

# Participatory Design and Infrastructures for Coordination and Communication in Interdisciplinary Mobile Health Teams

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## Abstract

*This paper reports on a current project exploring how wireless and mobile technologies, in this case Personal Digital Assistants (PDAs) and Tablet PCs, may be useful in clinical practices. In particular, the support and practices for coordination and communication among members in highly mobile health teams are focused. Their practice can be pictured as just-in-time access to information for coordination of care and treatment related to, but also different from, information traditionally stored in the patients' health records and clinical information systems (CIS). To facilitate discussion among and participation from various stakeholders, and between organizational contexts and responsibilities, we developed four video scenarios. The paper describes how development of these scenarios can be used in an organizational development setting to facilitate analysis and design of tools mindful of the relationships between complex and interwoven infrastructures of communication on one hand and just-in-time aspects of a mobile clinical practice on the other.*

## Keywords

Mobility, wireless devices, video based scenarios, scenario based design, user driven design, interdisciplinary collaboration, organizational learning, work flow, information and communication infrastructure.

## Introduction

Access to information at the point of need and when demanded is an important resource in clinical health care work. Currently, reports of inadequate access to information at the point of care, as well as in the patient-provider encounters, is a significant problem in clinical practice [1, 2, 3, 4, 5]. This state of affairs has contributed to inefficient communication and high demands for interdisciplinary coordination. Therefore, compensatory mechanisms aimed to alleviate the difficulties are common, such as frequent paging, interruptions from phone calls, ad-hoc personal notes, cumbersome, redundant

record keeping as well as heavy reliance on personal or collective memory.

Mobile technologies such as wireless PDAs, tablet PCs and the like, have been suggested and deployed as one of the approaches to allow better and more appropriate access to information [6, 7]. The reported studies most often focus on a single function or one constituency's use, and allow little interdisciplinary communication and coordination.

In this paper we describe the development of video-based scenarios to illustrate how the use of mobile technologies may improve commonly perceived inefficient communication situations. The scenarios are used to facilitate discussion and develop shared understanding of how to use mobile technologies in a clinical setting. This approach initiated discussions at different organizational levels to identify aspects of communication and coordination of work at the individual level as well as at the level of interdisciplinary teams.

The paper is organized as follows: first the case is described, followed by a description of the development and research methods. Two sections on mobility and infrastructures are provided to explain the project focus. Lastly the findings and results are discussed before we conclude the paper.

## The case: A Cancer Assessment and Treatment Unit

The project started as a user driven organizational learning project, initiated by physicians at Department of Otorhinolaryngology, Head & Neck Surgery at the Rikshospitalet University Hospital in Oslo. Bedriftsuniversitetet<sup>1</sup> funded the project, giving researchers at InterMedia the opportunity to work collaboratively with health professionals to address the relationship between mobile technology and organizational learning and development.

This ENT (Ear, Nose and Throat) department is highly specialized, carrying responsibility for care and treatment of patients

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<sup>1</sup> Bedriftsuniversitetet was established to support the University of Oslo, as well as three other higher educational institutions in Norway, in developing further education to adults.

in the in-patient units as well as outpatient clinics. This makes the information sharing and coordination needs intense, complex and also contextually bound. Although they assign responsibility for surgery, some of them are also needed in the operating theatre for peer consultation. Nurses and the staff in the in-patient unit as well as in the out-patient clinic are responsible for coordinating the unit.

Due to the high patient turnover, this case can be regarded as a fairly complex one, with significant challenges and a need for appropriate infrastructure to support and improve coordination and communication. As the providers have different roles and are in different locations, and to a large extent move between the locations, mobile technology may prove to be an efficient tool for improving the information flow.

## Research and Development Methods

This research and development project started January 2003, and this paper reports different aspects of the project.

### Participatory design

The project was user-driven and user-initiated, hence we benefited from a participatory design approach [8, 9] to describe and systematize patterns of communication and coordination, and to discuss and suggest new technology and its use. In particular the users were interested in how wireless and mobile technologies could be introduced and used in their clinical setting.

We set up a multidisciplinary team of health care providers, i.e. MDs and RNs, researchers (i.e. in informatics, sociology, health), and video producers. To facilitate interdisciplinary, common understanding and explore requirements and possibilities, we constructed scenarios to illustrate the complexity of everyday information exchange. Scenarios have a position in the Scandinavian approach to systems development, and are also previously used in health care [10]. In this project we developed the scenarios as short video sequences in order to:

- Contribute to a shared and concrete understanding of the future workflow and communication patterns, and compensate for the current fragmented understanding of the overall work process.
- Create anticipation about the future based on the introduction of a common artifact, and use this as a starting point for discussions and design activities.
- Understand and elicit users' requirements in terms of functionality and user interfaces of mobile terminals, e.g. in the purpose of information systems development.

We discussed how to understand and visualize communication and information flow between providers in different roles and locations. The iterative process to develop the bases for the scenarios revealed and sorted out differences between individual visions and a collective vision. Among the issues we worked with was how to visualize situations that would exemplify and

support mobility, communication and coordination. This included several common daily situations, such as:

- Personal information management to support the individual provider's work, e.g. access to one's patient lists, reference material, clinical guide lines as well as standardized assessment tools,
- Information exchange for coordination and communication within or between groups, e.g. a unit's patient lists; today's admission, in-patient updates (team sheet), schedule for surgery
- Video streaming of diagnostic procedures or surgery for peer evaluation and consultation.

### Developing scenarios

The scenarios were based on discussions with and descriptions given by nurses and physicians, coupled with participant work observation, focusing on the situational, "just-in-time" aspects of communication and coordination. From these discussions and a design workshop to illuminate the participants' visions and views about the project, we selected and described four, daily situations as cases for the scenarios.

The manuscript was developed and refined during a collaborative process. Mimicking and following existing communication patterns and cultures of the health professionals contributed to identify typical situations as cases for the scenarios, and a starting point for development of the scenarios. The manuscript passed back and forth as written text between the health professionals and the researchers, and was discussed at design meetings. The outcome of these iterations was a script with the following four scenarios [11] focusing on a typical day in the not so distant future:

#### *Scenario 1: Up-to-date Common Information Spaces.*

This scenario focused on interdisciplinary collaboration and coordination as part of the morning routine meeting and access to up-dated information about the patients. Three artifacts were introduced in this scenario; a networked Tablet PC, PDAs and a wall mounted electronic white-board. The networked Tablet PC was used to enter decisions about patient care and treatment made in the meeting. The information was entered into an imaginary clinical information system (CIS) (also part of the scenario), and made available on the health providers' PDAs through synchronization. Also, a shared artifact, the wall mounted white-board, was turned into an electronic artifact, being synchronized at all times.

#### *Scenario 2: Just-in-time Communication and Coordination*

This scenario focused on patient initiated communication and coordination needs. PDAs and electronically available calendars were the artifacts in this scenario. Nurses attending to patients' questions and needs could access the physicians' shared calendars to check their availability. In the scenario this was supplemented with instant messaging to exchange information, coordinate and notify each other.

### Scenario 3: Access to Clinical Information Systems

This scenario focused on Just-in-time coordination of resources shared between units at the hospital. PDAs and activity schedules were the artifacts in this scenario. The providers, nurses and physicians, could access updated in-patient lists before seeing the patient. They could also access the operating theater calendar to schedule surgical procedures or learn when a patient was scheduled for surgery, and they could access the lists of scheduled out-patient consultations.

### Scenario 4: Clinical discussions enhanced by Rich Media

This scenario focused on peer advice; situations where a colleague's opinion was deemed necessary to inform or validate suggested judgment. The artifacts introduced in the scenario were streaming media, as a connection between cameras and other media technology at the operating theatres, and mobile devices e.g. wireless PDAs.

## Mobility

The health professional practice is highly mobile. The lessons from the field observation indicate:

- A stationary approach to common information sources such as the operating theatre schedule, the in-patients' schedule, and a manual archive requires nurses and physicians to spend much time moving between places, consulting information sources at specific locations.
- The need for coordination and communication among various health care providers was institutionalized in morning meetings, radiology meetings, operation meetings, treatment plan meetings, pre-round meetings, end-of-shift reports etc. In addition to the institutionalized meetings, ad-hoc, predominately oral information exchange and coordination throughout the workday, was widespread.
- The diagnosis and treatment technology is highly specialized, hence health providers and patients go to and meet at specific locations during the day, and as many health providers are mobile, the need for locating them increases.

These observations demonstrate a need for mobile access to information,. They also highlight the essential role of information for coordination and collaboration in interdependent practices. Mobile technologies carry a potential to support interdependent practices in addition to offer domain specific information and support. Therefore, these observations also point at the need for focusing beyond the individual provider's request for personal information management support.

From the experiences gained in the iterative, participatory process to create the scenarios, adoption, integration and active use of mobile devices seem to be dependent on 1) the users' perception and experiences of "does it work", e.g. usefulness, understandability and affordance of the functionality, 2) organi-

zational aspects, 3) technology and infrastructure, 4) security, privacy and confidentiality

## Information and Communication Infrastructures

During the iterative, participatory process of creating the video scenarios, we became aware of the complexity related to the introduction and use of mobile and wireless devices. We identified three layers or areas of complexity: 1) areas of individual use, e.g. the person's information management, 2) areas of organizational infrastructure use, e.g. logistics and administrative data to support interdependent and collaborative practices and 3) areas of interface to and interaction with the CIS or the Electronic Patient Record (EPR). These different areas and uses for mobile technologies can be illustrated as follows:

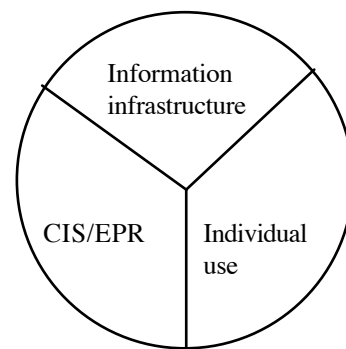


Figure 1: Areas of use for mobile technologies

In particular, we found it necessary to re-conceptualize information and communication infrastructures carefully as a critical step in expanding understandings of the complexities and gain deeper appreciation of the socio-historical character of such infrastructures. In parallel with video scenario development, there is a need for theory building to deepen the insights, in order to move forward regarding design and development of mobile technologies. For this, the theoretical work in socio-historical or cultural historical activity theory and actor-network theory is useful.

For example, Furberg & Berge analyses the potentials of handheld devices in learning situations from the perspective of social-cultural activity theory (and social-cultural theories in the broad sense) [12]. Fjuk and Smørðal apply socio-historical or cultural historical activity theory in discussing how networked computers play 'incorporated roles' in collaborative learning [13]. Generally, there is a movement towards integrating interdisciplinary and multidisciplinary approaches. Sjöberg [14] notes the latter trend:

'With the emerging third generation, activity theory is moving from the starting point with development, history and "zone of proximal development" to also focus on cultural diversity, multivoicedness, dialogue, macro-level networks, networks of activity and boundary crossing'.

Current work in activity theory seeks to combine actor-network theory's emphasis on the development of networks and the power of infrastructures with activity theory's emphasis on artifactual mediation and development of activities and social practices in cultural-historical contexts [15, 16, 17, 18].

Combining theoretical concepts can be helpful in analyzing interrelated networks, heterogeneity, boundary crossings and contradictions. By doing so, it appears that such theoretical work can also inform the role of participatory design in large and complex institutions, such as hospitals.

### **Discussion: The role of scenarios as a mediator of analysis and design across professions and organizational units**

We set out to explore the use of mobile technologies to support coordination and collaboration between health care providers in different roles and locations. In all phases of this project, we experienced both individual and local enthusiasm, and barriers and difficulties at the systemic and organizational level.

The participatory design approach and iterative processes to create scenarios provide a powerful approach and methodology to facilitate discussion and develop shared understanding of how to integrate mobile devices to support collaborative practice in health care. Of special importance to our project, the video scenarios contributed to negotiate idealism and realism.

#### **End-users' responses to the scenarios – does it work?**

The video scenarios were presented to RNs and MDs at the ENT unit. The scenarios facilitated discussions focused around information and communication patterns, addressing individual use of the PDAs and Tablet PCs, as well as their potential support for interdependent and collaborative practices, influences in the provider-patient relationship, potential to enhance learning and professional development and interaction with the clinical information in the EPR system.

The main issues identified in the discussions of mobile technologies as visualized in the scenarios were 1) potential for easier information sharing and more timely communication among the providers, 2) easier access to updated information about the patient's progress, care and treatment, 3) quality improvements, e.g. documentation of decisions currently shared orally, and easier peer-consultation for learning and professional development.

The benefits seemed obvious to both RNs and MDs. At the same time they were concerned about how easy or difficult this new technology would be to adopt to, and how the patients would react to the increased use of technology in their environment.

These issues are still under discussion, and may give important direction to understanding the possible future conflict between the predominantly oral information and communication observed in the team of providers, and the introduced artifacts'

embedded requirements for digitally written and stored communication.

### **Organizational acceptance**

The video scenarios have potentially a larger organizational use. In this project they acted as a catalyst to identify significant issues related to 1) future use of mobile technologies to support communication and coordination of work, and 2) privacy and confidentiality when accessing and communicating patient related information for scheduling or practical follow up in wireless networks.

Inadequate access to information represents a significant problem, and can cause errors or adverse events in patient care [1]. In our project, the video-scenarios played an important role to facilitate discussion and develop shared understanding of the work to be supported. They also set focus on the question of how to design an infrastructure for communication and coordination in mobile teams. At the same time, potentially inadequate security solutions can be a threat to confidentiality and patient safety. So far, wireless networks do not satisfy the demand for secure transmission of patient data. This must be solved before hospitals can fully benefit from the qualities of mobile technology in their everyday work.

It is an institutional challenge that mobile technology and wireless networks currently represent threats to confidentiality and privacy of patient specific information. The scenarios will be used to facilitate processes of reflection, and discussions of how improve current communication patterns to prepare for future use of mobile technologies in the clinical setting.

### **Conclusions**

We set out to explore the use of mobile technologies to support health care providers in different roles and locations. Use-cases and scenarios provided a powerful approach and methodology to facilitate discussion and develop shared understanding of how to integrate mobile devices to support coordination and collaboration in health care practice. Of special importance to our project, the video scenarios contributed to negotiate idealism and realism.

Design should not only be concerned with creating a standardized and possibly closed information- and communication environment which is mediated by PDAs or tablet PCs. Existing information sources and communication means already implemented and used should be integrated, mimicked and utilized. This implies finding ways to relate and align multiple activity systems.

The use of video scenarios enabled sharing visions between individual providers and organizational practices, layers and units. To summarize, the results from this part of the project are:

- Awareness in the project group about the role of infrastructure, both technical and organizational, in the development of new work practices involving mobile technology.

- Awareness that the development shifted from the initial individual focus, to collective and collaborative aspects, and finally to infrastructural aspects.
- Awareness of barriers and triggers of infrastructure development that need continuous attention.

The larger organizational context as the scene for future scenarios is rather new. This is an aspect we want to focus on in future research to better understand the context of individual use, support for collaborative practices, and use related to the infrastructures involved, e.g. clinical information systems or EPR systems.

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