

Active Involvement Of Older Users In The Design Process Of Smart Home Technology

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Abstract—the research efforts to involve older users in the design process have been based on a multimodal approach. A mixture of questionnaires, focus groups, scenarios and personas, interface design and multilevel prototyping were used. All approaches resulted in lively discussions and useful feedback from older users. Based on current experiences enough evidence is present to support the user centered design approach. The next challenge is to install the technology, designed on the basis of user requirements, in the home environment and evaluate the actual use of the installed functionalities and services.

I. INTRODUCTION

THE greatest advantage of Ambient Intelligence is that it uses non-intrusive technology that can be completely personalized to the individual. The greatest challenge however is to involve users into the design process to fully employ the potential of Ambient Intelligence. Involving users in this case means not only consulting them when the product is finished, but giving them an active role in the design process and the actual shaping of Ambient Intelligence. This requires an adapted and in some cases new approach to user research.

Current smart home technology is mostly developed from a technological point of view. Therefore the big challenge is to change this process. This not only requires changes from developers but from all involved stakeholders. Developers need to be able to translate user requirements into technological ideas and concepts. Users that aren't used to playing a role in the design process are suddenly asked for their input on the possible role of technology in their life and their requirements for that technology [1].

This paper focuses on the use of several methods to involve users in the design process used in two European IP projects on AAL (Ambient Assisted Living), called NETCARITY and SOPRANO. Within these projects Smart Homes Association, a knowledge center on Smart Home Technology and SVVE De Archipel, a care provider, are the participating Human-centered research partners located in the Netherlands.

Up until now six methods are used: 1) Questionnaire and interview, 2) Focusgroup on the basis of scenarios and

personas, 3) Focusgroup on the basis of challenges and guardian angel concept, 4) Presenting use cases by Multilevel Prototyping, 5) Focusgroup using cartoons and 6) Workshop on interface design. In this paper these activities, carried out during the first year of these projects, are described.

II. USER GROUP DEFINITION

Based on evaluations of realized smart home technology projects it was concluded that technology is not the solution to create a perfect home environment but has the ability to make a useful contribution. The environment as a whole, including for instance social contacts, options for support and services, location of the home and the (medical) problems people face are responsible for the overall satisfaction of the residents. Therefore it is important to gain insight into all these aspects of the users participating in the research. Therefore the *first research method* focused gaining insight in these aspects.

A questionnaire/interview was compiled that is filled in by persons participating in the projects. The measurement consisted of a questionnaire and an interview. The follow up interview was added to look at the answers together with the participant and to explain if necessary. Furthermore during the interview information about the health status was collected and photographs were taken to visualize the current living environment. Figure 1 displays some of the photographs taken at the homes of the participants. The questionnaire will function as a zero-measurement to have a starting point to measure changes that occur during the project.

Generally speaking the participants are a group of people who feel good about themselves and their quality of life but who also experience the downside of getting older or the difficulties of having a disability. At the moment it is only restricting them a bit from doing the things they want but this situation will alter the next years. This is what makes this group interesting for research. By monitoring them for four years we are able to draw conclusions on the fact if the use of technology allows them to longer live independently.

III. UNDERSTANDING USER NEEDS

To be successful in the marketplace for ambient intelligence, European companies need to understand users' needs. This means that there is a requirement to establish a human-centered design process that involves the user from the very beginning of the design process. This will enable users' requirements to be derived in a systematic way.

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Fig. 1. Examples of 'new' technology, 'old' technology and current solutions by participants.

The *second research method* in the SOPRANO research focused on the identification of key challenges for independence participant's face at this moment and possible support they could receive to face these challenges. This was done using focusgroups with multiple stakeholders: end users, informal carers and professional carers. During the focusgroup participants stated challenges and the SOPRANO system was represented by a "Guardian Angel". The Guardian Angel is to be understood as a personification of the system to avoid a technology centered way of thinking.

Challenges were first written down individually to take advantage of individual creativity and were followed by a group discussion. Based upon the challenges described and possible solutions presented by the users eleven use cases were developed that form the bases of further research in the SOPRANO project. Use cases were formulated around the following topics: "Medication", "Holiday", "Open door", "Exercise" "Fall", "Remembering", "Entertainment", "Active" "Safe", and "In touch".



Fig. 2. Focusgroup on scenarios.

In the NETCARITY project a *third research method* was used. Scenarios including personas were built around the four Netcarity areas, Inclusion, Protection, Assistance and Health. Scenarios were designed to elicit users' feedback about: usefulness and appreciation, and advantages and disadvantages of the suggested solutions [2]. Personas were used because they are archetypical users favoring empathy and personification [3].

In the scenarios technology was mentioned but special attention was paid to the level of detail of the presented technical solution. Enough information was provided to start a discussion but the use of technology wasn't specified too much in the scenario, in order to have a broad discussion about the possible use of technology without the necessity to delve into the details of a specific solution. Figure 2 displays participants involved in the focusgroup on scenarios.

IV. DESIGN IDEAS

Next step in the SOPRANO research is to further specify the use cases formulated. Since the level of detail of the developed use cases differs multiple methods are used.

Use cases that were still on a very global level were explored by a theatre approach [4]. The problem area of the use case was acted out by the theatre group. This stimulates the focusgroup where participants were asked to produce own ideas on how to best address the problem from their point of view. Ideas were collected and mapped to the design idea classification. Afterwards the theatre group played the design solution as provided by experts. Participants were asked to give feedback about the solution. This feedback discussion led directly



Fig. 3. Example of Multilevel Prototyping.

into a comparison between the design ideas generated by the participants and the design solution generated by experts. Finally the group decided for a solution that they feel is useful, acceptable and usable.

Another way to gather more specific input for the use cases, the *fourth research method* that was used, was using Multilevel Prototyping (MLP). The problem area was presented through MLP. This stimulated the focusgroup where participants were asked to produce own ideas on how to best address the problem from their point of view. Ideas were collected and mapped to the design idea classification. Afterwards MLP was used to present two to three alternative solutions. The presentation of alternatives was necessary as MLP is not as flexible and quick presenting the input from users as the theatre approach. The presentation of alternative solutions stimulated the focusgroup. This feedback discussion led directly into a comparison between the design ideas generated by the participants and the design solution generated by experts. Finally the group decided for a solution that they feel is useful, acceptable and usable.

Use cases that were specifically formulated were presented to users via an “animated movie”. The presentation of Multilevel Prototypes based on Multimedia Mock-Ups is a promising way to get detailed feedback of early stage prototypes. The overall system as well as individual pieces of technologies and interfaces can be experienced from general to more specific. That is, the Multilevel Prototype approach enables the stepwise integration of more and more concrete technology throughout the project runtime. This is a huge advantage as the presentation setting can be adapted to the change in prototype sophistication.

Although design ideas can be generated, the main focus of this approach is the evaluation of design solutions presented. Participants had the time to ask questions directly after the presentation. These questions were recorded as they are valuable qualitative feedback. Afterwards questionnaires addressing acceptance, usefulness and usability were filled out by each of the participants individually. In the end a group discussion was established where participants were asked to exchange their ideas freely. This group discussion was another source for feedback. Figure 3 displays screenshots of the MLP used in this research.

In the NETCARITY project the focus of the next research was on functionalities and services that could be integrated in the home environment. Considering the phase of the project that we were in, the decision was made to focus on the non-critical solutions we could present to the participants. These solutions are useful but not life threatening if by any change the Netcarity system doesn't work as it is supposed to.

A cartoon sketching of a potential service, the *fifth research method*, was used as stimulus material. But instead of already filling in all the possible solutions, the cartoon was kept at a very basic level: only a short introduction to the service and some triggering questions were presented to the participants. They all received a set of possible answers to the questions asked. Each participant had their own color to make it possible for us to see the story composed by each participant. Everybody was free to make their own choice, but since the focus group consisted of approximately six people they could also consult each other and discuss about possible other solutions that were defined. So, we could benefit of the individual perspective, but also use the power of the group for giving comments and defining new solutions. Figure 4 displays a detailed image of one of the used cartoons.



Fig. 4. Cartoon used during focusgroup on services

The answers given during the focusgroup on services were used to formulate a more concrete scenario for each of the services described. The participants were then asked to envisage the type of interaction device



Fig. 5. Photographs taken during the interface design workshop

they would prefer to use to access those services in their home environment, the *sixth research method*. To gain insight into their ideas, workshops with elderly people were organized. In preparation they all received a letter including the scenario that would be covered during the workshop and were asked to collect images of products that they liked.

Goal of the workshop was to design the shell of the device. Participants individually designed their own device, in 2D or 3D, with different types of material that was supplied. To assist the researchers, employees of SVVE who on a day to day basis assist elderly people with activities, participated in the preparation of the workshops and were present during the actual workshops. From the models that are made by the participants criteria for the interface can be withdrawn. This is partly done in cooperation with the participants: after the models are finished participants are asked to explain why they made certain design choices. Figure 5 displays some of the prototypes made by participants.

V. IMPLEMENTATION OF TECHNOLOGY

From a user perspective it is important to realize that residents consider their home to be a safe and comfortable place to live in. Sometimes technology is seen as an intruder in their safe environment, residents are afraid to lose control over their home. Some people even fear the use of technology in their home. So technology and the home environment are not naturally a perfect fit.

From the first smart home projects it can be concluded that users allow technology into their homes; however not at any price. Involving them early on in the design process can result in greater acceptance and actual use of the technology

Special attention needs to be paid to defining what conclusions and consequences can be connected to the collected data inside the home environment. When installing technology that allows the system to automatically interpret behavior and respond to behavior or to distribute data to a third party there has to be an agreement on what is allowed and what not.

Using actual homes as a place to gather information about new technologies and services remains a powerful instrument since in a lab people behave differently than in the security of their own home.

In both SOPRANO and NETCARITY the developed technology will be installed in real homes in large scale field trials later on in the projects. A large part of the evaluation will be directed towards an evaluation of the research methods used throughout the project.

VI. CONCLUSION

All methods used resulted in useful input from users into the design process. By using different types of methods we could cover several aspects of the design process and not only focus on initial requirements. It is important to realize that involving users is an ongoing process and doesn't stop after consulting them once at the start of the project.

However involving users and establishing an equal relationship with them is a time consuming process. All project partners need to be aware of the fact that input gets more concrete as the human-centered design process continues but not immediately. Furthermore establishing relationships with stakeholders is something that doesn't feed directly into the design process but is extremely important in order to keep them involved for the total duration of the project and to use them as an ambassador for the results of the project.

Finding the right balance between presenting solutions to stakeholders to keep the design process going and to let the stakeholder guide the design process based on their own ideas and requirements is an aspect that requires a lot of attention during these types of projects. The methods currently used provide input on how to establish that balance.

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