workers have the same lunchroom, which is situated in the basement.

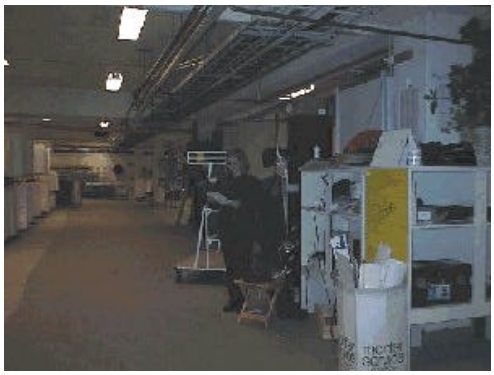

Figure 7.4 The ALU space in the basement.

Awareness is important to Monter Services' work situation. There are often situations when they use the information of where people are at the moment.

One example is when they are getting deliveries, this happens several times a week. The person who ordered the delivery should if possible pick it up. Sometimes this is not possible because of other work tasks that have a higher grade of priority. In such case the manager calls the one he thinks is the closest to the delivery gate to order him to receive the delivery. As the situation is today it is quite hard to make this guess because it could be over an hour since Joshua last saw one of the group members.

7.1.3 Communication

Monter Service communicate a lot. The group members use their phones and make personal contacts, this communication is mostly informal.

The only Information Technology Monter Service has is their phones and a computer, which they use to fill in their time report and for entertainment. All of the permanent employees have phones. These are wireless, phones which can be used both for internal and external phone calls. It is possible to receive calls and make calls. The phones should be carried at all times and are very important to the way the group works. There are no extra phones for the temporary workers to use in the same sense the ordinary staff does but they can use the stationary one in the ALU.

All internal information, between the departments in SECC, is sent via e-mail. The only person who reads the e-mails sent to Monter Service is the manager. He receives all e-mails and distributes the information relevant for the work group. This is mostly done at the group meeting held on Wednesdays every week. At the time of the study this was the only formal communication in Monter Service. The manager of Monter Service is involved in a lot more formal communication than this. Joshua spends most days of the week occupied with administrative tasks and meetings with managers of other departments. He was also the one to manage all the construction work before the group decided to alternate this duty among the workers. This decision was made because the manager and the workers at Monter Service wanted to achieve solidarity and this was a step to make everyone equal, everyone should be able to do everything. Also he did not quite have the time to coordinate the work in a satisfactory way because of the other workload he was coping with.

Most of the contacts between the group members are, as mentioned earlier, informal. We divided the contacts into two different types,

phonecalls and face-to-face. The nature of these contacts can be either *planned* or *unplanned*. The planned contact is, for example, when someone seeks another person. The unplanned contact is when one person bumps into another person not knowing that he was supposed to be there.

We have also noticed three different purposes for establishing contact. These are; *social chat, to locate someone or something* and to *notify the workstatus*.

Social chat is the most common type of communication at Monter Service. The workers talk about their families and what they did last weekend etc. We do not classify the social chat category as work related.

To *locate someone or something* is often work related but not always. It is work related when Joe walks to Chandler to ask if he has seen the ladder, but not work related when Joe calls Joshua to ask where Joshua is and if he will come soon because of their daily workout during the lunch break.

Notifying the work status is always work related. The most common way to do this is to make a phone call to the team leader to get further instructions on which task to do next and how the work is matching the work schedule.

It is common that a conversation includes several types of information. The caller wants to make a phone call to receive information about work status, but in the same conversation he locates the other person which he talks to. This was an example of a phone call that was unplanned. Private chat, work status and the location of someone or something can both be planned or unplanned. Also private chat can be of a planned nature, like when one person in the group wants a break in his work and walks to another group member for a chat. There is not a straight line between the work-related and not work-related communication. Often workers talk about all kinds of private things but in the same conversation they ask what to do or where someone is.

Several times during this week of observations we noticed that they called a colleague just to ask where he was. A few times he was standing just around the corner. A typical way of initiating a conversation is to ask "- where are you?"

When someone needs help with something they call the person they think is the closest. This is of course hard to keep track of when everyone is moving around as much as they do.

In times when there are no fairs going on there are very big open spaces in the exhibition halls. It is almost possible to make visual contact over the whole floor. This makes it possible for the individual workers to see where the group members are located in the exhibition hall. This in turn leads to the possibility to see which group member is the closest to himself and to call for help. When there is a fair going on the visibility shrinks down to as short as a couple of meters because of the showcases.

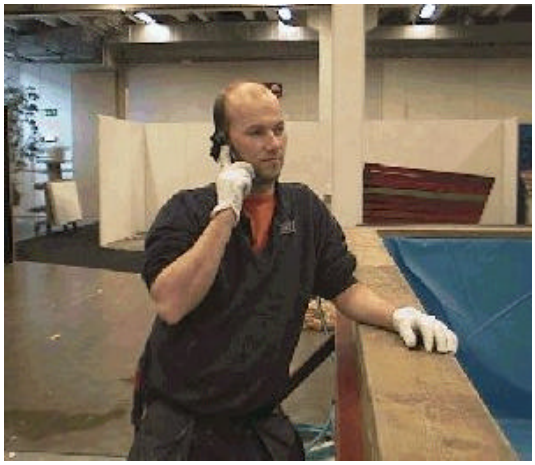

Figure 7.5 One of the members of Monter Service communicates with one of his work mates.

The phone rings very often and when this coincides with the performance of a task the owner has to stop working to answer it. This does not seem to disturb them at all, but we can not assume that it does not disturb the others in the group.

Monter Service does not have a fixed schedule for the day, they take the duties as they come. In the morning, at 6.50 a.m., many of the members of the group gather together in the lunchroom for a cup of coffee. This is not a part of the workday but a rather nice start of the day. They talk about all kinds of things, mostly of a social character but also about the day and what the status of the situation is. Is there a lot left to do or is the construction of the fair almost completed?

When one work task is done they usually call the team leader and get further directions on what to do. This is to make sure that it is

the right task that will be prioritised. The temporary employees that do not have phones either will walk down to the ALU and wait for the team leader to arrive, call him on the stationary phone in the ALU, search for him by foot, or try to figure out what to do on their own. Most of the times the temporary employees work together with a permanent employee. This is for many reasons but the most important one is that it is more efficient to do it this way, less time is spent looking for the group leader or running up and down the stairs just to use the phone.

An observation we made was that the closer a fair was, the more frequent was the client[3] contact. Usually it is the client that takes the initiative to the contact. Most of the times they can receive help from Monter Service. But sometimes it is too big a problem for Monter Service or out of Monter Service's area of responsibility. At these times the clients are sent to the Customer Service, which is always available for the clients.

7.1.4 Coordination

At Monter Service there are nine permanently employed workers - one manager and eight constructors. When there is a big fair going on, Monter Service uses temporary workers, and the group expands from nine to over twenty workers. The temporary workers usually work for a firm of contractors.

Before every fair the group choose a team leader from the group. This duty alternates between the members. Monter Service's motto is that everyone should be able to do any task, and that all of them have the same knowledge and competence.

The groups' tasks are not physically hard but take some concentration and precision. The tasks are not complex enough to demand total concentration though. This is making the social rules of the work situation slightly different from the regular office rules we have encountered in related papers regarding awareness and the other related research areas brought up earlier in the thesis.

The manager together with the group plans the work schedule so that there are fewer people working during slow days and more people working in the busier periods. They call this resource planning. Most of the work group is happy with this and thinks it

[3] The client is the exhibitor or the person that pays for the exhibition case to be built.

works out nice to work harder during some periods of the year and have a lot of time off during the summer which is normally a very slow period of time in this business.

During slow periods, for example when there is an ongoing exhibition, the group manage the storage and the other spaces used. They also take the opportunity to make repair work and other tasks put aside during busier times. At the slow periods there are only two or three workers at Monter Service because of the resource planning.

The main task for the group is to build the exhibition cages from the aluminium profiles and wall pieces with standard measurements. Sometimes there is an order of a custom made exhibition cage but it is usually no more than four or five per exhibition. These custom-made exhibition cases take more time and concentration to build. However most of the members of the group like these occasional breaks from the routine.

One of the most important means of help the group has is their carts on which they stack the building material to transport it from the storage to the halls and vice versa. There are four carts custom made for the exact measurements of the profiles used. During the construction/dismantling of an exhibition or a fair these are most often all in use.

At a table in the ALU lies a map over all halls and all the showcases. Monter Service has a folder where the members keep all the tasks that need to be done, and one folder of tasks that have already been completed. There is a steady flow of documents coming from the fax machine. Often it is new order forms from the clients. These forms should be added to the “to-do folder”. Sometimes it is changes from the original order forms thus these should be replaced in the “to-do folder”. The manager receives these facsimiles and distributes them to the team leader on duty.

Most of the time the group members work in pairs. It is more practical but most of all because it is nicer and more social. The members decide whom they are going to work with when meeting each other in the morning. It is common that there is a change of group constellations during the day. They also work alone sometimes, with simpler tasks and when there is a lot of work to be done in a short time i.e. before the opening of a fair.

All groups at SECC are dependent on each other. The hall needs to be cleaned and a carpet to be placed on the exhibition space before

Monter Service can start construct the exhibition cases. The furniture needs to be placed after construction of the exhibition cases is done. This is to make it possible for Monter Service to get around with their equipment. When everything is done in the right order the work is much easier and more effective.

7.2 Phase two

Our intention was to let the group try the device out for four weeks. We felt this was enough time for them to get used to the technology and to invoke it in their regular work habits.

7.2.1 Introducing the device

Before we could distribute the Hummingbirds we had one problem to solve. The men in the group already had several gadgets to carry around and there was little or no room for more. The only solution possible was to find or make little bags for the Hummingbirds that could be fastened to the belt or hung around the neck.

We were lucky enough that there already was a Game Boy bag/holder on the market and this saved us a lot of sewing. We had to make some adjustments to these bags. First we had to cut out a hole for the display; it would be too tedious for the test group to take the Hummingbird out of the bag every time they wanted to watch the display. Further we cut out holes for the antenna and by putting the Hummingbird “head first” into the bag we also managed to simplify the battery change. It was possible to turn the device on and off without removing the bag. This reduced a few of the most urgent difficulties with the design of the prototype itself.

We now distributed the Hummingbirds in the group and we observed the work and communication for 40 hours while they used the device. These 40 hours were spread over the time of two weeks.

The Hummingbird was introduced to the work group one morning. We explained the device and once again the concept of the IPAD. This was done in a very brief way in order not to disturb the groups’ natural response to the device.

During our observations we did not witness any situations where the Hummingbird was used for any particular reason or when the information from the Hummingbird was initiating any other actions. The interviews gave more in this sense.

A feeling we got was that they were proud of being in the test group. When other people that did not know what the Hummingbird was came up to talk to them, they seemed happy and quite special. At these times they explained with their own words what the Hummingbird was.

In the morning two days after we distributed the Hummingbirds we received a call from the group manager. The range of the Hummingbird was so short that there was no use carrying the device around. We had to try to come up with a solution to the problem very fast. After some testing on the site we decided to bring the Hummingbirds back to the lab. This was a total mystery; we had no idea what had caused the sudden change of range. After a few days of testing we had made changes that, if not restored the former range, at least increased it to an acceptable length. One of the significant changes made was the change from the Color Game Boys to the originally used Game Boys. This resulted in a reduction of the battery durability from seven to two hours, the reason for using the Color Game Boy in the first place. We felt, however, that the range was more important to the test than battery durability.

A few days delayed we once again started the evaluation period. We had to reduce the test group from nine to six persons. This was because of different practical reasons. We had learned some things from the first, short, interrupted test earlier. This time we tried to foresee the problems ahead and kept a few Hummingbirds to use for spare parts in case something went wrong. It later turned out that this was a very good idea. This time the initial reactions were more positive. “Now this thing might even be useful” was one of the early comments. We had no possibility to extend the test to last the extra week we had lost so we settled for a test period of three weeks.

7.2.2 The test group

How many and who?

We had decided to include everyone in the workgroup in the test. This was for several reasons, one was to bring the most benefit possible to the group during the test. As we know from other research for example Grudin *(1994)* the critical mass is very important when it comes to Groupware. The more people using it the more benefits are provided for the users. We had decided to let the test group have some time to get to know the device before we started the second period of observations. This was mainly to give

the group a chance to experiment with the Hummingbird without us hanging around watching over their shoulder. We did not want to interfere with anyone's first encounter with the Hummingbird. Most of the group members had very little or no computer experience and in their eyes we were some sort of experts on the topic. This might feel very intimidating to some test subjects.

To the question posed about the size of the test group the reaction was evidentially that "the more the merrier". Parts of the test group felt that it was bad when the group was reduced from nine to six. One person in the group had not noticed the difference at all. The benefit from the Hummingbird is more evident when the group is bigger. For example one day when many in the group were not there, this was during an exhibition and this is a slow period for Monter Service. The three people from the group being there at this point felt that they had total control over where their mates were and it felt useless to carry the Hummingbird around. In this case the benefit from the Hummingbird was way smaller than the effort to carry the Hummingbird and to make sure it had batteries at all times.

Commitment

The involvement from the test persons varied a lot from person to person. Some asked questions and seemed very anxious while some did not seem to want to use the Hummingbird at all. We believe that this is quite normal and that it gives us the opportunity to become aware of many different aspects of the device. Not everyone is embracing new technology.

In order to find out how consistent the group was in carrying the Hummingbird we asked them if there was any time they deliberately chose not to wear the device. Most of the participants answered that they turned it off and left it on the ground when they were up on great heights and in unaccustomed places. They felt it was in their way and it was another thing to keep track of in a situation when you have enough trouble keeping track of your own limbs. The interesting thing was that Pete who is almost always up in the Genie Boom (a very tall lift with a small basket carrying 1-2 people) didn't feel this insecurity at all. One of the members in the group solved the problem of carrying the Hummingbird whilst in tricky situations in the lift by attaching the device to the rail of the basket with some scotch tape.

The attitudes from the test group members varied from the one thinking it was great fun and with lots of ideas to the most negative individual who thought the whole thing was a waste of time. The positive attitude has been dominated though and the ideas brought to our attention have been numerous. The group also had an attitude towards the test from the beginning that this was mostly a "fun thing" with no real use. This came to pervade the whole study, and made it hard for us to invoke a genuine feeling for the test in the work group.

During the observations we got the feeling that the group was only using the Hummingbird when we were around to watch. During the interviews we discovered that this was not the case. We also observed that one of the test persons, Pete, did not carry his Hummingbird from time to time. We decided to question him on this during the interview. At the question if he at any time deliberately chose not to use the Hummingbird and why, he said that he did not chose not to wear it; he just forgot about it sometimes just as he forgets the phone every now and then.

7.2.3 Awareness

On the direct question whether they had any use of the Hummingbird the majority of the group said *no*. But when we asked about when they had watched the Hummingbird and why they had watched it we started to get some interesting information. The manager described how he watched the Hummingbird when coming down the stairs and thus already knew who was in the ALU at the moment. This awareness was (as described in one of the following sections, 7.2.5 coordination) used to help him. Others talked about how they used it when someone asked about a group members' whereabouts. One said that he used it to see if the manager was around when he needed to talk to him. Mark had another example of how he explicitly used the Hummingbird. This was when he needed help and called someone already in the proximity.

Another example of the way the Hummingbird was used was the "Ross way". He felt he had no real use for the Hummingbird himself but used it only when someone else asked him if he knew if this or that person was around. Another situation where it might be useful according to Ross is when expecting a delivery or during contacts with clients. Ross also adds that he thinks he is the wrong type of person to have a device like this since he is always trying to manage his tasks on his own, and not to put himself in a situation when he needs to call for help.

Most of the test group talked about some time when they had looked at the Hummingbird and the information given was used in the work. But the most visible result we got from the interviews was that the group thought that the prototype was too “weak”. The group wanted better range and more functions in order to find any usability of the Hummingbird.

Figure 7.6 A member of Monter Service using his Hummingbird.

7.2.4 Communication

We could not see a direct impact on the communication. Maybe the situation had been different if the prototype had worked better. We did notice that the group was talking a lot about the Hummingbird though and it was the subject to talk about the first week. So in this aspect it changed the communication and added some new words to the vocabulary of the group. When someone was around not wearing the Hummingbird and the others noticed this they often cracked a joke like: “Hey you’re not HERE!” or “How can you be here when you’re AWAY?”

During the first phase the group realised the importance of formal communication. This caused them to have morning meetings every day. To make everyone arrive on time they have a list where they keep track of who has been tardy. There is no way for us to know whether they reached this conclusion by themselves or if it was our questions during the first interviews that planted the idea.

7.2.5 Coordination

The above mentioned morning meetings were held in order to support the coordination in the group. During the meetings they went through the day in order to give everyone a better sense of what the others would be doing during the day and where to expect them to be.

The manager of the group was more positive to the whole idea of the Hummingbird than the rest of the group. He mentioned during the interview that with the help of the Hummingbird (when it functioned as intended) he could plan ahead in a different way. An example is when he was walking down the stairs to the basement and could check beforehand with his Hummingbird, to see who was down in the basement already. This information was used to immediately call this person over the phone and ask him to do whatever task needed to be done. In this case a conversation to locate someone was replaced by a glance at the Hummingbird.

7.2.6 Problems with the test

During the test we had some technical problems. We changed four Hummingbirds that were broken. Most of the times it was the program that had lost the memory of name and group identity. This was an easy problem to solve, in fact so easy that we taught a few of the group members to do this themselves, but not all of them had the interest to learn this.

Even if the situation described above was not a huge problem it added to the inconsistency in reliability of the Hummingbird that some of the test group members was experiencing. Another fact affecting the reliability was the changing range of the Hummingbird. The range was very short in the basement and longer in the halls. The range depended on too many factors to be easily calculated. The group could never really trust the information they got from the Hummingbird. They did not learn to manage this difference of performance before the test was over.

When asked what they thought of the test in general they immediately had comments on the physical design of the Hummingbird. In the beginning they seemed to think that this was a product test rather than a test of a concept. The remarks of the Hummingbird always came down to two things, the design and size of the device and the range and accuracy of the device. We noticed that it was a problem that the prototype did not work well enough for the group to easily see through the physical device. However, parts of the test group felt less of this problem so we eventually collected enough information for this thesis.

8. Discussion

We have evaluated the Hummingbird in a situation where mobility served as an important factor. The workers moved over a big area while building the exhibitions. The environment was ever changing and most times it was hard to find your way around even if you had worked there for several years. During a normal workday the group was scattered over an area as big as 51 000 m^2 and there was no way to find out who was there and where they were, without calling them over the telephone.

We would like to describe the studied situation as something in between a regular co-located work group and a distributed workgroup. Our studied group was too scattered in their work situation to function as a regular co-located work group but had on the other hand very few of the problems associated with distributed work groups. We intend to draw some parallels between the theories discussed earlier and the situation as it was. By doing this we will clarify the awareness situation of the group as it was at the time of the study and the impact the awareness had on the communication and coordination.

8.1 Awareness

We have used a slightly different angle in our evaluation than the ones discussed in *Mobile Awareness (Falk 1999)*. This was because we wanted to stress the importance of being aware of your work mates with emphasis on work situation something not done before. We believe that the need for awareness depends just as much on the nature of the work and the difficulty to keep track of people as on the familiarity of the surroundings.

There is a lot of research done on the subject awareness and there was almost a bottomless well of literature to search from on this subject. Most of the research is regarding office work and situations tied to a desktop. But as we know from the theoretical framework this is not the only work situation where *collaboration awareness* and *group awareness* are essential *(Dourish and Belotti, 1992)*.

Monter Service got c*ollaboration awareness* through the intent stimulus, which was interesting in this study. An example of intent stimulus in the studied situation was when Ross saw a Genie Boom and instantly thought of Pete probably wondering if they were going to have lunch together. We have noticed that the situation differs

quite a bit from the theoretical framework we have been using. There was basically no strolling down the hall since there was no hall and the area were too big for wandering around hoping to find someone to talk to. But there was always the possibility to meet someone when they were moving from one task to the other. There was also the fact that being contacted via phone was not considered as disturbing. One was not in need for an intent stimulus in the same sense as in office settings since there were no social restrictions for how to use the contacting facilities offered (the phone and face-to-face contacts). The group seemed to be in a constant state of intent comfort there was very seldom a feeling of hesitation to pick up the phone and make a call. There was a definite lack of intent opportunity face-to-face because they are scattered over such a big area, but there was always the phone. Continuing the example above the phone, and the fact that Pete was always carrying his phone, was the intent opportunity. The intent comfort was making sure that Ross makes the call the instant he was triggered by the intent stimuli, seeing the Genie Boom.

An example of workspace awareness from our study was Ross drawing the conclusion that the rest of the workgroup were up in the exhibition halls building exhibition cages because all the carts were gone. These kinds of conclusions were being made all the time. The information needed to make these conclusions was gathered from the surroundings. It was not actively gathered but rather instinctively picked up from the workplace. This is the same phenomenon as in office settings.

The members of the group also got workspace awareness from looking at the task folders over the showcases for the fair. They put their names on the folder representing the showcase, which they worked with. When they used the Hummingbird they were able to make a qualified guess what the others were doing when they saw them on the display and combined this information with the information of the showcase folders and other peripheral information.

We have also described the concept “informal awareness” in the theoretical framework. The informal awareness is the kind of awareness, we have encountered, that we believe is the most suitable to be supported by the Hummingbird. Informal awareness is the knowledge of who is around in general and this knowledge is very hard to achieve in a mobile situation like Monter Services’. We did not see evidence of the Hummingbird explicitly support this. We think this was due to the unpredictability of the device. If the group could have trusted the Hummingbird and its indications they most likely would have experienced the device as a support.

8.2 Communication

We have already stated that we might have influenced the group to start having meetings each morning to outline the work for the day. These meetings can have reduced the need for additional awareness during the day. By informing everyone in the morning about what is going to happen during the day a lot of the uncertainty has been reduced. This was an unexpected twist of the situation.

We do not think that the Hummingbird influenced the amount of time spent communicating nor did it influence the way communication was conducted. But to some extent the Hummingbird influenced the choice of person to communicate with. As described in the example in section 7.2.5 coordination, the manager used the Hummingbird to see who was in the basement and thus probably free to take on a new task. This might also have had an impact on the choice of whom to communicate with. Now he had a smaller choice of people to choose from and this might have made a difference. It is evident that the areas of communication and coordination is very close and often overlap. One has to communicate in order to coordinate.

8.3 Coordination

We have found some coordination dependencies in the situation. A coordination dependency is when the work is dependent on coordination to function. The Hummingbird, when working as intended, might influence some of these dependencies *(Table 8.1).*

Dependency	Way to coordinate	Role of the Hummingbird
Shared Resource	First come/first serve, priority order	None
Task managing	The one nearby and available, The one who first shows up	Easier to see who is nearby.
Building order, dependency from other work groups	Scheduling, synchronisation	None
Deciding work mates, asking for help	The one nearby and available, The one who first shows up	Easier to see who is nearby.

Table 8.1 The Hummingbird support for coordination

This model is based on one of Omicinis (1999) models. We have removed some of the columns not important to our study. To illustrate how the Hummingbird affects the coordination we added the column with the role of the Hummingbird.

It is important here to remember that these are possible scenarios when the Hummingbird is working as intended. We have not actually seen the Hummingbird used in this fashion. But we have, from conversations with the work group and the interviews, drawn the conclusions that they might use the Hummingbird this way if it worked properly. We still do not think that the Hummingbird would serve as a strong support for coordination.

8.4 Difficulties

There were a lot of difficulties with the test. We had the first try when the range was so short that we had to collect the Hummingbirds and take them back to the lab to fix them. This added to the already existing suspicion amongst the group members concerning the device. The expectations before the failure were not great and they did not get any better after we had to interrupt the test.

It was almost impossible to get the test group to see beyond the prototype. At this stage the prototypes and studies are not tests of the actual design, they are tests of how a support for group awareness can help the collaboration and how such a support should be designed *(Norman, 1998).*

One of the biggest problems during the test was the unpredictability of the system. This unpredictability was partly caused by the changing quality in range and partly by the needs for constant battery replacement. The batteries needed changing every two hours, most of the test group constantly forgot to carry extra batteries and changing them.

One of our problems was the critical mass *(Grudin, 1994)*. We had too few participants, especially during the second test when we only had six participants out of a group of nine. Some days during the test there were only two or three participants there and this is way too few for the remaining participants to gain any kind of benefit. Ross, one of the participants said in the interview that he felt that the usability was reduced with the number of users. He felt it was "pointless to use the Hummingbird when there were only three active users".

The sound level of the environment was way too loud for the "calm" sound of the Hummingbird to be heard. This function was thus not working which was a problem since it is one of the major features of the Hummingbird. The sound is meant to work as an indication of how many and if any group members is around. When it is turned off or when it is impossible to hear like in our study, there is only one way to receive information from the Hummingbird and it is to pick it up and look at it.

8.5 Benefits

In this section we will compare the intended benefit from the Hummingbird with the actual benefit received in this test group. We will also compare it with benefits found in other evaluations when relevant.

The Hummingbird is supposed to give the user a sense of who is around. This awareness is then intended to be used in a way that simplifies the coordination of the work or just act as a comforting knowledge. In our test these benefits were hard to find. The test group felt it was more of a fun "thing" than a device to help with the work.

One of the biggest obstacles in the way of getting any benefit out of the Hummingbird was the fact that the test group could not interpret the information given by the Hummingbird. This since the same information meant different things in different situations.

The manager had the greatest need for awareness of the members in the group. He is also the person that seemed to have had the most benefit from the Hummingbird of the test group. The reasons for this might be that he had the general overview of the group and also the responsibility to coordinate the work. The team leaders' need for awareness also differed from that of the other group members in the sense that he seemed to have slightly a greater need, but not as great as the manager.

We have not found the exact same benefits as in the earlier tests. For example, the sensation of having a person close is not there as it was in the Roskilde test and in the ACM conference test. This could to some extent be explained by the fact that the earlier prototypes used in these tests were slightly better in terms of range (even if they were significantly more fragile). Also could the fact that the group partly knew what they were looking for (see section 3.2.1 The Roskilde test) have something to do with this.

8.6 Privacy

Privacy is a very important matter in this context. The test group felt like they wanted the additional information of where the others are, i.e. which exhibition hall the person is in. The knowledge that this or that person is around somewhere was not sufficient in this situation. Constantly giving away the information of your location might be a little bit too much for comfort though. Do I want everyone in my work group to know where I am at all times? There might be a number of answers to this question depending on how precise the information would be and on the different views of privacy that one can hold.

The technology of today has made it possible to store more and more data in information systems. This combined with the fact that the more support one wants from a collaboration system the more information is needed from the users, has increased the risk of inadvertent intrusions on privacy.

There are ways to decrease the feeling of being watched or controlled. One way is to increase the control and feedback of the system to the user *(Bellotti and Sellen, 1993).* Control in this context is to have the knowledge about what information one projects and who can get hold of this information. Feedback about when the information is used and who is using it is also comforting. In the case of the Hummingbird it is easy to get this control and feedback

since everyone receives the same information. We want to stress this point further by comparing this to ICQ where one can choose to be invisible to some users and thus increase the uncertainty of who is able to "see" you at the moment.
We will later discuss the differences between the Hummingbird and the Active Badge. One of these differences is important also in this context, namely the fact that the Active Badge is centralised in the sense that there is only one node in the network that receives information. In a Hummingbird community it is the opposite; here everyone is receiving the information produced by the system in a decentralised way.

8.7 Is there a need?

As the Hummingbird works today Monter Service has other needs that the Hummingbird can not provide. One reason for that was because they had an already existing network between each other. They were having a lot of informal communication. As known from the first phase of our field study the group was co-located even if they were working over a rather large area. Hence the problems found in distributed work situations did not exist here. The group was sharing a common place for facilities such as the lunchroom and office area.

There were also differences in sensitivity for disturbances caused by the nature of the work. The difference between a desktop situation and the situation of Monter Service was amongst others that an interruption was less harmful in the Monter Service environment. The work group was often using the phone to take the "stroll down the hall"; it was easier than actually looking for the person physically since the area was so big. The reason for this being socially acceptable was the fact that the work was not complex enough to demand full concentration and thus a phone call was not too intrusive in the work. An interruption would easily be handled.

8.8 Improving the Hummingbird

Sometimes during the test the group members would ask us for future design and functions, some even gave us their ideas about the Hummingbird. We noticed that they thought about the Hummingbird even when we did not ask them about it. It was positive that they somewhat could see beyond the weakness of the prototype they were testing. There were big variations between the persons in the test group on this matter. Some of the members had a

difficult time understanding the concept of the prototype at all whilst others had a great understanding of this.

We think the following aspects would be worth considering in case of further research.

First of all the size needs to be reduced. It is too heavy to carry around now, especially since the test group has much to carry as it is.

The entire test group felt that the range was too short. They wanted a range at least the double of the tested one, which is approximately 70 m when in an open area. There were also ideas about seeing where in the building the others were working. Some examples were; seeing which of the exhibition halls the person is in, which floor the person is at, or in what direction someone is (like a compass card). At the very least there is a need to know how far away a person is approximately. During the exhibitions there were walls everywhere and there was no way to know if you had a co-worker nearby or if you were alone. Then it would have been of help to be able to see the others on the Hummingbird and how far away they are.

One of the informants thought it was a good idea to wear the Hummingbird as a watch. Others thought this was a bad idea since most of them were not wearing watches in their work, they feel like the watch gets stuck in things and it is not comfortable or safe to wear a watch during this kind of work. Another idea was to integrate the Hummingbird into the telephone. As one informant, Ross, put it:

> *"When you want help, and you look at the Hummingbird, most of the times you are going to call someone on the phone. So it is probably a good idea to put the Hummingbird in the phone. That way you only have one thing to keep track of".*

The reliability of a technical device, even if it is a prototype, is important. The participants were never sure if the Hummingbird worked or not. There were two reasons why the participants did not trust the Hummingbird. First the need for changing batteries every two hours, second the variation in range. Every time the subject of how they thought the Hummingbird could support their work came up they answered something like this:

" If the Hummingbird worked properly we might have some use of it…"

8.9 Better solutions

In this section we will move away from strictly handling the IPAD concept as we formerly have done. Here we try to find other solutions that might fit better in the studied situation by combining different concepts that we have come across in our literature survey.

The results from the interviews showed that the test group felt a need for more details than the Hummingbird provided. They needed to know in which exhibition halls the others currently were. At the very least there was a need for knowing approximately how far away the others was.

In this work situation and in situations such as this it might be better to have a permanent infrastructure such as with the Active Badge but a support of the same type as the Hummingbird where every participant receives the same information. It is the knowledge of *where* the group members are, *not* if they are *close* that give Monter Service the information they want.

In this situation it is obvious that it would be possible to create the infrastructure needed to give this detailed information. The group is moving over a large area, but it is a defined area with clear boundaries. The group is seldom working outside of this space and when they do it is in situations where there is no extra need for awareness support. One example might be the rare times one or two people from the group are sent out to other exhibition centres or fairs to build exhibition cases ordered from and designed by SECC. At these times the "team" sent out is seldom wandering about losing track of one another, they work close to each other.

We think that the IPAD concept is a good solution in situations where there is a need to be able to be 100% mobile i.e. one needs the device to work regardless of where one is, whether in the jungle or in a metropolitan area. In this case it is impossible to rely on an underlying infrastructure.

In a semimobile situation like the one at Monter Service it might be a better idea to let the device have an infrastructure that makes it possible to produce better and more precise information. It is important not to forget one of the other basic ideas with IPADs, namely that all group members receive the same information and

can collect the same benefits from the device. This as opposed to the Active Badge that only gives information to one node in the network of people.

In a situation where people are not mobile at all or move around very little, for example in the regular office setting, it might be suitable with a desktop solution to the problem, for example ICQ or a similar concept. Evidentially, it is also hard to keep track of people in these situations. The problems in this case might be flexible work hours, numerous meetings, and difficulty to know if a person is available to a conversation when he is in his office. We believe that these problems can be solved in a more satisfactory way than with the Hummingbird.

8.10 Possible reformations of the procedure

One thing that disturbed the evaluation was to make the participants see beyond the prototype because it was not good enough. If we would have tested the Hummingbird more before the implementation at Monter Service we might have been able to reduce the uncertainty of the prototype.

We could have made more extensive tests of the performance of the device before we distributed them. The only test we performed before the distribution was of how long the batteries would last and that all the Hummingbirds were able to receive and send signals. We did not take into account that our changing from regular Game Boy to Color Game Boy could have any impact on the range of the device.

One thing we noticed that could have benefited the test was if we would have made the observations in phase two more structured and concentrated in terms of the time spent there. We planned our observations from day to day feeling that the total amount of time was the only thing that counted.

We had, as discussed above, big problems with the batteries. The duration of the batteries was ranging from one and a half hour to two and a half hours. This could have been fixed but we did not have the knowledge nor the time. Now after we have analysed the results from the study we would have put more effort into this matter and maybe let someone take the time to fix this even if it meant that our project would lose one extra week.

9. Conclusions

In this section we will try to summarise the most important findings of this project. We will present the answers to our questions and a few of the ideas brought to us that we found enthralling.

Is the Hummingbird a good tool for supporting awareness in a blue-collar work situation?

It is hard to generalise in this question but we believe that most blue-collar work situations are somewhat similar to the studied situation in the sense that they are not 100% mobile. Added to this we can establish that the culture in a work situation like this has less formal rules of how, when, and why one can engage in a conversation than the traditional office culture. Based on this we will answer *no* on this question, the IPAD in itself is not the most suitable concept to use as an awareness support in this kind of situation.

One reason for this conclusion is that the group asks for more information than the IPAD provides. They want to know *where* the rest of the group members are or at least *how far* away they are. The IPAD is only providing the information *if* the group members are in the proximity. Another reason is that it is possible in this situation to take advantage of the possibilities to build an infrastructure and thus being able to provide the group with the extra functions of the Hummingbird they are asking for.

How would the ideal support for awareness in this blue-collar work situation be constituted?

This is a little bit easier to answer. This is because it does not force us to make any generalisations since it is exclusively concerning the situation we studied.

The first thing the group had opinions on was the size. It needs to be small and not too heavy to carry. One of the suggestions was to integrate the device in the portable telephone. The manager wanted to wear the Hummingbird as a watch but this was not as popular with the rest of the group.

We think that it would be more suitable for this workgroup use a device somewhere between the Active Badge and the Hummingbird. This for the same reason as we answered no to the other question. The participants' need information about where the group members are located instead of if they are in the proximity. The Active Badge part would be the infrastructure that makes it possible to give this information about where one person is located. The Hummingbird part would be the idea that everyone has access to the information provided by carrying the device around.

During our study we have seen evidence of people working more and more networked. This not only in office settings but also in the kind of setting we have studied. With this comes the increased need for technology that supports workers less bound by time and place. In our opinion the development of different technological aids are far behind the development of the social structures. We think that the kinds of concepts, such as the IPAD, are very important for the future development in this area. In the present situation it is not the ideas that are limiting, but the technology itself that is not sufficient for implementing these ideas successfully.

We would like to conclude this thesis with a reflection over the things we have learnt during this project. The work with this thesis has brought us a great understanding of how important the three concepts, awareness, communication and coordination are to group work. We hope that by writing this thesis we can give some of this understanding to the reader.

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