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Communications of the **A**ssociation for **I**nformation **S**ystems

MOBILITY IN-SITE: IMPLEMENTING MOBILE COMPUTING IN A CONSTRUCTION ENTERPRISE

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ABSTRACT

This paper reports on an ongoing case study of a mobile computing pilot project at Sweden's largest construction company, Skanska AB. The company has recognized the potential of a mobile computing platform based on the tablet computer user device for construction site management purposes. A global initiative within the company has started with the aim of improving information management and project communication at production site operations with the use of tablet computers. The paper portrays Skanska's ambition towards the creation of usefulness and benefit of the tablet platform for the mobile workforce in the initial development and implementation process.

Keywords: mobile computing, construction site, production management, tablet computer, usefulness, implementation

1. INTRODUCTION

It is widely known that the construction industry worldwide has problems related to efficiency and productivity as well as quality and risk management in the production operations of construction projects. The profit margins of construction projects are generally a couple of percent of the total production costs and the cost of construction defects and building rework usually comprise a considerable part of these total costs [Josephson and Hammarlund 1999].

In the construction industry much effort has been made to improve processes with the help of Information and Communication Technology (ICT), but the industry has not achieved increased productivity to the same extent as many other business fields. Samuelson [2003] shows that while the utilization of ICT was high in the design phase and in facility management, the use of ICT by contractors and site workers in the production process is surprisingly low. Part of the poor productivity figures in the construction industry could be explained by the fact that the information needs and communication behaviors in the production at the construction sites are not adequately met.

In the past, the ICT needs and demands of production operations in construction have been forgotten, and many of the implemented information systems and ICT tools has certainly not been in line with construction site requirements, or been asked for by production personnel, for that matter. Therefore, the full potential of these systems and technologies have not been utilized. It can also be argued that the appropriate end-user ICT for construction sites has not technically been available previously. The rapid development of mobile and wireless ICT and handheld

computer devices have now enabled new possibilities of portability and on-demand access of information systems and communication tools that the production organization is requesting.

In the continuous search for an improved and more cost-efficient construction process, construction enterprises have recently drawn attention to how the advances in new wireless and mobile ICT can enable an improved information and communication platform for the production environment to create better coordination, collaboration, and exchange of correct construction data. The following paper reports on an ongoing case study of a mobile computing pilot project for construction site operations at the Swedish construction company Skanska AB. The paper describes how the project was initiated within the company and how they have moved forward in their mobile ICT innovation process. As will be shown, this process has been characterized by a strong focus on everyday usefulness of the technology for the mobile workforce, where the development is directly influenced by the intended end users and to a large extent in a trial-and-error fashion. A large part of the following text is based on case study material presented in a recently published licentiate thesis [see Löfgren 2006]. The case study at Skanska was initiated in the late summer of 2005 and will be finished in the end of 2007.

II. THE ISSUES OF ICT IN CONSTRUCTION MANAGEMENT

The production environment of the construction site involves a very tight time schedule with the full attention to planning, coordination, and completion of the building activities. Production managers, construction supervisors, and superintendents are needed on site to coordinate work, do inspections, conduct environment and safety rounds, document and follow up ongoing and completed construction activities. The very same persons also need to be located at their computers inside the site office ordering equipment and building materials, exchanging digital drawings between architects and design engineers, e-mail subcontractors about upcoming work, follow up budget figures and invoices as well as prepare deviation reports on construction work with unsatisfactory result. In addition to this, there are daily production meetings that afterwards need to be transcribed in computer documents and e-mailed to all involved parties.

Construction projects of today are dependent on reliable and updated information through a number of ICT-based business systems, communication tools, and shared storage servers. To solve arisen on-site problems and critical construction issues, there is a need for quick access to necessary information. To solve a site problem, production management personnel have to run back and forth between the construction site and their computers inside the site office. This leads to inefficient use of managerial resources due to that the production management team is occupied at their computers a large part of their working hours. Production managers and construction supervisors experience that they often have to be at two places at the same time; at the site office doing administrative work at their computer as well as being out on the site coordinating work [Löfgren 2006]. Documentation of building activities, production meetings, and various inspections often has to be carried out twice; once when they are actually occurring and then again in a computer document using different templates.

Even though the intentions of the ICT-based business support systems are to improve project communication, they have lead to production managers, construction supervisors, and superintendents experiencing that they are doing the wrong things. For example, whole days are sometimes spent in front of the computer writing protocols from previous meetings. This has resulted in negative effects on management presence and leadership in the production site environment [Löfgren 2006]. Most of the available project-oriented ICT tools are meant for formalized office use. These tools only give modest support to the craftsman-like construction activities and the unpredictable and mobile environment that the site personnel work in. Improving information and communication support for the core activities at construction sites is a strategic challenge for the construction industry to increase efficiency and productivity in the construction process [Samuelson 2003].

III. THE TABLET PROJECT

Skanska AB is Sweden's largest construction company and one of the top-five largest revenue-making building and engineering firms in the world [Engineering News-Record 2006]. In recent years, the company has recognized the issues of information handling and project communication of its on-site production operations. Skanska's interest for mobile computing solutions truly took off at the company's USA based subsidiary, Skanska USA Building, with an individual creative initiative during a construction project at Duke University in North Carolina in 2005.

The Duke University site management staff evaluated their existing building processes in the search for new solutions of deficient handling of construction site work activities. Members of the project team began to investigate ways to improve field construction information by expanding the use of ICT onto the jobsite. In their evaluation, the team found that managing the physically overwhelming quantity of information that is passed to the construction site often generated poor quality of information in the field. As a result, construction personnel were forced to deal with slow problem solution and construction rework. In the search to improve this situation, the project team combined several existing commodity wireless ICT with internally developed software to create tools to provide field-based construction personnel with the same quality of plans and specifications found in the project management office to enable higher distribution speed of information. After the team implemented digital document management tools and practices, software tools were used to wirelessly synchronize the latest plans and specifications with tablet computers used by supervisors in the field. A tablet computer looks like a laptop computer without a keyboard, and is therefore thinner and lighter than a regular portable computer. The main property of the tablet computer is that it consists of a screen with the size of an ordinary sheet of paper on which the user navigates with an electronic pen writing directly on the screen, shown in Figure 1. The project focused on the management of drawings and specifications used on the construction site. The targeted users were field supervisors and how their administration of construction site activities could be improved with the mobile tablet computer platform.

Figure 1. Tablet Computer with Electronic Pen

As new systems and tools expanded, a user champion was identified to support their development. The champion's role at Duke University was loosely defined, but included training, support, and encouragement of the use of the technology by other members of the team. The champion started this process by replacing its own work routines with those possible using the new mobile computing tools. To help carry new ideas to realization, the champion together with the project manager expanded the relationship with a software consultant that initially deployed project Web tools for the Duke University construction project group. This collaborative effort between the developer and the production-management team resulted in improved understanding of the limitations of existing technology and the generation of new tools that were more useful to the construction site environment. As needs of the project evolved, so did the tools

that were designed to meet them. The result was a growing ICT enabled toolset that could replace existing administrative on-site work processes.

In the production management team's own evaluation of the test of the new ICT tools at Duke University, the users experienced improvements in their own personal productivity when equipped with updated project information on tablet computers. With the extra time generated, they were able to respond to a larger amount of issues in more detail to prevent construction rework. Once an issue was identified in the field using the mobile computing system, resolution of the problem by the project management staff avoided many of the traditional obstacles that delay responses including information and material distribution, issue clarity, and redesign and reprinting of drawings. With issues resolved quickly and returned to the field accurately, field staff was able to continue to work unhindered.

The tablet computer document management project at Duke University showed tendencies of improved project performance by increasing issue resolution speed, reducing rework, allowing crews to maintain productivity, and ensuring that construction quality standards were maintained [Löfgren 2006]. When issues were identified in the field, the use of tablet computers enabled supervisors to generate better documentation. Using document annotation software, they could clip a portion of a plan or other document, insert relevant photographs taken with digital or Web cameras, draw sketches, and handwrite explanations. With the presence of a wireless network on site, this information was transmitted directly back to the project management staff for review. The project also identified that with several existing software packages on the tested mobile computing platform, superintendents in the future could develop new administrative routines for digitally handwrite quality control forms, punch lists, daily reports, and safety audit protocols directly on the tablet computer screen.

Figure 2. Tablet Computer Use at Duke University

The tablet computer pilot project at Duke University received attention both within and outside of Skanska. In the fall of 2005, a global mobile computing effort within the company was initiated. A coordinator was appointed to encourage that the tablet computer technology is implemented, used and evaluated in various construction projects at Skanska worldwide. The corporate management team requested that tablet computer tests were to be carried out in various kinds of production operations and building project types.

At Skanska Sweden a tablet computer pilot project was initiated in the fall of 2005 at the construction of a shopping mall in the Stockholm house building region. The Swedish pilot project was set up in a similar fashion as the tests at Duke University, focusing on site management

usage and potential usefulness of the tablet computer device in the production environment. The Swedish pilot project was a collaborative effort between the project-based production organization and the Swedish ICT unit at Skanska's head office, with an appointed user champion in the construction site environment and the pilot coordinator at the ICT unit. The objectives were to identify how the tablet computing platform should be designed and what its benefits could be compared to the current way of working with construction data and project communication on site.

Small-scale tablet computer tests were also initiated in the UK and Norway operations at Skanska. These pilot projects have not been studied further. The rest of this paper will further discuss the mobile computing initiatives at Skanska Sweden and Skanska USA Building.

IV. CASE DISCUSSION

The mobile computing pilot project at Skanska has so far shown three development aspects and process factors that appear to be more distinguishing than others. First of all, the concept of usefulness and what benefits the mobile technology is believed to contribute to is a persistent focal point of the project. Second, a large part of the development and implementation process itself could be characterized as a learning process through trial and error. Third, the input and commitment from key users in this socio-technical learning process is to a large extent the driving force of the pilot project developments. These three main characteristics and their interconnected and reinforcing dynamics will now be further discussed.

USAGE AND USEFULNESS

The tablet computing tests in Sweden have so far had a more cautious approach compared to the pilot project at Skanska USA Building in North Carolina. The Swedish approach has been more in the form of a feasibility study where the tablet devices are put into the hands of construction site management personnel and together with ICT development staff try to figure out how the technology possibly could improve their everyday administrative work in different ways. They did not want to "go live" with the tablet computer platform on site before they had evaluated its usefulness and possible obstacles for adoption and use.

Early on in the Swedish tablet tests it was acknowledged that there were differences in contract forms, project setups, and how general routines for problem resolution and updates of blueprints were handled in Sweden compared to USA within Skanska. These diverse prerequisites result in different potential and application areas for on-site use of tablet computers. While supervising teams in the U.S. appreciate the tablet computer as a tool for handling and updating digital drawings, in Sweden that has a very limited application area due to a completely different way of administrating the blueprint-update process. For Skanska Sweden it is more interesting to be able to use the tablet computer for field-work report forms and online mobile use of various central information systems, such as procurement systems, activity-based project management budget tools, and resource planning systems out on site. Interviews with both ICT developers and the pilot users involved in the Swedish tablet computer project reveal that the increase of mobility and flexibility of these existing information systems is considered as the foundation for creating future benefit of any site-oriented mobile computing platform [Löfgren 2006].

Creating improved on-site management of construction site operations was the starting point of the mobile computing effort at both Duke University as well as the pilot project at Skanska Sweden. The basic idea is that on-site leadership and coordination of project resources can be improved if production management's ICT-based business support is made portable. This concerns changing the current situation of construction management staff being tied up at their computers inside the site office, or running back and forth between their computer desk and the site. But while the tablet computer use at Skanska USA Building were concentrating on the handling of drawings and specifications on site, the focus of the tablet computer project in Sweden has been leaning more toward enabling more effective on-site administration of

construction activities through mobile on-demand access to existing business information systems and construction project administration tools. For example, with wirelessly connected tablet computer the procurement system can be brought up on site and additional equipment and material purchase orders can be placed immediately as they are discovered. It can enable production management staff to be online with activity-based project management budget tools on site when doing inspections and follow-ups of current and completed construction work. Environment and safety rounds, deviation reports and other inspections can be filled out on site directly on the tablet computer in digital forms and templates using the electronic pen and then uploaded on shared project storage areas or e-mailed to the concerned project participants. One interesting usefulness aspect of the tablet computer concept seems to relate to the procedure of working with a pen directly on the tablet computer screen. This appears to be an intuitive user interface because construction management staff is accustomed to using pen and paper on site doing inspections, documentation of activities, and taking notes on purchase orders and other on-site administrative work. With the tablet computer, the idea is that these administrative duties are supposed to be carried out once only, at the time of occurrence. This way of working could also include many of the administrative tasks in the site office. Meeting notes can be taken directly with the electronic pen on the tablet computer. Using the built-in tablet computer text recognition tool, the notes can be translated into an ordinary data text document when the meeting is over, which directly can be distributed via e-mail to project participants. The test users of the Swedish tablet computer project also identified the potential of the combined use of the tablet computer and a digital camera on site. By photographing observed construction problems, the photographs can then immediately be transmitted between the camera and the tablet computer and attached to site inspection reports. The construction issues can be further described using the tablet computer electronic pen to highlight pictures and other parts of the document, before sending it to the project participants concerned. In this way the distribution speed, information quality, and understanding of production issues communicated to involved actors can be enhanced.

At Skanska Sweden computers and ICT systems have been used in the production environment for a long time. Swedish users already have desktop computers with good performance. Therefore, many users feel that they were taking one step back when using the tablet computer. The tablet computer has an overall lower performance compared to the regular desktop PCs, especially when working with several applications at the same time. In contrast, for some of the tablet computer users at Skanska USA Building it was their first professional use of a computer. These users did not have previous experiences of computer use which they could relate to. The use of the tablet computer is therefore an overall positive experience. Another technical obstacle in Sweden regarding the development and extended use of the tablet platform is the lack of handwriting recognition for Swedish language. This function translates text written with the electronic pen on the tablet computer screen into ordinary data text, which is useful for form-based documentation out in the field. The handwriting recognition feature for Swedish language has not yet been released on the tablet operating system platform. The climate condition in Sweden is another barrier for efficient use of the tablet computer, e.g. bad battery time in cold weather and thick clothing during the winter period raise issues how to protect and carry around the computer device without creating extra burden for users. The desire from site management personnel in Sweden to be able to be always online with various information systems out on site also raise great challenges of covering the whole construction site with wireless connectivity.

In the end, the user acceptance and benefit of the technology is a matter of creating everyday usefulness. The use of the ICT should not be conducted at the expense of other activities such as social collaborative processes, work practices, or project management and leadership. Mobile computing tools must be designed in such a way that they fit the existing construction process and work practices, rather than to disrupt them. If the technology does not serve and enhance these processes, it will be considered as an obstructive element for effective construction operations and project delivery. Therefore, the technology has to be intuitive and effortless to use to be able to create the necessary everyday usefulness and acceptance of the intended user. The usefulness perspective comprises the adjustment of a technology to an existing user context. In the Skanska case it is about how mobile computing tools should be designed to improve the

performance and quality of work for construction site operations. In this sense, usefulness can be described as the balance between the formal use, structure, and functions that is embedded in ICT systems technology and the complex fluid and social nature of on-site work practices and collaborative activities.

Usefulness should not be confused with ease of use. Usefulness is not just about where buttons and icons are localized on the screen; it includes both utility and usability aspects and is about making the technology fit the organization, its business activities and specific work routines. This is illustrated in Figure 3. User involvement in the technical development and implementation process is critical for achieving long-term usefulness of mobile computing tools for the mobile workforce out in the field.

Figure 3. Cause and Effects of Usefulness [see e.g. Davis 1989; Nielsen 1993]

IMPLEMENTATION DYNAMICS

The tablet computer project at Skanska has so far shown that the implementation process itself as a key information source for obtaining improved understanding of the interdependent and reinforcing concepts of usefulness and benefit of mobile computing in the construction site environment. Implementation can be considered as the enabling force for communicating and aligning different professional and organizational perspectives of usefulness and benefit. This is important to be able to identify and satisfy diverse needs, demands and objectives for the involved parties in the technological development process. Implementation is often confused with installation, the final stages of putting a system into productive operation, but implementation has a much wider scope that comprises a complete bridge and feedback loop between design and utilization [Fleck 1994]. This definition of the implementation process recognizes the crucial role of the people inside the user organization, its social structures and interactions between individuals and technology. It is a dynamic process of mutual adaptation between the technology and its environment. The adaptation process is necessary because a technology rarely fits perfectly into the user environment. Even though technological uncertainty is reduced by prototyping and refinements, as soon as the technology gets into the hands of the users the complexity will increase again. This complexity consists of technological, social, and organizational misalignments [Leonard-Barton 1988]. These misalignments can be corrected by altering the technology or changing the environment, or both.

The tablet computer test at Duke University started as a bottom-up project where people in the production management team had ideas of how to satisfy the ICT needs in their own job situations. These ideas then eventually reached all the way up to the senior executive team of the Skanska group who encouraged production units across Skanska globally to test and adopt the tablet computer technology.

Even though the tablet computer project has become a global development initiative coordinated from corporate management within Skanska, it tries not to be a project that pushes inefficient technical solutions into the hands of the construction site personnel. Instead, the approach so far has been to listen to the information needs and communication demands of the production environment and trying to translate that to appropriate mobile project communication tools [Löfgren 2006]. The tablet computer project has emphasized the important role of getting the users of the technology involved in the development and implementation process from the beginning. Getting the appointed key user champions and pilot test persons acquainted with the technology and let them explore, figure out, and explain potential usage and application areas of the tablet computer for the development team is a central approach of the project. This integrated socio-technical teamwork process emphasizes the dialogue and collaboration between the proposed construction site users and the ICT staff at Skanska to be able to translate practical on-site communication issues into useful ICT tools that generate improvements. The essential source of information is obtained through the frequently occurring feedback meetings in which both users and technical developers are participating. During these meetings, the key user champions and the other test users can describe how they are using the tablet computer, for what purposes and in what situations. This information can then be used to identify positive and negative effects of specific tablet computer applications and user interfaces as well as the effects of the use of the technology in general in the production setting.

The findings of the Skanska case study have indicated so far that the often-alleged conservative ICT culture at construction sites is somewhat false. Interviews and conversations with construction site personnel show that they are in fact aware of the inefficiencies of information management and project communication at the site operations, and not seldom they have own ideas of how to solve these problems with assistance from technical solutions [Löfgren 2006]. In these discussions handheld computers have often been mentioned and the mobility and flexibility of information and communication systems are of high priority. The key issue of improvement in their point of view is to be able to carry around the needed ICT-enabled business support to access it at any time.

The described way of collaborating and communicating within the tablet computer pilot projects also enables vital mechanisms of shared understanding between production site personnel and the technical development teams. ICT developers will enhance their knowledge of the complexity of introducing the mobile technology in the construction site setting, and may realize that their conceptions of information and communication issues in the production environment as well as the needs and demands of construction site personnel are somewhat simplified, or even incorrect. The construction staff users on the other hand may understand the possibilities of the new technology and develop a positive attitude toward adopting new ICT solutions that are actually improving their work. The users may also be able to better comprehend how the existing ICT based business support systems work, how they are designed, why they are constructed and integrated the way they are, and how and why this determines the possibilities and delimitations for further development of mobile computing extensions.

USER DRIVEN DEVELOPMENT

This way of moving forward in Skanska's tablet computer project is an organizational learning process where the configurational implementation/innovation process is a matter of learning through the struggle to get the technology to fit into its social and organizational context, which can be referred to as a matter of learning by trying [Fleck 1994]. This means that improvements and modifications are made to different technical and organizational components more or less in a trial and error fashion to be able to resolve a configuration that will eventually work as an integrated entity within its user environment. This configuration is the result of substantial user input and effort. From the very beginning of the tablet computer tests Skanska has emphasized getting the users involved in the implementation process. Collaboration, communication and feedback between users and developers are critical to succeed in the acceptance of the technology [Voss 1988]. It is often through the use of technology that various problems arise and

potential opportunities for improvements are noticed. In this innovation process it is regularly the users who observe the bottlenecks of the technology, identify their own needs and can come up with creative solutions to solve the problems [Von Hippel 1988]. This user-oriented innovation process is especially important when introducing and utilizing more complex technical systems such as aircrafts and computing systems. These kinds of systems have a high level of complexity which results in that it takes time to get acquainted with the technology. Therefore, system utilization by the physical users is crucial to achieve technological and organizational fit. This user-driven development process present in Skanska's tablet computer pilot project is often referred to as *learning by using* [Rosenberg 1982].

The Skanska tablet computer project has also illustrated the importance of having innovative and pragmatic key user champions in the operational production context where the mobile technology is implemented and used. The champions play the vital role of being the link between technical development and the targeted user group [Voss 1988]. These people are important to get other users acquainted with the technology and its possibilities. Through the champions a dialog between ICT developers and the proposed users can be established and maintained. This is the primary source of information to collectively be able to find appropriate work routines and discuss areas of utility for the technology, which can then be translated into fitting tools and applications. The construction site workers can provide the invaluable information on how they currently conduct the administration of various construction activities, what the deficiencies of these routines are and how a possible improvement should be designed from their user perspective. Distinct administrative construction activities that suffer from deficiencies can then be identified from this information. Subsequently, the ICT development team will be able to better translate these administrative issues to refined information and communication tools that reduce or eliminate the problems. This hands-on user orientation of the mobile computing implementation process leads to improved technology fit, acceptance and benefit of the system. The user champion role is also important for training the construction site personnel in using the technology and creating understanding for the mobile tablet computing platform as an administrative tool that is helping them in their everyday work. The champion helps bridging the cultural issues and resistance to change that may be present in the construction site work environment.

V. CONCLUDING REFLECTIONS

The mobile computing adoption at Skanska does not involve radical disruptive innovation that contributes to fundamental changes to the corporate ICT platform. Wirelessly connected tablet devices on site only enable new functionality and flexibility of existing fixed communication infrastructure and information systems. This concerns extending, recombining, reorganizing, and integrating existing technology to provide customized project ICT tools for the mobile construction site workforce, with the anticipation of making better use of both technological and organizational resources within the company.

The ongoing case study of the tablet computer pilot project at Skanska has so far shown that active workforce participation in both development and implementation seems to be a central knowledge contributor of how to create usefulness of the mobile technology in everyday construction work. The role of user champions and cross functional project teams appear to be a key functions in bridging the perspectives of technical development and production operation issues to communicate what needs to be accomplished in moving forward in the process.

The mobile computing initiative at Skanska has so far shown four overall patterns of the development process that are interesting for further research and analysis:

1. A *bottom-up technology pull process* where the end users are strongly influencing the technological configuration and its areas of use
2. Authorization and encouragement from top corporate management, including global coordination connecting the pilot projects together for experience sharing

3. A strong *focus on usefulness* and its resulting benefit of the technology for the mobile workforce in the field
4. An overall development process that is more characterized by trial and error than a linear accumulation of incremental improvements. This *learning by trying* development is a social collaborative process in the search of improved understanding of how to get the technology to fit the dynamic and mobile construction work environment.

The recognized problems with information management and project communication at production sites at Skanska and in the construction industry in general could be partially explained by a misleading conception of what *mobility* is and what production site-based *mobile work* involves. ICT systems designed for stationary office use have been pushed out to the production environment, which have resulted in that construction management teams are tied up inside the site offices at their desktop computers a large part of their working hours. The ICT implementation at construction sites during the last 15 years have gradually forced production teams into partially unnatural and ineffective administrative work routines, due to the inflexibility and fixed nature of the ICT systems. But wirelessly extending these business systems to the construction site using certain mobile computing devices will probably not be a sufficient solution of these problems in the long run. A legacy office-based system design will then be forced into a mobile ICT platform that might need an alternative design to better fit the mobile work context. There are differences in how ICT is related to different work types. In office work the computer is often the main tool for performing work, and functions virtually as the workplace itself. In mobile work the main job activities are regularly taking place external of the computer, and often demand high level of visual attention and hands-on execution [Kristoffersen and Ljungberg 1999a]. Therefore, in mobile work environments like construction sites ICT-based systems only play a supportive but important role, if they are designed according to the needs and demands of the mobile workforce.

A part of the design problem of mobile ICT systems is that mobile workforces like construction site personnel are often considered to have a base for their work, e.g. their desk or office. Mobility is often seen as transportation between places of work, e.g. wandering, visiting, traveling [Kristoffersen and Ljungberg 1999b]. The mobility of the workforce is seen in relation to a place, from which workers move away. Designing mobile ICT then becomes to give people the same possibilities in the field as they would have at their bases. But mobility can also be a more fluid form of activity, where there is no such thing as a base. In work types like construction site work the mobility is an important component of the work itself. In these work environments people are mobile as the work activities occur, they are not mobile in order to transport themselves to some place to perform the work. This constant *inbetween-ness* [Weilenmann 2003] is an important part of genuine mobile work. This view on mobility poses new challenges of understanding what mobile ICT is supposed to deliver in terms of usefulness and benefit in its specific job environment, as well as appropriate system design and use of the technology for mobile work contexts.

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