Balancing user control

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ABSTRACT
Often elderly people experience problems when introduced to assisted living technologies in their homes, as many of these technologies are based on principles of automation and invisibility. This paper reports on field studies of assisted living technology in the homes of seven elderly people, the Eldertech study. Based on the fieldwork and issues related to palpable computing we argue that when designing for assisted living a balance must be found, between ambient technology and palpability. Palpable computing provides support for balancing between automation and user control and between visibility and invisibility of information technology systems. We have found these challenges very relevant for the domain of assisted living and in this paper we explore how the challenges can inform the work done in the Eldertech study.

Keywords
Palpability, assisted living, elderly people, design, user-control, visibility.

1. INTRODUCTION
In recent years there has been an increasing focus on developing technology for assisted living, both within research communities and within the commercial sector, as there is a growing need for technology that can support elderly people in staying in their homes for longer time. A common approach to accomplish this has been to develop systems that are based on a host of sensors to monitor the daily activities. Most predominantly, activity sensors are placed in the apartment of the elderly person providing input to e.g. family or caregivers on the activity level and activity pattern of the elderly person. The degree of detail varies, from changes in shape of butterflies on the family portrait [9] to elaborate visualization that allows for caregivers to zoom in on a particular type of activity, such as opening the fridge door or putting on the kettle [2, 3]. In case of abnormalities, the system intervenes, e.g. by informing the homecare service if the person has fallen or if the person leaves the apartment at an unusual time of the day or night [2, 3, 6, 11, 13].

The main purpose of such systems is to remotely monitor the elderly person, where it is assessed that the person needs to be kept an eye on. In our view, such systems reduces the elderly person in question to being a passive object for monitoring, as the person is seen as being without resources and capabilities and thus should not be implicated in such matters. However, in this paper we propose a different approach to developing technology for assisted living. We argue, that elders living at home should be seen as resourceful and should as a starting point be involved in using new technology for assisted living.

This recognition is in line with the observation of Walter [12] who in 1973 described how dignity of the users could be kept intact by reducing the dehumanization of computer systems. His experience shows that systems created by distributed computing where every single part of the system is developed with its own "sponsor" are less dehumanized. The author ends the article by urging designers to help people, lots of different groups of people, to compute. Which is in line with our wish to enable the users to understand the systems that they use.

More recently the ELDer study has touched upon the issue of usability and design of healthcare technology [5]. The abilities of elderly people change over time, and it is important that the technology not only empowers users, but also does so in a manner that does not stigmatize the elderly. Rather, it should support a positive self-image for the elderly persons.

However, to accomplish a higher degree of user-control, there are of course many considerations and obstacles to be addressed. To explore this we take our starting point in the Eldertech project, which differs from the concept of automation and remote monitoring by having some degree of user involvement. The elderly should, for example, monitor their own weight on the scale or take their own blood pressure readings, while the Eldertech system would then transmit the readings to the relevant homecare service staff. However, while the elders had a good understanding of how to use the devices, their understanding of how the information was transferred over wireless connections to homecare service, was minimal if existing at all. In the absence of such awareness of connectedness, the elderly misunderstood the consequences of their actions and could not use the technologies effectively.

Thus in this paper we discuss, how such pitfalls can be avoided and a higher degree of user control can be obtained. Two of the challenges related to the notion of palpable computing are to balance between automation and user control and between visibility and invisibility of information technology systems. We have found these challenges very relevant for the domain of assisted living and in this paper we explore how the challenges can inform the work done in the Eldertech study, in particular, and for the domain of assisted living in general.

2. THE ELDERTECH STUDY

The paper reflects on findings from a Danish research project, called the Eldertech study, described in [1]. The Eldertech project involved development of assisted living technology for elderly persons living in protected residences. The project was carried out in collaboration between the Municipality of Aarhus, IBM Denmark, and the University of Aarhus. One of the main purposes of the system was to increase the quality of life for the elderly persons by, among other things, remote monitoring of the health conditions of elderly.

Seven elderly persons participated in the project and had the Eldertech system installed in their homes for a period of up to three months. The elderly persons were between 75 and 88 years old with an average age of 81 years. They all lived in protected residences and all but one received daily visits by healthcare workers who assisted with personal care such as taking baths, getting out of bed, and cleaning as well as more clinical issues such as preparing the medication dosage and care for wounds.

Throughout the project period of 9 months, ethnographic field studies were carried out involving interviews and observations of the elderly and their caregivers. Each participant was interviewed on at least two occasions, each interview lasting at least one and a half hour, sometimes longer. Observations were made of the training classes with the elderly as well as the installations and use of the Eldertech system in the homes of the elderly.

2.1 Eldertech Prototypes

As described in [1] the Eldertech system was designed to monitor blood pressure, weight and medication intake of the elderly and was deployed with the following set of devices in each home: (i) a tablet PC with web access to for example a medication administration module, (ii) a one-button wireless scale for monitoring weight, (iii) a one-button wireless blood pressure monitor, and (iv) a wireless hub responsible for gathering the data from the monitoring devices and sending it to the application server (see figure 1).

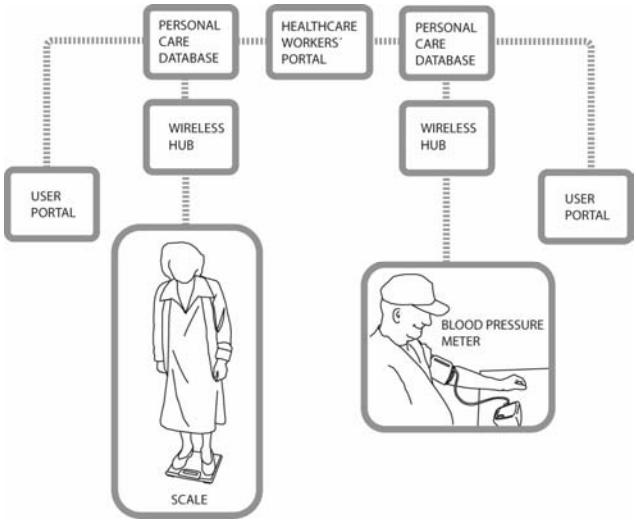

Figure 1: The Eldertech system

During the pilot, the elderly used the scale and measured their blood pressure daily or frequently. All but one of the elderly liked using the blood pressure equipment. Some emphasized that they themselves could keep an eye on the blood pressure; others mentioned that it was nice to know that others were monitoring it for them. The participants had very different levels of understanding of their blood pressure. Some had a very accurate and clinical understanding of their blood pressure and knew what their blood pressure should be. Others had very narrow understanding of their blood pressure knowing perhaps only that their blood pressure should not be above a certain limit.

Many of the elderly liked using the scale—they liked keeping an eye on their weight as they were already used to. The scale was—as they experienced it—primarily for their benefit and something they should monitor themselves and not something that would interest the healthcare workers.

Most of the elderly did not consider documenting medication intake as very useful for them. They explained that taking their medication was a steady routine [8], and thus the documentation was mostly for the benefit of others. Furthermore, some uncertainty regarding the documentation existed, as it could be difficult to establish if the medication that the elderly person is about to take actually is equivalent to the medication that s/he signs for on the medication administration module. To establish this, the elderly person must know the medical name, the dose and what the medication looks like, which not all elderly people do, even though they are still able to take their medication at the right time. Lastly, all of the elderly experienced some type of difficulty in their use of the computers. Thus, by the end of the pilot three had entirely given up using the computer, two elderly used the computer regularly, and two had only used the computer very infrequently.

3. Balancing palpability challenges

Many of the elderly people participating in the Eldertech project had problems using the technology introduced in the project. We found that this was mainly related to the balance between user control~automation and visibility~invisibility.

In the following we show how these challenges are important issues for the Eldertech study and describe how we can utilize aspects of the support for making computing palpable developed in the PalCom project to address them.

3.1 User-control~automation

Giving user control to the elderly people has been poorly prioritized in earlier software systems designed to assist them. This is an important design parameter when developing systems for use in the personal space in general. Most people, including elderly people, want to be involved and active in using the technology in the home. This is illustrated in the Eldertech study when one of the participants, Jens, experiences a breakdown in the system: The hub falls to the floor by accident and shuts down. Jens tries to turn it on again, but realizes that he does not know how. It turns out that he needs a pin code in order to turn the phone back on—he does not know this, nor does he know where to find the pin code and he has to call for assistance. This dilemma is not only experienced by elderly people. Most people have experienced the frustration of attempting to install new technology at home, such as a new DVD player or television. The experience of not being able to understand buttons on the devices even though the manual has been read closely has often led to the

annoying experience of having to rely on others to solve the problem.

For elderly people, when introduced to new technology, they have often already experienced reduced ability in various ways. Some have problems with their short-term memory; others might have visual or other physical disorders. If not done in an appropriate way, introducing new technology to people under these circumstances can easily be interpreted and experienced as humiliating, irresponsible and alienating. A significant issue for many of the elderly people in the Eldertech project was the frustration of being dependant on others. The two following citations indicate this. In the first citation in relation to the everyday life and in the second regarding use of the touch screen interface of the computer used in the Eldertech project.

"I can't cook any longer. It's my big grief—that you can't manage things on your own. That you are dependent on others. (…) I used always used to cook myself. Now I don't even dare make a fried egg. I'm afraid that I can't manage the frying pan—in case I lose my strength". (Anna, 88 years old)

"It's a pity when it doesn't work. X had shown me how I should pres on the screen with the pen, but it isn't always easy. My helper told me that I did it in the wrong way but when she tried it then she didn't even have to touch the screen—she just held it in front of it and then it worked. It's a mentally stressful when you can't get it to work. There're so many things that I can't do these days". (Anna, 88 years old)

On the basis of these observations it has become evident for the authors that when designing systems like the Eldertech it is important to keep in mind that the notion of user-control as an important parameter. Dependency on others should be reduced to a minimum regarding interaction and understandability of systems and technology. Involving the user in the design process as done in e.g. participatory design [4] can provide important information early in the process, making it possible to identify the users' needs and capabilities, as well as the users' ability to understand the system. It is of course important to recognize the need for allowing shifts in user control, as the given situation of the elderly person changes. During the nine-month period of the Eldertech project all of the elderly participants were hospitalized, in most cases leading to deterioration in their condition. In relation to the assisted living technology this would mean a need for an increase in the level of user-control, depending on the specific situation of the elder.

In PalCom systems automation is defined by policies requested by the user. The control of these policy levels can also be constrained by the user. For instance, a policy may state that the infrastructure must automatically try to find a replacement of the display of the blood pressure results, if the display on the blood pressure device fails. However, at the same time the policy may put constraints on the characteristics of a potential replacement, e.g. size of the screen.

This automation is implemented alongside with support for user control. The user can change the policy while the system is running or it can be changed remotely e.g. by caregivers deciding what level of user control is relevant for this particular person. Based on our experience of the Eldertech study, this possible distribution of automation policies, seems to be an important quality in system architecture for assisted living.

3.2 Invisibility~visibility

To be able to make use of a system, the user has to be able to understand the system or have/create a conceptual model [7] of it. One way of providing this is to create systems that allow users to make elements and connections between elements visible. Like a coffee machine that does not work, where you would check the cord to see, if it was in the right place and plugged in. The challenge is to support people by making some things visible and others things invisible, when required. If every little detail of the system is visible, as often can be seen in very powerful VHR or DVD machines, the user drowns in information, and is unable to correct or even detect errors. Thus, the system should support the user in creating a balance between visibility and visibility.

In the Eldertech study the elderly people are unable to understand the connections between the different artifacts and are totally in the dark about how the system is supposed to work.

"But it was Sunday, and I think it was closed, because there wasn't light in that one [the hub in the shape of a mobile phone] on the nightstand. When I take my blood pressure, right, and weigh myself, then there's light in it. So I thought that it was closed, you see". (Ida, 84 years old)

Making relations in the system visible is also useful in another way. When new technology is installed in the homes, this implicitly involves construction~deconstruction. Deployment of systems that consist of small, dedicated devices needs construction and deconstruction of assemblies of services [10]**.** An approach to achieving a higher degree of user-control would be to design the system in such a way that is supports the user in the actual installation of the system in their own home. In contrast, the Eldertech system is so complex and difficult to understand that the elders are unable to install the system themselves. They need technical help to make the system work in their environment. This is not necessary when they need to use a new blood pressure meter, or a new scale, because they have previously learned how to read the scale and how to work the blood pressure meter. When a new device and /or a system is installed in which they have no means to apprehend, they can loose the comfort in using it and they definitely loose the comfort in deconstructing and reconstructing it with new devices and systems. Thus, the user-control is diminished.

The drawback of this is illustrated by the example above, where Jens experiences a breakdown when the hub falls to the floor. As Jens has little understanding of the system he does not know how to fix the problem, even though he is in this case able to locate the specific problem. Thus, he has to call for assistance.

When installing systems and devices in the homes of elderly, the functionality of the devices should be noticeable if present. A multifunctional device dedicated for a single use as hub in the previous example with the mobile phone in the Eldertech system, can be purposeful if it is used because the user is familiar the functionality. However, in the example with Jens he is obviously not familiar with the use of a mobile phone. He knows that the phone is a part of the Eldertech-system, but he has not been instructed in the use and the setup.

The example with Jens leads to two major issues. Firstly, in relation to visibility~invisibility. In many situations it is preferable that devices and systems are noticeable and apprehendable for the users. Visibility offers the opportunity to

see if the connections and devices are working if appropriate feedback is available, thus leaving the user in control. However it naturally requires that the users have sufficient information and knowledge to intervene and respond equivalently. Secondly, it opens up questions regarding automation~user control. In the example with Jens, there was actually no reason why the mobile phone should be visible and present, when Jens had no means of using it. If systems do not offer user control, they should not be noticeable but be automated and out of the way. Unfortunately, this would also have the consequence that the users often would be prevented from handling breakdowns and exceptions.

Our approach to design in home care is towards systems that are understandable, that is, systems the users are able to understand sufficiently to make the intended use of them. It is not enough to make a beautiful GUI on a laptop; the users need to be enabled to understand the essence of the system and viewing the details if needed.

The PalCom architecture supports visibility~invisibility by enabling the user to notice and inspect the elements and the connections between the elements of a running PalCom system at various levels of granularity. Inspection of singular elements is enabled through so-called inspectability interfaces on the resources. Through these, the user can query a particular resource about the parts of its internal state that it is designed to reveal. Additionally, the architecture provides a way of turning the elements inside-out to enable the user to go deeper into the state. This is implemented with a user interface that makes the user notice the possibilities.

4. CONCLUSION

In this paper it becomes clear that systems and devices in the domain of assisted living need to balance between user control~automation and visibility~invisibility. In some situations, such as a worsening of the elderly person's condition, there will often be a need for raising the level of automation in order to compensate for the physical or mental disabilities, thus making the system invisible. Nevertheless, we find it important that it goes this way around. Lack of user control should follow the elderly person's evolving lack of skills.

Systems should not per se take for granted that the elderly persons have no insight in "new" technology. On the other hand, new technology must not expose if the elderly lack skills in controlling their own situation. This is important for two reasons. Firstly, because of obvious ethical issues related to our understanding of being able to take care of ourselves and control of our own lives. Meaning that dependency on others should be reduced to a minimum. Secondly, and this might be regarded as a more pragmatic level even though it is closely related to the previous, the elderly people should be seen as resources for maintaining the systems and devices. Elderly people are, naturally, perfectly capable of handling a vast range of devices from televisions to blood pressure meters if given the relevant training and introductions. This is important to keep in mind when introducing systems and new devices.

The PalCom architecture allows the user to inspect the system and assembly of devises. A palpable system should afford configuration by the elderly user or the caregivers. This will make it possible to tailor the system so that it offers adequate balance between user-control~automation and invisibility~visibility.

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