Hopper's Home and Hopper's Hospital – Usability Laboratories for Home Care

Jakob E. Bardram and Simon B. Larsen
Centre for Pervasive Healthcare
Department of Computer Science, University of Aarhus
Aabogade 34, 8200 Aarhus N, Denmark
{bardram,simonbl}@daimi.au.dk

ABSTRACT

Usability labs have become a widespread tool in HCI research and practice, used in the design and evaluation of interactive computer systems. However, when designing pervasive computing applications for home health care, the traditional lab seems insufficient, because it cannot take into account the close cooperation over distance between health professionals and the patient. In this paper we present the approach taken at the Centre for Pervasive Healthcare, where two labs located opposite each other provide the opportunity to simulate 'both ends of the line' in tele-medicine applications.

Keywords

Usability Labs, Home Care, Pervasive Healthcare, Participatory Design, HCI

1. INTRODUCTION

The use of usability laboratories in the design of interactive computer applications has been commonplace in the field of Human-Computer Interaction for more than a decade now. A substantial body of knowledge of the set up and use of such labs for the purpose of designing and evaluating desktop-based computer applications have be achieved and the use of such labs are common for most software companies creating interactive software. Because much HCI research takes an outset in cognitive psychology, the prototypical design of such usability labs resembles the labs used in cognitive psychology. Hence, one 'test subject' (a user) is placed in a controlled environment in front of a single computer and is intensively monitored via video cameras, computer logs, eye tracing, etc.

With the introduction of the principles of pervasive or ubiquitous computing [4], these assumptions of one person using one computer in a controlled environment are no longer valid. The one-to-one relationship between man and computer is replaced by a many-to-many relationship – one person is using several computers and the same computer is used by many users – and computers are no longer personal devices used in solitude, but social devices used for cooperation, coordination, communication, social games, instant messaging, etc. Thus, a 'traditional' usability lab seems inadequate for the design and evaluation of pervasive computer technology.

Moving further, the use of pervasive computing in healthcare – pervasive healthcare – in home care sets up additional challenges to the usability lab setup. When designing pervasive computing technology for home care it is necessary to take into consideration that the technology is used by elderly, potentially disabled (physically as well as cognitive) persons with no flair for technology at all. Furthermore, the whole idea in home care is to use technology to facilitate a social or collaborative environment between a patient (or citizen in general) and his or her GP, a hospital's outpatient clinic, relatives, or peers. Finally, most patients' homes are not what one could characterize as a 'controlled environment' – on the contrary. Hence, in the case of devising technologies for use in home care one could question the ecological validity of a traditional usability lab.

We therefore argue that the design of pervasive computing technologies for home care on the one hand puts up several challenges for the use of 'traditional' usability labs, and it would be fair to question the benefit of using such a lab in the design of home care technologies. On the other hand, the use of labs have proved very valuable, because they can highlight and focus on usability and design problems before the technology is put into production. Especially if these problems can be discovered in an early stage of the development cycle. The question then is how we can create usability labs which are better suited for the design of home care technologies. This position paper presents the approach taken at the 'Centre for Pervasive Healthcare' at the University of Aarhus.

2. HOME CARE USABILITY LABS

Figure 1 illustrates the layout of the home care labs. They are located in a building on campus named after the computer scientist and mathematician Grace Hopper, thus the names Hopper's Home and Hopper's Hospital. The labs are designed according to a few basic principles: (i) focus on design rather than evaluation, (ii) focus on cooperation in

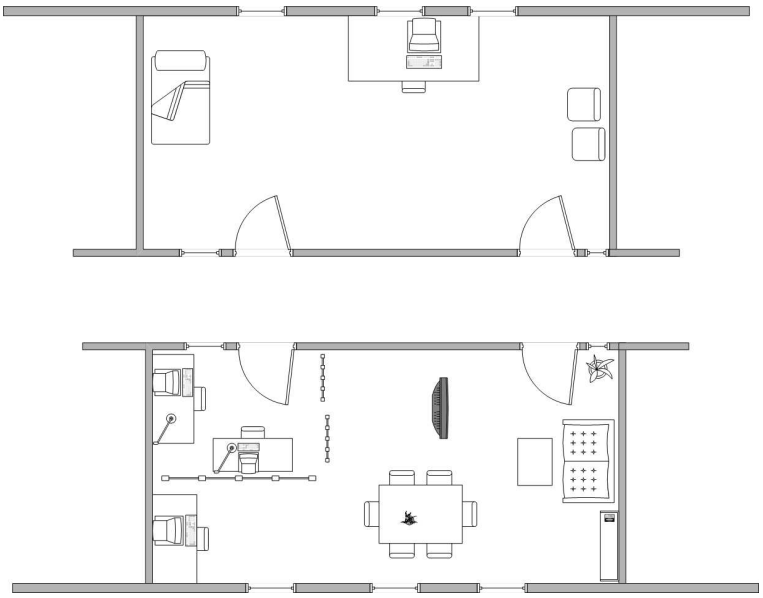

Figure 1: The layout of the home care labs at the Centre for Pervasive Healthcare at the University of Aarhus. The labs are actually two labs in close proximity to each other, one used as the patient's home (Hopper's Home) and the other used for clinical purposes, e.g. as a GP's office, a hospital ward, or an out-patient clinic (Hopper's Hospital).

home care, (iii) flexible staging, and (iv) focus on ad hoc technologies. Let us consider these principles in greater detail.

2.1 Design vs. Evaluation

It is the intention to use our labs as early in the design process of a new home care technology as possible. There are obvious reasons for trying to have users evaluate and use a home care product before too much efforts are invested in product design, development, and production. The labs are designed to be used in cooperative and participatory design sessions (c.f. [1, 3]), which emphasizes the use of mock-ups and simple prototypes (see also section 2.4 below) in scenario-based design. Emphasis is also on the cooperation between users, developers, and other participants like medical staff and research physicians in the case of home care technologies. Hence, in our lab there is no one-way mirror separation between a user using the system and the developers and usability experts evaluating the user's use of the system. All participants are located together and each take part in the role-playing of the scenarios used during the different design sessions. Furthermore, we seldom use fixed cameras but use only one hand-held camera, which follows 'the play'.

2.2 Cooperation in Home Care

An absolutely crucial aspect of home care technologies is their cooperative or social nature. It makes little sense to design and evaluate home care technology for e.g. heart monitoring without being able to take into account what goes on 'at the other end of the line'. The physical layout of our lab resembles an effort to be able to design and evaluate the cooperative aspects of home care technologies. As illustrated in figure 1, the home care lab is made up of two separate labs located opposite each other, just separated by a small hallway. The home lab (Hopper's Home) is used for activities taking place at the patient's home, like setting up the equipment, calling the GP, measuring heart rhythm, sleeping, etc. The clinical lab (Hopper's Hospital) is used for clinical purposes and can be equipped (see section 2.3) to be a GP's consultation, a hospital ward, an operating room, and out-patient clinic, a call centre, etc. The proximity of these two labs is intentional because it enables a lively debate across the hallway of good and bad design suggestions, it enables people to easily walk over to each other with e.g. post-its notes resembling messages, and it enables the people responsible for the design session to have an overview of what is going on at two separate places simultaneously. At the same time, the setup allows for complete separation of the two locations by just closing the two doors, thereby evaluating e.g. the use of video-conferencing between a patient and his or her GP.

2.3 Flexible Staging

The home care lab is designed to stage a number of pervasive healthcare design sessions and projects. The lab is therefore designed as a 'theatre scene' which can be equipped with appropriate props and pieces of scenery for various scenes in different 'plays'. The intention is to acquire proper scenery for the different projects, which are going to use the lab. Currently, Hopper's Home is equipped as a home for young people (age 20-35) with furniture from Ikea. We also have props and scenery for an elderly patient's home nearby. Hopper's Hopital is currently equiped as a GP's office, and we are acquiring medical equipment for a hospital ward and an operating room. The whole idea is to be able to change the scene in a flexible way, thereby enbling several types of technologies to be designed and evaluated in scenario-based

role-playing sessions.

Furthermore, in contrast to many 'future home' labs, like the AwareHome [2] or the In-Haus at the Fraunhofer Institute, Duisburg[1], we deliberately think of our labs as a workshop. We have bought cheap Ikea and second-hand furnitures for Hopper's Home and we use old, discarded hospital equipment in Hopper's Hospital. This encourages designers and students to embed technology in the materials available in the labs by just cutting up e.g. the Ikea sofa to install pressure sensors.

2.4 Ad Hoc Technologies

There is very little technology available in our labs. We try to introduce technology ad hoc, i.e. by having only technologies in the labs, which are usually found in peoples homes. This, of course, varies, especially between young and old people and we adjust the technology to this. This is also in contrast to many 'future home' labs, which are pre-equipped with the most advanced high-tech equipment available on the market or in the research labs. Testing new technology under such circumstances does not resemble the real-world of many users of home care technology. This, however, does not imply that we do not try to design and create visions and technology for the future – on the contrary. It means that we try to introduce our visions for new technology for the users as we engage in a series of cooperative design sessions. Hence, users seldom meet a pre-equipped lab with lots of technology, but they help to design, install, and evaluate such technology themselves.

3. A CASE – TELEMEDICAL MEASUREMENT OF BLOOD PRESSURE AT HOME

This section shortly introduces a project that has been using the home care labs described above. We use this as a background for a discussion in section 4 of our experiences of using the lab so far.

3.1 Project Background

Hypertension (high blood pressure) is becoming a mass disease due to stress and the general unhealthy ways of living. It is estimated, that 20-30% of the population suffers from hypertension, which causes increased mortality due to complications in brain, heart and kidneys [5]. Effective diagnosis and monitoring of the disease is a condition for lowering the number of complications. There are, however, a number of problems associated with the conventional methods for measuring hypertension. For instance, measuring blood pressure in the consultation at the general practitioner causes a 20-40% of false positives – the so-called "white coat hypertension". Letting the patients measure their blood pressure themselves at home would overcome the white coat problem, however since most of the patients are elderly with more than limited abilities with technology and electronic devices, it is not a trivial task to design a system that is usable for the situation.

The purpose of the 'Telemedical Measurement of Blood Pressure' (TMBP) project is to design home care blood pressure monitoring technology and to establish if there is clinical evidence for more accurate measurements at home. Besides researchers from our centre, the project group includes medical researchers, GP's, and a major Danish medico company.

3.2 Technological Setup

Overall, the system being designed in the TMBP project consists of four components: (i) a blood pressure measuring device, (ii) an interactive communication system between the patient and the GP, (iii) a server for data management and storage, and an interface to the data for the GPs in charge of the patients. The statistical data collected in the server is also to be used by the medical researchers at the local hospital, who are in charge of the clinical trial.

3.3 Using the Home Care Labs

Two 'real' patients and members of the project team took part in a one-day (8 hours) workshop held in the lab. The methods used were roleplay of of different scenarios, which were video-recorded. The scenarios covered the whole story: From the first visit with the GP, where the patient is asked to use the monitoring equipment to the experiment ends, and the equipment is handed back. Both patients and members of the project team took part of in the roleplaying.

The first 'play' served mainly to introduce the different participants to the 'game', and elaborated on the naive assumption, that everything went well (the technology worked without problems, all parts were able to keep the appointments etc.). However, in the later plays more and more difficulties and troubles were introduced using 'breakdown cards'.

Figure 2: An image from the workshop. The patient is installing the equipment at home before the first use.

As stated in 2.1, we strive to put the labs into play at an early stage in the design process. The pieces of hardware and software that were ready in some version at the day were tested. The rest was mocked up with low level protoypes. For instance, the application that controls the blood pressure meter and helps the patient communicate with his GP, was mocked up using hand-drawn sketches.

[1]See `http:\\www.inhaus-duisburg.de/en/index.html`

4. DISCUSSION

After the workshop the project team evaluated the use of the lab. There was a general acknowledgement of the benefit of the workshop and the use of the labs. The designers and engineers of the applications in question had discovered several issues in their system design that had to be changed, as well as user-interface issues, which were hard to understand and use. Moreover, fundamental problems in the design of the patient-specific devices were discovered. For example, troubles in setting up the equipment in the home (see figure 2), and problems in contacting the GP. These issues had never surfaced in previous evaluations, because the scenarios of getting the equipment at the GP's office and installing it at home were never tried out before. Finally, and maybe most importantly, inconsistencies and problems in the clinical protocol were discovered. If these problems had gone unnoticed all the way to the clinical field trial, the whole project might have meet some fundamental challenges at a very late stage. The main conclusion in the project team, was that it was a pity that this workshop had not been made at an even earlier stage.

As for the patients, they reported having had an inspiring and interesting day and they were glad that they were able to help in technology design, without having any knowlegde on technology at all.

The day gave us a lot of inspiration to change things in our lab, and – as the workshop it is – we are constantly tinkering around in it. We are currently planning more design and evaluation sessions to take place in the labs, thereby extending the set of probs and scenery we can support there. We are also trying to create a toolbox of user-centered and participatory design and evaluation methods, adapted to be used in the lab. As for the TMBP project, the next step is to evaluate the technological setup in real patients' homes.

Acknowledgements

The Centre for Pervasive Healthcare is funded via ISIS Katrinebjerg. The TMBP project is funded via the Danish 'IT Corridor' research initiative.

5. REFERENCES

[1] J. Greenbaum and M. Kyng, editors. *Design at Work - Cooperative Design of Computer Systems.* Lawrence Erlbaum Associates Publishers., Hillsdale, NJ, 1991.

[2] C. D. Kidd, R. Orr, G. D. Abowd, C. G. Atkeson, I. A. Essa, B. MacIntyre, E. Mynatt, T. E. Starner, and W. Newstetter. The aware home: A living laboratory for ubiquitous computing research. In *Proceedings of CoBuild'99*, 1999.

[3] M. Kyng and L. Mathiassen, editors. *Computers and Design in Context.* MIT Press, Boston, MA, 1997.

[4] M. Weiser. The computer for the 21st century. *Scientific American*, 265(3):66–75, September 1991.

[5] WHO. World Health Organization - International Society of Hypertension Guidelines for the Management of Hypertension. J. Hypertens. 17:151-83., 1999.

About the authors

Jakob E. Bardrams main research areas are pervasive and ubiquitous computing, distributed component-based system, computer supported cooperative work, human-computer interaction, and medical informatics. He received his PhD in computer science in 1998 from the University of Aarhus, Denmark. He currently directs the Centre for Pervasive Healthcare at the University of Aarhus.

Simon Larsen is doing his PhD in pervasive healthcare at University of Aarhus, Department of Computer Science.