Tailor to Fit It

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Abstract

This paper is a result of research activities within wearable communications carried out at the Ericsson Norway Applied research center in collaboration with the University of Oslo. The research activities are based on the conviction that the user and usability should be in focus. The research is grounded on a field study conducted to investigate a highly mobile activity, namely bike messenger services in Oslo and New York City. Findings from this field study are the motivation behind the component-based terminal presented in this paper. Instead of building a terminal by integrating several terminals into "one", our approach suggests, first, a dissolution of the current terminals into pieces called "basic components", and then reassemble the selected "basic components" to form a customized terminal.

Keywords: Mobility, Contextual inquiry, Communication, Wearables

Introduction

The bicycle is a fairly new invention. The wheel has been around since about 3.500 BC, but until about 150 years ago, nobody had made it possible to move by two wheels in parallel. Some scholars date the bicycle back to the quintessential Renaissance man, Leonardo da Vinci or one of his student's mechanical drawings known as "Codex Atlanticus". However, investigating the copies of the drawings today tells us that the bike did not work (Pridmore and Hurd 1995).

Electronic telecommunication is also a fairly new invention. The telegraph, the telephone and the radio were all invented around the same time period as the bicycle (Pasachoff 1996). Today, electronic telecommunication is used almost everywhere, from homes, from offices – and from other places and in transit. Electronic telecommunication has become ubiquitous (Fisher 1992).

There are very few bikers that use electronic telecommunication devices, but some do indeed depend on the possibility to communicate over distance while biking. Bike messengers and police bike inspectors are two such groups. There are also a growing number of bike commuters that use electronic telecommunication solutions.

The bike messengers investigated in this paper use terminals for electronic communication, like pagers, cellular phones and private mobile radio terminals. The term "terminal", strictly speaking, means a device to terminate some activity or an end point. In communications, a terminal is device that terminates the telecommunications systems. It is obvious that such a definition is net-centric or operator-centric. The network or operator has the main focus in this definition.

However, if the focus is reversed i.e. if the user has the main role then the "terminal" is actually the start of every activity. It is through the terminal that the user comes into contact with the technology, the networks and other people. The terminal hence plays a crucial role in the adaptation of the technology to the user. The less effort the users have to make in accessing services and applications, the more functionality must be integrated in the terminal. The terminal can no longer be a simple device terminating the network but must be an advanced device. The terminal must show both high level of flexibility and high capabilities i.e. offering multiple functions. Ideally, the terminal must be capable of adoption to the user's customs, habits, communication patterns, etc. and melt away or become transparent. It should be transparent to the user in the sense that he can just communicate or use any service without having to be concerned about the presence of the terminal.

Another issue originates from the composition of the terminal. In the early days of telecommunications, there was only the telegraph instrument and the telephone instrument (Pasachoff 1996). There have emerged multiple types of communication terminals, such as: pager, laptop PC, PDA, dealer board terminals, cellular phones etc. When talking about terminals, it is unclear whether it is the telephone alone, or the connected laptop alone or the combination of both. Quite often a user has the need of multiple terminals for different services, e.g. PDAs, cellular phone, pager, radio etc. but wishes to view them as an integrated terminal. In other words, all the terminals although still as separate physical devices, are able to collaborate and act consistently in order to provide the user with a coherent interface. Unfortunately this wish cannot be fulfilled with current solutions. One approach to the mentioned problem adopted by some terminal manufacturers in the construction of recent terminal family such as the Nokia 9000 terminal or the One Touch Com terminal from Alcatel, is in fact the packaging of several terminals into one composite terminal. Such approach succeeds in expanding the functionality of the terminal, but at the same time has some disadvantages. Cumbersome interfaces both in hardware and software is necessary. The degree of flexibility is consequently low. The level of collaboration between different components is also quite restricted since the terminals are meant to work together. Last but not least, such a composite terminal may satisfy the needs of some users but may be considered as unnecessarily complicated for others.

Instead of building a terminal by integrating several terminals into "one", our approach suggests, first, a dissolution of the current terminals into pieces called "basic components", and then reassemble the selected "basic components" to form a customized terminal. In the assemblage of components, the connections and communications between components are, however, not necessarily realized by wire or electronic circuits e.g. I/O bus, but by wireless link. Examples of such wireless links are BlueTooth (Haartsen 1998) or IEEE 802.11. By this way, the assembled components do not form a rigid physical device but constitute a virtual distributed terminal. Such a virtual distributed terminal can become transparent, i.e. unnoticeable and unobtrusive to the user, if each basic component fits well to the human user and they are able to cooperate and synchronize in the delivery of the services.

In order to fit well to the human user, a "basic component" can be small, light and worn by the user but it can also be large and placed at fixed location. The most important requirement is that it does not obstruct the sensory apparatus of the human user, and that the user feels comfortable when interacting with it. Such a "basic component" can also be moved easily.

Before going into the description of the component based terminal in detail, one of the field studies that has informed the design of the component based terminal is presented.

Field study of bike messenger services

The field study, which this paper is based upon, was conducted at bike messenger operations in Oslo and New York City. This field study is part of a suit of field studies conducted to investigate highly communication intensive activities, and highly mobile activities. The other field studies are Bike Police operations and field engineer work (Herstad 1998) and Sports Activities (Redin 1998).

The study has been conducted between 1997 and 1999, and the main method used for the study has been contextual inquiry (Beyer and Holtzblatt 1998) and unstructured interviews. Since the operations in question are conducted in varying contexts, it was necessary to employ a method that enabled the capturing of contextual information. In addition, unstructured interviews have been used to elicit further information pertaining to some of the issues found using the contextual inquiry method. Elements from the Delta method (Carlshamre 1994) have been used for the usability engineering phases of the research. There have been four researchers involved in this study, and 20 contextual inquiry sessions have been conducted. Four different bike messenger operations are investigated, two in Oslo and two in New York City.

The fieldwork has studied the operations of the messenger companies, the services delivered and the different type of users. The main user group that has been studied is the bike messengers, but the dispatch centers has also been studied to get an overall picture of the operations.

The main operations of the bike messenger is to pick up packages at given customer site, transport the package to another customer site, and deliver the package to the customer. In order to do this, there is a complex web of communication networks and terminals to support the bike messengers. The bike messengers are equipped with communication terminals such as:

- Cellular phones for voice communication and messaging by SMS
- Private Mobile Radio (PMR) terminals for access to private radio networks
- Pagers for messaging between the dispatching center and the messengers
- Paper based workflow system on clipboard with pen

In addition to the above mentioned communication terminals, some of the users are confined to use fixed terminals, such as public pay phones or the desktop phones at customer sites.

The contextual inquiry has shed light into the use of the existing communication terminals for this highly mobile activity. The terminals are at all times mounted on the body, both during biking through the city, during walking inside office building, at the pavement etc.

There are five findings from the field study that are relevant for the component-based terminal, and that has implication for the design of the platform for the component based terminal. These findings are grouped into the following areas of concern:

- Component selection and choice
- Differentiation of communication media
- Direct communication and communication at a distance
- Task at hand
- Context variation

Each of these findings is described in more detail in the following sections, and the implications for the component-based terminal is outlined.

Component selection and choice

The user have different preferences when it comes to mounting and wearing the communication equipment on the body, much in the same way as they have different preferences when it comes to type of bike, type of light, type of tires etc. There are identified a set of problems with respect to the wearing aspects of the basic components such as microphones, loudspeakers, displays and so forth. This has implications for the component placement.

The figure below is illustrating a common situation, where the radio is mounted on the bike messenger bag and the cellular phone is mounted in the user belt. The bike messenger is engaged in a telephone conversation with one of his colleagues using his mobile phone in a handsfree fashion while on his bike.

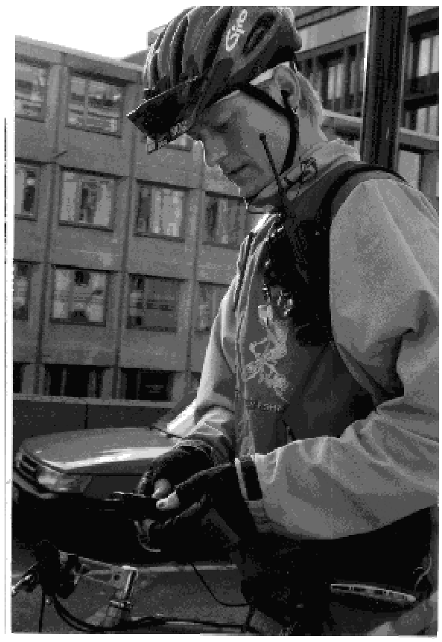

Figure 1. Component placement

The users are tailoring the existing communication equipment to fit their use situation and their individual preferences. During the contextual inquiry, we have observed that the bike messengers are tinkering (Ciborra 1996) with cables, devices and accessories so as the make the communication terminal fit. The users define their own subjective definition of what does indeed fit. One bike messenger may be happy with a solution that someone else of the same overall shape and size would reject. The history of fashion and the difference between cultures make it clear that "fitting" is an interpretation within a particular horizon (Winograd and Flores 1986).

During peak hours, the user has to use the communication terminals both during biking in the streets, and when the user is inside the customer's premises. The mounting of parts of the terminal on the bike is therefore not done, since the need for communication is present also when the user is not with his bike. This points to the need for a flexible choice and placement of on body components.

Differentiation of communication media

The users have miscellaneous preferences when it comes to differentiating the various communication media and communication channels. The main channels for electronic communications are:

- Internal communication between the bike messengers and the dispatch operation users at a distance
- External communication with customers, suppliers etc. at a distance

Internal communication points to the communication that takes place within the Messenger Company, whereas external communication is the communication between the messenger companies and customers outside the company.

Priority between electronic communication channels is done manually and often in an ad hock manner. This is pointing towards requirements when it comes to component configuration.

Direct communication and communication at a distance

The bike messengers operate in their own region. A region may be defined as any place that is bounded to some degree by barriers to perception. Regions vary, of course, in the degree to which they are bounded and according to the media of communication in which the barriers to perception occur. Thus thick glass panels, such as are found in broadcasting control rooms, can isolate a region aurally but not visually, while an office bounded by beaverboard partitions is closed in the opposite ways (Goffman 1971). At the same time as operating in their region, the bike messengers are engaged in electronic teleconversations outside their region.

The switch between "distance communication" and "direct communication" is experienced as challenging for the bike messengers. The mechanism to signal to the environment, which is both the region of operation and the distant party, what kind of communication is at hand differs between the users. This is pointing towards requirements for component placement, component configuration - in addition to new services.

The figure below is showing a common situation, where the bike messenger is talking directly with a customer when he is picking up or delivering a packet - and at the same time the messenger is communicating to the dispatch center at a distance. This is a highly situated action (Suchman 1987), the calls from the dispatch center may arrive while the bike messenger is engaged in a situation with a customer.

Figure 2. Direct communication and communication at a distance

In this situation, the bike messenger has no standard way to indicate to the people in his region that he is engaged in electronic communication over distance.

Task at hand

The task at hand when interacting with the communication terminals while biking is observed as:

- Reading signs and symbols in the environment like street signs, traffic lights, movement of traffic flow etc. used for navigational purposes
- Planning collection and delivery routes
- Communication with the dispatch center for updating job log
- Communication with other messengers for sharing stories and planning activities

This indicates that the users main attention is not directed towards the terminal in use, but to the objects that appear in the environment as a result of the movement of the users. This is pointing towards the usability of the components itself.

The bike messengers share stories or narratives of their work. The stories are about the customers, the dispatch center and the equipment they are using. This sharing of stories is mostly done face to face during lunch breaks and during informal meetings, but also via electronic telecommunication while on the road. As described in (Orr 1996), the narratives that bike messengers share in the triangle of equipment, customers and bike messengers is mainly done by talking.

In the case of a user navigating through the traffic, the basic components have to be unobtrusive, and draw minimal attention from the users. Handsfree operation is a basic requirement, since both hands are used for biking.

Figure 3. User in a traffic situation

During periods when there is little activity, the user is usually stopping while communicating with the dispatch center. This so as to only do one task, that is to receive updates on new delivery missions. However, during high activity periods, it is seen that the messenger does not stop while communicating with the dispatch center. The messenger is then receiving new commissions while biking.

Context variations

The users are operating in varying contexts; like on the road, on the pavement, inside office buildings, in basements, during varying climate, traffic patterns, light conditions, temperature conditions etc.

The observations with respect to the use in different contexts has shown the following about the person using the communication terminals:

- Person cannot see very well (or at all), e.g. delivery is done in the evening
- Person cannot hear very well (or at all), e.g. found in noisy traffic situation
- Person cannot read very well (or at all), e.g. while biking from a pick up site to a delivery site
- Person cannot move their heads or arms very well (or at all), e.g. while biking from a pick up site to a delivery site
- Person cannot speak very well (or at all), e.g. while at he premises of a customer
- Person cannot feel with their fingers very well (or at all), e.g. while it is too cold
- Person cannot remember well (or at all), e.g. while there are more than five pick up and delivery addresses

This is not a result of the communication solution or technology per se, but a direct result of varying context that the bike messengers are operating in. This is pointing towards requirements for component selection, component placement and component configuration.

The next section will describe the proposed component-based terminal.

The component based terminal

The field study described above is pointing to shortcomings of the current communication solutions in use for the bike messengers. Based on these shortcomings, the following three problems are addressed:

- The assemblage of terminal components to fit the user
- The placement of terminal components to fit the user
- The configuration and reconfiguration of terminal components to fit the user

The observed users use different terminals to communicate through a number of different communication networks with a number of different communication services. The discussion to follow about the component-based terminal is on a concept level, and not tied to any specific implementation of terminal/network or client/server configuration such as GSM or DECT.

The three problems are discussed below in more detail. For each problem, there is a scenario that is exemplifying the problem.

The assemblage of terminal components to fit the user

The users observed have different preferences when it comes to which components to use in a communication situation. The selection of the various components is determined by the architecture of the terminal in question, and the user has in most cases no choice in selecting individual components according to his preferences. The selection is done on a per terminal basis, and not on the component level of the terminal.

Assemblage scenario

Contractual workers that do installation, support and inspection of physical objects in the field need to communicate to an in house expert. When the person go on a field mission, he simply pick different components that is needed to do the installation, support or inspection job, much in the same way as he is picking up the tools, programs and other equipment that is needed to do the job. The basic components that are picked up are assembled on the fly to form an efficient and effective communication terminal that is needed for the job in question.

The placement of terminal components to fit the user

The users observed have different preferences when it comes to mounting the equipment on the body, much in the same way as they have different preferences when it comes to mounting and wearing other types of equipment like glasses, shoes, tools etc. There are identified a set of problems with respect to the placement aspects of the basic components such as microphones, loudspeakers, displays and so forth.

Placement scenario

A person is working in the health care sector, mostly out in the field. During the day, he need to use both his hands to do the job, and has to place his communication components on his body, so that these components are not taking the focus away from the task at hand. He is placing a microphone at his vest, a display on his arm, an earpiece in his ear and the on-body hub computer in his belt. During some activities, he needs to place the basic components on other parts of his body and in the environment to do the job in question. He may shift around the components that he is using and place them on other places, so as to optimize his use and interaction with the basic components. In the evening, he is using other basic components, may be less rugged and smaller, that are placed on again other places on his body, according to his preferences.

The configuration and reconfiguration of terminal components to fit the user

The users observed have different preferences when it comes to which terminal components to use in different contexts. This is a result of the introduction of mobile communication terminal. When the user is mobile, and using mobile communication terminals, he is often roaming into areas where there are fixed terminal components. In a situation where a user is switching between mobile communication terminals and fixed communication terminals, there is an inherent problem. There is no general method of roaming between fixed telecommunication terminals and mobile telecommunication terminals.

Configuration scenario

A business user is traveling between offices. He is entering his home office wearing some basic components. At his home office, he has a loudspeaker at his disposition. When he enter into the vicinity of his home office, he may choose to reconfigure his basic components, so that he uses the microphone that he is wearing, and the fixed loudspeaker. This reconfiguration is done, so that the user is using a mix of both on body basic components, and fixed components in the environment.

The solution for the transparent terminal

The design of the component-based terminal is informed from the findings in the field study. In addition, the ideas found in (Norman 1998) has been guiding the design. The borderline issues introduced in (Brown and Duguid 1994) have been used as an analytic device to investigate the use of mobile electronic communication terminals. The latent border resources, which lie beyond what is normally recognized as the canonical artifact as for example a phone, are investigated. These, often unnoticed, resources are often developed over time, as an artifact is integrated into an ongoing practice and stable connections or genres grow up around them (ibid). An example may illustrate this. The cable is today used to interconnect various parts of an electronic communication setup. When the cables are removed from the user and replaced by wireless connections, some of the borderline issues that needs to be understood to inform design is shown, such as security, visibility of connection, mechanical pulling out the plug etc. The various types of mobility described in (Heath and Luff 1998) have been used to guide the design of the on body – off body mobility.

The component-based terminal consists of a set of basic components. These basic components are of two types, that is:

- Effectors
- Sensors

The effector term is used as a generic term for the component that is giving output to the user. The sensor term is used as a generic term for components that is receiving input from the user.

Below are some examples of basic components, classified as effectors and sensors. The classification is done according to the human senses, and not according to the network or services. Note that this classification is not restricting for human users only. The user of the component-based terminal may also be non-human. Examples of effectors are listed below:

- Loudspeaker
- Display
- Buzzer

Examples of sensors are listed below:

- Microphone
- Camera
- Keyboard
- Touch sensitive display overlay
- Sensors for contextual information such as GPS, temperature, blood pressure, etc.

For each basic component, there is a corresponding "component agent". The "component agent" is the name of the program and related data that has responsibility in the system for the basic component. The information that the "component agent" holds is related to the basic component, such as:

- Identity for identification
- Capabilities
- State

- Owner
- Network Access Points (NAP)

For each user, there is a "terminal agent". The "terminal agent" is the name of the program and the corresponding data that has the responsibility in the system for the assemblage and configuration of the different basic components that the user may use, and for the communication to the corresponding network(s). The information that the "terminal agent" holds is related to the basic component, such as:

- User identity
- User preferences/profile
- Network Access Points (NAP)
- List of component agents

With the different parts of the system defined, "effector", "sensor", "component agent", and "terminal agent" the figures below are explaining the high level properties of the component based terminal.

The figure below is illustrating the general hardware architecture of the component-based terminal. The hardware for the terminal is a number of basic components and transmission links between the basic components, and between the basic components and the network. The question if the physical transmission medium is of wireline or wireless type is transparent to the component-based terminal.

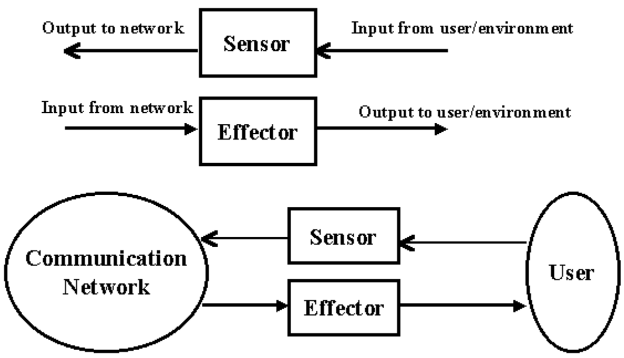

Figure 4. General hardware architecture

The next figure is included to illustrate the general software architecture for the component-based terminal. The two software blocks are the component agent and the terminal agent. These basic software blocks are represented at the terminal side, and in the network itself. The distribution of which functions that are placed at the terminal side, and which is placed at the network side, and which are placed both is transparent to the component-based terminal, and is an issue of implementation concern. Functions like user control, authentication, fault correction, security and so forth are handled by the software entities in question.

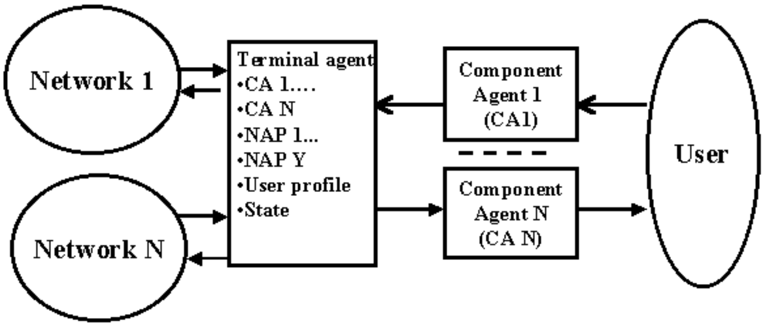

Figure 5. General software architecture

The next figure is illustrating the assemblage of the basic components. The assemblage of basic components is here illustrated with on body components only. Basic components may be added or removed from the user.

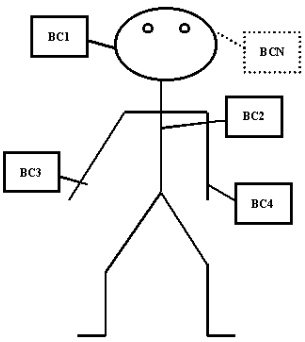

Figure 6. Assemblage case

In the last figure, the situation where the user is using basic components from the environment as well as on the body-mounted components is shown. The shift between on body components and off body components is done dynamically.

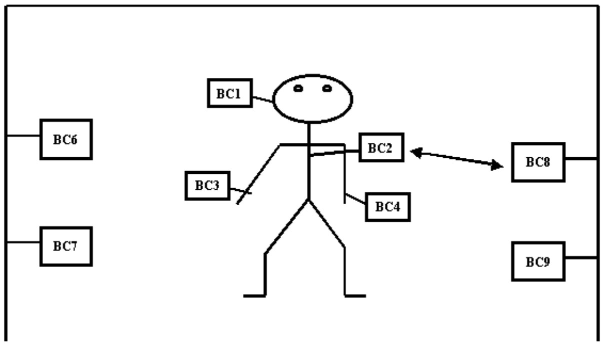

Figure 7. On body components and components in the environment

Advantages of the component based terminal

The component-based terminal is solving the three basic problems of:

- The assemblage of terminal components to fit the user
- The placement of terminal components to fit the user
- The configuration and reconfiguration of terminal components to fit the user

By solving these three problems, there are a number of advantages as seen from the user. These are listed below as:

Flexibility: Higher degree of mobility and flexibility for the user changing on sensors/effector level instead of terminal level according to: availability, location, context and user preferences. The flexibility achieved is an extension of the terminal mobility described in (Thanh 1997).
User attention: The user need not to make effort or notice the terminal when accessing the service or application because he may need to devote full attention to other task such as driving, biking, working at physical objects at hand etc. This is achieved by giving the user freedom to assemble the components and place the components according to the requirements from the situation at hand.
Tailoring: Customization/tailoring to fit individual user preferences when it comes to ergonomics, aesthetics and functionality.
Upgrading and introduction of new media: When new media are introduced, this can be done in a flexible and modular way.
Media selection and change: The user can at own preference select and change the type of media at hand.
Media conversion/translation: Translation between media formats is enabled.
Media collaboration: Collaboration and interworking between the different basic components is enabled.

Conclusion

This paper has introduced a new way of viewing a communication terminal. The field study has informed us about the tinkering that the bike messengers are doing with the on body terminals. The tinkering is done so as to make the various terminals fit the individual user and the use situation. We have discussed the bike messenger field study in this paper, and let the field study inform the design of the component-based terminal.

The component-based terminal is not fully implemented and tested outside the laboratory. Indeed, there is a great need to conduct further research in this field of wearable telecommunications solutions (Crabtree and Rhodes 1998). With the emerging new open standards for wireless communication, prototypes based on the component-based terminal will be implemented and tested outside the laboratory.

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References

Beyer, H., Holzblatt, K. (1998). Contextual Design: Defining customer centered systems. Morgan Kaufman, 1998.

Brown, J., S., Duguid, P. (1994). Borderline Issue Social and material aspects of design, Human Computer Interaction 1994, Volume 9, pp. 3/36.

Carlshamre, P. (1994). A Collaborative Approach to Usability Engineering, Linkoping Studies in Science and Technology, Thesis No. 455, 1994.

Ciborra, C. (1996). Groupware and Teamwork, what does groupware mean for the organization hosting it?, John Wiley and Sons 1996, ISBN 0-471-97064.

Crabtree, I. B., Rhodes, B., J., Wearable computing and the remembrance agent, British Telecom Technology Journal Vol 16, No 3, July 1998.

Fisher, C. S. (1992). America Calling: A social History of the Telephone to 1940, University of California Press, 1992.

Goffman, E. (1971). The presentation of self in everyday life, Penguin books 1971, ISBN 0-14-013571-5.

Haartsen, J. (1998). Bluetooth -The universal radio interface for ad hoc, wireless connectivity, Ericsson Review, No 3, 1998.

Luff, P., Heath, C., (1998) Mobility in Collaboration, CSCW 1998, Seattle Washington USA.

Herstad, J., Olsen, J.O., Koht-Tøfte. E. (1998). Important Aspects of Person Oriented Mobility, the twenty-first Information systems Research seminar In Scandinavia, (IRIS 98) Sæby, Denmark, 1998.

Norman. D.A. (1998). The invisible computer. MIT Press, 1998. ISBN 0-262-14065-9.

Orr, J., E. (1996). Talking about machines, an ethnography of a modern job, Cornell University Press 1996, ISBN 0-8014-8390-5.

Pasachoff, N. (1996). Alexander Graham Bell, Making Connections, Oxford University Press 1996, ISBN0-19-512321-2.

Pridmore, J and Hurd, J. (1995). The American Bicycle, Motorbooks International 1995, ISBN 0-7603-0037-2.

Redin, M. S (1998) Marathon Man, Thesis for the master of engineering in electrical engineering and computer science at Massachusetts Institute of Technology, 1998.

Suchman, L. (1987). Plans and situated action, Cambridge University Press 1987, ISBN 0-521-33739-9.

Thanh, D. v. (1997). Mobility as an Open Distributed Processing Transparency. Thesis for the Doctor Scientiarum degree, Department of Informatics, University of Oslo, 1997.

Winograd, T. and Flores, F. (1986). Understanding Computers and Cognition: A New Foundation for Design, Addison-Wesley 1986, ISBN 0-201-11297-3.