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Eliciting User Requirements for Ambient Assisted Living: Results of the SOPRANO Project

Sonja MÜLLER[1], Marco SANTI[2], Andrew SIXSMITH[3]
[1]*empirica GmbH, Oxfordstr. 2, Bonn, 53111, Germany*
Tel: +49 228 985300, Fax: + 49 228 9853012, Email: Sonja.Mueller@empirica.com
[2]*University of Stuttgart, IAT, Nobelstraße 12, Stuttgart, 70569, Germany*
Tel: +49 711 970 2028, Fax: +49 711 970 2300, Email: Marco.Santi@iao.fraunhofer.de
[3] *Gerontology Research Centre, Simon Fraser University, 2800-515 West Hastings Street, Vancouver, British Columbia, Canada, Tel: +1 778 782 5375, Email: ajs16@sfu.ca*

Abstract: The SOPRANO project is developing supportive environments for older people based on the concept of "ambient assisted living", using pervasive ICTs to enable older Europeans to live independently in their own homes. A feature of the Experience and Application Research (E&AR) methodology used in the project is the active and strong involvement of older users throughout the entire R&D process. Participative methods in the area of research and development enable to thoroughly focus on the users when defining the user requirements, iteratively generating design solutions and evaluating those design solutions in real life settings. This paper presents the results of the first phase of user research carried out in SOPRANO in order to determine user requirements for the system. After describing the need for ambient assisted living and E&AR approaches in a first section the paper presents methods and results from participatory requirements engineering. It concludes with an outlook on the next phases of user involvement.

Keywords: Ambient Assisted Living, Independent Living, user requirements, smart technology, E&AR

1. Introduction: The Need for Ambient Assisted Living

Over the last decade, considerable RTD efforts have been pursued by the European Commission, national governments and relevant industries to provide an adequate technology response to the challenges of an ageing society. In terms of technology uses, the so called "independent living" or "assisted living" domain today comprises a heterogeneous field of applications ranging from quite simple devices such as intelligent medication dispensers, fall sensors or bed sensors to complex systems such as networked homes and interactive services. Some are relatively mature and some are still under development.

When it comes to more complex systems in particular, the potential ICT generally holds in relation to independent living – e.g. in terms of quality of life for care recipients – are very likely to be not enough for the sustained success of ICT enabled social and medical support services.

Experiences from previous research suggest for instance that organisational, cultural and other non-technological issues come into the play if ICTs are to be successfully introduced into daily practice (see for example [1], [3]). However, also in relation to the technology itself, up to now all too often simplistic assumptions have been made in relation to the needs and aspiration of those who's independence is ultimately to be supported in one way or another, and of those who provide assistance to them as well. There is for instance some evidence that many older people, despite being in need of some help, are

wary of giving outsiders intimate insight into and access to their homes (e.g. [2]; [4]). It seems very likely that they would accept technology based help more readily if they had more say in what information is sent out, to whom and under what circumstances. Also, the complexity and novelty of many systems and devices that have been developed during recent years seem to bear the risk to exclude older people from using these technologies.

At the same time, recent research suggests that a large segment of the growing number of older people in Europe can be offered ICT enabled support services which considerably improve their quality of life, provided usability of ICT systems can be equally improved.

The opportunity to do so is given by recent developments in ambient intelligence and new abilities of software systems to communicate with. Against this background, SOPRANO aims at taking a leap forward in the way users can interact with and take charge of their living environment and in the way professional care personnel can support them when called on to do so. In that sense, the SOPRANO system is not to act as a traditional "smart home", passively receiving user commands, nor as pure "remote care", monitoring user activity to alert outside staff when action is needed. Instead, SOPRANO shall act as an informed, friendly agent, taking orders, giving advice or reminders and ready to help, and get help, when needed.

2. Experience and Application Research

Addressing the target group of older people requires methods that perfectly suit this group. Standard tests can for example be too tedious, standard questionnaires might not be understood by everyone or expecting new ideas to be understood might be too challenging. In addition to this in ambient intelligent systems the context of use of a system is much more relevant than in standard office environments. The project thus needs to develop methods and tools in order to prototype context with users. SOPRANO does not only want to gain a quick insight in the system usage and user acceptance but also gain understanding of learning effects that are especially important in applications used on a daily basis.

Both established and specially developed methods based on the latest Experience & Application Research (E&AR) approaches are deployed as “innovation enabler”, ensuring that SOPRANO systems fully utilise the potential of technology innovation to meet user needs and gain wide acceptance.

The concept of E&AR was developed in 2004 by the Information Society Technologies Advisory Group [5]. E&AR asks for research, development and design by, with and for users. It also requests research into methods and tools that enable this. This approach is crucial to the development of human-centred ambient intelligent systems. One of the aims of involving users in ambient intelligence R&D processes is to create useful and successful products. Researchers and developers increasingly recognise the need to cross the barriers of disciplines to create products that match the future demands of users. A more multidisciplinary approach to the development process opens up to new possibilities, perspectives and methods. The possibilities and constraints of ambient intelligence are dependent on user evaluations in the context of their everyday lives. E&AR must also consider relevance to social and cultural practices.

SOPRANO follows the E&AR approach not only by involving users from different European countries throughout the whole R&D process but also by developing new methods and tools that not only are adapted to the target group of SOPRANO but also go beyond state-of-the art approaches by developing new methods and tools.

3. Participatory Requirements Engineering in SOPRANO

3.1 Ecological Model for Guiding User Research

Home technologies must be designed having the needs of older people in mind if these are ultimately to be successful in supporting their independence. Therefore, an extensive program of user-related research has been implemented during the first year of the overall project.

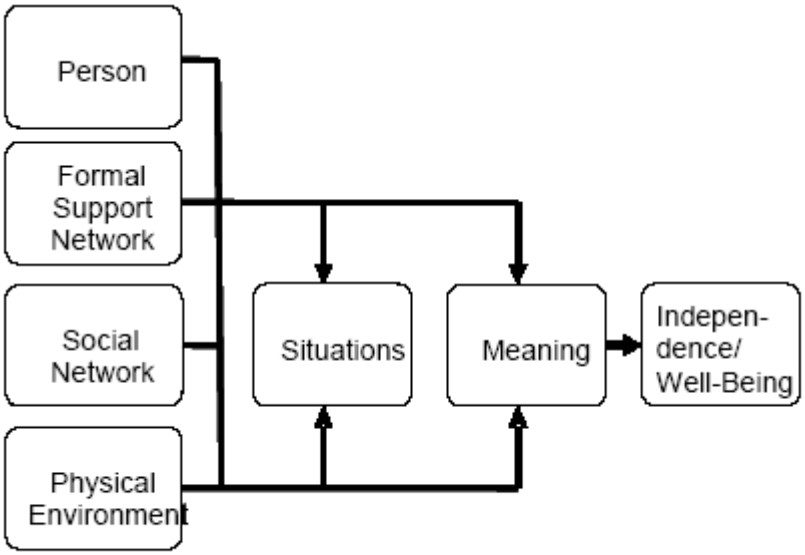

Figure 1: The Ecological Model

An 'ecological' model is a useful framework for guiding the user research [6]. While many models of ageing have been developed, the ecological approach was particularly suited to the SOPRANO project because it focused on practical aspects of everyday activities of the person, highlighting opportunities for technology and design solutions to support these activities. The model draws on the work of researchers such as Lawton and Kitwood [7][8]. The underlying argument of the model is that the activities that comprise a person's everyday life are shaped by a range of different factors, including attributes of the person (functional ability, cognitive ability, psychological factors etc.) and attributes of the immediate (formal support network, social network, physical environment) and wider socio-cultural contexts. These personal and situational factors operate together in a functional, 'ecological' relationship to facilitate or constrain (affordances) a person's activities. The ecological approach is useful in looking at the independence and quality of life of older people, because it highlights the impact and experience of age-related dependency (e.g. cognitive impairment) within its context and allows us to explore how this affects everyday life and well-being. How a person derives meaning from their everyday activities and environment is central to their well-being. Positive well-being is where these factors work together, while conversely apparently minor obstacles in any of them can prevent a positive outcome. Technological and design interventions can potentially play an important part by ameliorating some of the personal and contextual problems faced by a person who is experiencing cognitive decline. The argument here is that a person's well-being will be enhanced if the intervention facilitates activities that are meaningful and valued by the person and takes into account the contextual factors within which the person lives.

3.2 Stepwise Approach Towards Elicitation of User Requirements

Work started with the conduction of an extensive literature review. Here the focus was on gaining a better understanding of physical and other changes that tend to come with the process of human ageing and their potential impacts on a person's experience of life in old age. This preparatory exercise was to lay the ground for the identification of key challenges to independent living, with a view to identifying options for the provision of an adequate technological response to these.

Further to this, a repository of generic situations potentially threatening older peoples' independence or quality of life was compiled on the basis of the knowledge gained from the literature, and on the basis of feedback received from those project partners who have experiences in providing support services to older people.

The next step in requirements elicitation focused on involving potential users of the SOPRANO system in order to gather their feedback on a) key challenges to independence/quality of life and b) initial ideas on how technology could be harnessed to better cope with these challenges. To this end a qualitative methodological approach was adopted, involving both focus groups and individual interviews. The "situations inventory" compiled earlier in the project was used for triggering responses and stimulating lively discussions at the part of the participants. Overall, 14 dedicated focus groups (with more than 90 end users) were conducted with older people, informal carers and care professionals in the UK, the Netherlands, Spain and Germany. Individual interviews with older people took place in Germany, Spain and the Netherlands.

4. Development of Scenarios of Use

Key themes that emerged from these activities for further consideration in the SOPRANO design process included both technical and non-technical aspects. These issues include:

- Social isolation/loneliness: Perhaps one of the biggest problems mentioned at the part of the users concerns social isolation resulting in many negative outcomes such as loneliness, depression or the feeling of being cut-off. An aspect mentioned in this context as well concerns the feeling of boredom which seems to be related with a feeling of being socially excluded in many cases.
- Safety and Security: Another challenge that was frequently mentioned concerns the desire for safety and security. Important issues that were highlighted in this context include for example falls, disorientation, control of household equipment or receiving help in the case of emergency.
- Forgetfulness: Forgetfulness seems to be a challenge to independence for many and concerns taking medication or finding objects in the house. Particular issues that were mentioned around taking medication are multi facetted and relate to forgetting to take the correct medicine at the right time and to find the medicine in the house, but also to undesired side effects when taking different kinds of medicine. Also, some people seem to have problems in handling or managing their appointments or a normal calendar.
- Keeping healthy and active: Challenges were also reported in relation to keeping healthy and active in later life, e.g. physical and mental activity and exercise, good nutrition, good routines (such as sleep patterns) and, again adherence to appropriate medications. Some people reported difficulties in adhering to specific regimes that have been determined by health professionals, including rehabilitation programmes.
- Community participation/contribution to local communities: During a UK focus group there was a strong emphasis on the desire to participate in local government activities and informal and semi-formal support networks. While this seems a somewhat unique view, this outcome points into the direction that community participation and contribution to local communities should not be underestimated.

- Accessing information/keeping up to date: Keeping up to date seems to be a crucial issue for many as well. Here, access to local news or the possibility to read newspapers were emphasised, as was the need to find tradesmen to do little jobs around the home, such decorating, cleaning, repairs, etc.
- Getting access to shops and services: People often seem to have difficulty getting out of the house for shopping, banking etc. These kinds of services and support are usually outside the remit of local authorities so the person in need to support must get such things done on his/her own, or is dependent on others or voluntary organisations.
- Checking up on care provision: Local authorities can be purchasers and/or direct providers of care at home. As care is provided in the community within the person's own home, it seems not always easy to ensure that the right amount and right quality of care is delivered.
- Mobility inside and outside the home: Keeping mobile inside and outside the home was mentioned as a problem area as well. This concerns on the one hand being able to walk as long as possible and the use of public transport on the other hand. Mobility restrictions were reported especially common in winter and evenings.

In each case, delivery of improved services supported by SOPRANO systems was seen as having great potential to increase the quality of life of older people and to support their independence, enabling them to stay in their own home as long as they wish.

Ideas for improved services were developed in response to each challenge to independence, taking into account not only features of technology seen as desirable by focus group participants but also their fears or rejection of other features of technology and of action by service providers seen as intrusive or unnecessary.

Criteria to be taken into account in assessment of service ideas were not only the degree of importance for older people but also the level of intrusion including false alarms, the load on service providers, and the technical feasibility and cost of service delivery.

Scenarios of SOPRANO use were developed based on ideas for new ICT-based services to address key challenges to independence. The scenarios of SOPRANO use include use cases. Use cases are seen as an effective way of capturing functional requirements of a system via describing interactions between a user and the system.

To see the design problem in SOPRANO as that of designing a technical system to offer new services without reference to the social world within which the person lives would be to miss a great opportunity - and very likely fail. It is therefore a key question how the technical systems being designed in the SOPRANO project take part in and are embedded in the process of delivering new ICT-based services. Based on these considerations, the technical components under development will explicitly be conceived and designed as part of a socio-technical overall system for delivering (new) ICT-based services to older people.

Against this background, a set of initial use cases were developed to effectively capture functional requirements on the technical SOPRANO system by describing interactions between one or more users and the system itself. The scenarios not only reflect functionalities of the technical system under design but also the processes, actions and interaction of 'components' of the overall socio-technical system – i.e. informal and formal carers, service providers, GPs/hospitals etc. - and the assisted person himself or herself.

The following SOPRANO scenarios of use have been developed:

- "Medication reminding" dealing with how to improve the situation of a person forgetting to take medicine.
- "Open door" dealing with enhancing safety and security at home.
- "Safe", monitoring activity for signs of problems.
- "Fall", adjusting care to increasing frailty.
- "Easy to use home automation" demonstrating smart home components supporting independent living.

- “Exercise”, helping older people to recover from hospital on their own.
- “Active”, monitoring signs of problems and supporting good routines.
- “Remembering”, coping with cognitive ageing.
- “In Touch”, combating social isolation
- “Entertained”, countering boredom.

User research also revealed some important horizontal issues that need to be taken into account for system development. Affordability of any kind of support, let it be technology based or not, seems to be a crucial issue for a large part of the participants. Furthermore, trust in technology is a major issue that needs to be taken into account when developing support systems. Many older people seem to not entirely trust technology and thus are not prepared to rely on it. Also computer anxiety and intimidation by technology appears to affect a considerable share of older persons. And many participants expressed a fear that they would possibly break new technology they attempt to learn. More generally, fear of being dependent from technology was commonly mentioned. In such cases people seem to be intolerant of the way technology works and may only tolerate face to face interaction with other humans.

5. Conclusions and Next Steps

With the results shown above the first steps within the user centred design process as implied by ISO 13407 [9] are taken, i.e. (1) understanding and specifying the context of use and (2) collecting and analysing users’ needs and requirements.

The state of the art approach for involving users throughout the whole R&D process is typically followed by the development of prototypes by experts (see also Figure 2). By doing this, decisions about the conceptual design, i.e. what kind of functions are to be developed and what the interaction should be like, are made by experts. That is, experts define which functions and services are to be used and how the user should interact with the device or system in question. The prototypes, based on those conceptual design ideas, are then evaluated by users. Therefore, the initial design ideas are not based on the mindsets, experiences and mental models of the users but on the experts. The user can intervene only through the fourth step – the user based assessment.

The E&AR approach applied in SOPRANO is to change this situation. Instead of having experts to lead the development of prototypes, a more user centred design process is to involve users when developing the conceptual design and, later, the prototypes.
The idea is that it is not the users who respond to ideas of experts. Experts should listen to the input from older people and respond to their input.

SOPRANO will follow the process presented in Figure 3, where in comparison to Figure 2 the project phases from step two, “Specify the user and organisational requirements”, to step three, “Produce prototypes” are driven by the input from users. These project phases will use new methods to allow generating new design solutions and evaluating design solutions derived from the first phases of user involvement. Theatre methods, a new prototyping technique called the Multilevel Prototyping (MLP) and Focused Design Discussions (FDD), in which the use of the newly developed Guardian Angel metaphor helps to overcome a technology centred way of thinking, will be used to include the user in the process of conceptual design of AAL technology.

Theatre methods are able to portray a situation in a very naturalistic and more immediate manner which makes it easier to imagine and to remember the scene. Plays are very suitable for activating memories and emotions of spectators [10]. Theatre plays offer the possibility to enact a kind of play between users and experts and to include prototypes into the play. Also, the dramas give a good basis for semi-structured interviewing. The Guardian Angel Approach helps to not to narrow the idea generation through explicit

assumptions about what might be possible with today's technology. The metaphor will be used so as not to have to explain exactly how information is gathered in the home or exactly how information is given. Participants should overcome a technology centred way of thinking and therefore to be as close to their real needs as possible.

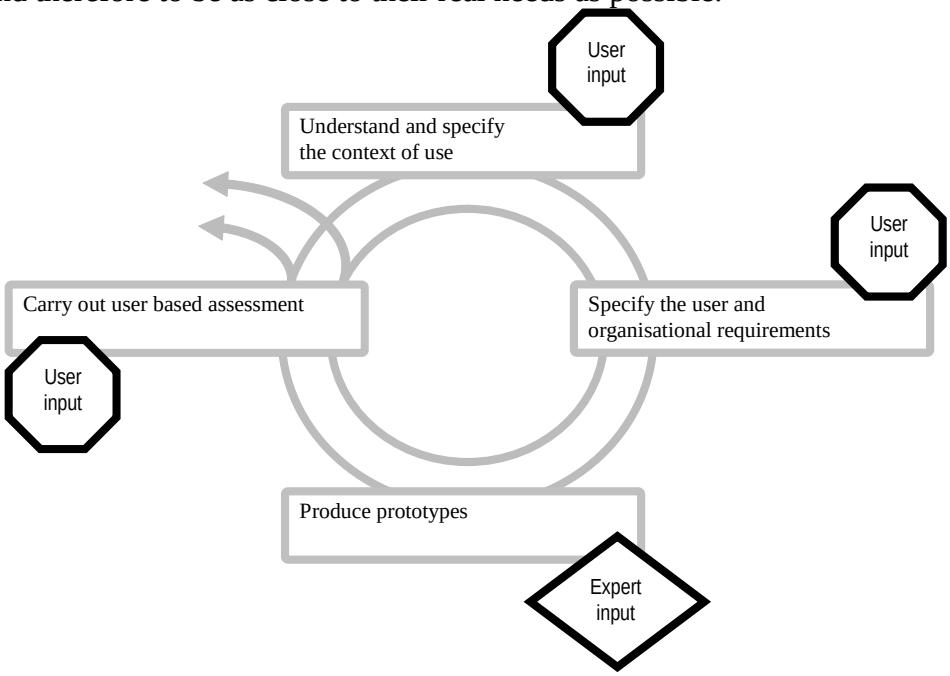

Figure 2: Degrees of User Involvement as Implied by the User Centred Design Process (ISO 13407) [5]

The presentation of MLPs based on Multimedia Mock-ups is a promising way to develop design ideas together with older people and also to get detailed feedback about early-stage prototypes. The overall system as well as individual pieces of the technologies and interfaces can be experienced from general to more specific. That means the MLP approach enables the stepwise integration of more and more concrete technology throughout the project runtime.

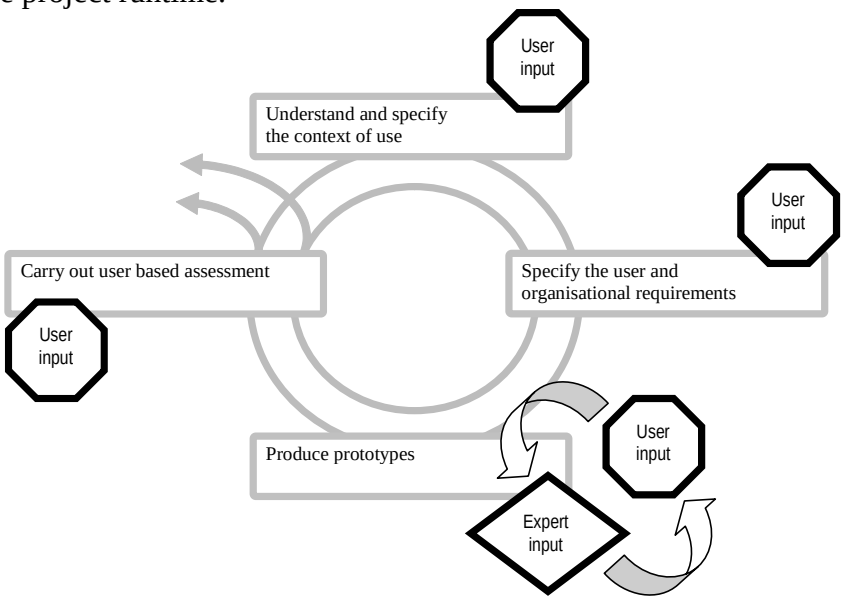

Figure 3: From specifying requirements to producing prototypes: SOPRANO's proposed change of user involvement compared to stat of the art procedure implied by the User Centred Design Process (ISO 13407) [5]

The greatest challenge is to work together with experts and users in the same design step. This makes it possible to combine knowledge at every moment in the process and is

not sequential. For instance, experts are not the only ones who can introduce creativity. Users can also give creative solutions, although maybe on a different level of abstraction. Experiences from previous project phases show a great source of user input in that older people constantly develop solutions for challenges themselves. Those ‘inventions‘ can be the kind of input for experts. The challenge in SOPRANO is to develop a research method that will allow this kind of cooperation.

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