

# User-centered design of ERCP teleguidance

Oscar FRYKHOLM<sup>a,1</sup>, Hedvig AMINOFF<sup>a,b</sup>, Kristina GROTH<sup>a,b</sup>, Urban ARNELO<sup>a</sup>

<sup>a</sup>*Karolinska University Hospital*

<sup>b</sup>*The Royal Institute of Technology*

**Abstract.** We are designing a novel telemedicine service, where an experienced endoscopist at a central site can guide endoscopists at remote hospitals during procedures (mainly ERCP). This can be done simultaneously to several hospitals at once, using several displays in a control room setting. As this is a new way of working, we design the teleguidance room at the same time as we learn about user needs. We have conducted field studies and created scenarios to gain knowledge about the usage context and target groups, and we have used mock-ups and high-fidelity prototypes to evaluate the usage situations. The user-centered design activities have helped to articulate user needs, surface technical difficulties, iterate design solutions, create a shared understanding of the telemedicine service within the project team, and prepare for implementation in clinical work.

**Keywords.** User-centered design, teleguidance, telemedicine, ERCP

## 1. Introduction

A number of Sweden's most experienced endoscopists work at the Karolinska University Hospital, treating both patients from within the Stockholm region as well as conducting more complicated surgeries on patients from other parts of the country. Today, videoconference (VC) technology and infrastructure are readily available and can be used to offer the endoscopists' expertise at other hospitals without physically being there. Teleguidance emerged as a solution to the fact that at about half of the Swedish hospitals, adequate numbers of endoscopic retrograde cholangiopancreatography (ERCP) procedures and frequency per physician is less than what is internationally recommended for acquiring and maintaining proficiency. In a proof-of-concept study, it has been shown that the use of teleguidance in ERCP leads to an increased amount of successful procedures at the local hospital [1].

Karolinska is now in the process of scaling up the teleguidance service to several hospitals in Sweden. This means that an experienced endoscopist at the central site will be able to guide ERCP procedures at several remote sites simultaneously. This has led to the decision to design a dedicated ERCP teleguidance room with multiple VC systems, and to explore behavioural aspects of this new way of working. Here, we describe how we apply user-centered methods to design the teleguidance room, and the importance of clinicians and designers working together to explore user needs and design solutions. A prototype of the teleguidance room is currently equipped with three separate VC systems, each of which receives audio and video streams (endoscopy

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<sup>1</sup> Corresponding Author, oscar.frykholm@karolinska.se.

camera, x-ray images and room camera), and transmits audio and video to the remote site.

## 2. Background

There are structured approaches to conducting user-centered design, where the ISO definition of “Human-centered design for interactive systems” is a fundamental resource [2]. It outlines four overall user-centered design activities: 1) Understanding and specifying the context of use; 2) Specifying the user requirements; 3) Producing design solutions; 4) Evaluating the design.

As both designers and researchers, we follow an approach of action design research, which recognizes “the inseparable and interwoven activities of building the artifact, intervening in the organization, and evaluating it concurrently” [3]. Working in healthcare, we have previously reported on mutual advantages of user-centered design activities [4], experiences from working in that complex context [5], and the importance of maintaining long-term collaboration between with healthcare personnel [6]. The usefulness of prototyping has been shown to facilitate organizational development and change, specifically by making early stage ideas tangible, accelerating learning through “quick and dirty” prototypes, and exploring new behaviors that arise [7].

## 3. Design activities

Before implementing the new telemedicine service in clinical work, we need to make sure that it will actually work as intended and is beneficial for the patient, the remote operating endoscopist, and the guiding endoscopist. To ensure that organizational goals and user needs receive a prominent position in the system development, we work according to the standard for human-centered design for interactive systems [2]. The design activities described below are a product of this design approach.

**Field studies:** We have conducted extensive fieldwork by observing and interviewing healthcare personnel (including physicians, nurses, administrative and technical support staff) at the ERCP clinic at Karolinska and at remote hospitals. The fieldwork has given the designers a deep understanding of the different contexts, resulting in preliminary specifications of the teleguidance solutions, and production of user-centered material (personas, scenarios, experience and effect maps) [8].

**Paper prototyping:** To further understand user needs, a group of final-year MSc. students conducted a design project where they explored different design solutions using paper mock-ups together with three experienced endoscopists (see figure 1). Results from the prototype evaluations show that the guiding endoscopists have needs and requests beyond the current technology solution available in the guidance room.



**Figure 1.** Three mock-ups of screen layouts (the one to the left was preferred by the guiding endoscopists).

One large display in the middle is used to show video and images from one hospital at a time (i.e. the hospital in focus). The other hospitals are shown on smaller (vertical) displays on both sides of the main display. On the side displays, the guiding endoscopist can still monitor the ongoing procedures, and bring them to focus on the main display.



**Figure 2.** (Partial) scenario of a typical teleguidance work-day.

**Realistic simulation:** To learn more about the practical and cognitive needs during simultaneous teleguidance, we set up a semi-realistic test situation in the prototype teleguidance room. The evaluation was prepared using a timeline scenario of a typical work-day of teleguidance (see figure 2), and the endoscopist was to simultaneously guide three procedures (one on each VC system). The intention was to create a heightened situation with a certain stress level. The procedures were not real, as we connected from three offices in the hospital. They did however have a certain fidelity, as we sent (previously recorded) video of the endoscope and x-ray, and the room camera. This way, we wanted the experienced endoscopist to, in a realistic manner, interact with the three systems and “hospitals” at the same time (see figure 3).



**Figure 3.** The experienced endoscopist simultaneously guiding three “procedures”.

A detailed script had been prepared on the basis of the scenario. The test participants in the offices were instructed to demand the experienced endoscopist’s attention on four occasions: 1) when starting the connection and making sure that sound and imagery are satisfactory, 2) prompting the experienced endoscopist that they are close to the critical step and will require guidance, 3) calling for urgent attention, and 4) concluding the procedure and ending the call. The total test, from first call to end of last call, lasted about 45 minutes and was video-recorded. The whole test situation was concluded with a discussion between the test leaders and the experienced endoscopist. During this test, technical support staff was invited to observe the simulated teleguidance, to get an understanding of how the technology will be used.

#### 4. Results

The different design activities have served different needs of learning about the usage context and user requirements.

**Field studies**, including observations and interviews, were invaluable for learning about the context and target group. The user-centered material was used to communicate results from the field studies within the project team. This is especially important in healthcare development projects, where it is difficult to gain access to users.

**Prototypes** and mock-ups were efficient means of testing design solutions, where ideas could easily be modified, rejected and enhanced. They also served as ways of getting the stakeholders to think “out-of-the-box” and not be limited by existing technology and routines. The unconstrained design thinking that the students brought to the project helped surface important design considerations, such as size of displays, layout of video streams, and using a smaller display to interact with the larger displays.

**The realistic evaluation** was used to broaden the scope and understanding of the teleguidance solution, and to some extent evaluate interaction with the VC systems. Results from the evaluation can be categorized as pertaining to technology/hardware (e.g. the use of individual VC systems not developed for simultaneous use), interaction (e.g. layout and size of different videos on a display, and noticing attention from remote site), patient safety (e.g. identification of patient and hospital) and organization (e.g. the timing of when sites connect).

#### 5. Discussion

The teleguidance design project exists in a complex context, regarding for instance: ensuring patient safety and benefit, involvement of several important stakeholders (physicians, nurses, administrative and technical support staff, as well as managers, legal and economic expertise), advanced technology to be used in a control room setting, and issues of responsibility and compensation.

The complexity of the teleguidance itself and the project setting demands a multilevel approach to the development and assessment of new methods. This has been done through field studies, prototypes and user tests. As we refine the prototype, based on results from the evaluations, we will move closer to more realistic testing, and a final design of the guidance room. The user-centered design activities have acted as a catalyst for ideas and solutions, and have been a good way to:

- explore and understand user needs and usage context in early stages,
- discover potential risks and unexpected effects of this new way of working,
- involve all stakeholders in the project and create a shared understanding.

The project may at the beginning have appeared to be straight-forward, but it developed into something quite complex that needs careful design attention involving different competencies. Results from our design activities show that the scope is larger and that several stakeholders need to be involved in order to make it a complete service concerning both technical and interaction related matters. User involvement and an iterative design approach have helped surface these complexities. We are confident that, with time and iterations, all stakeholders will share an understanding of the ERCP teleguidance service, which will help procuring and integrating it in clinical processes, and assuring long-term acceptance and diffusion of teleguidance.

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