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Older People and the Adoption of Innovations: A study of the expectations on the use of social assistive robots and telehealthcare systems

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Abstract

Aims and objectives: The research presented investigates older people's expectations of social assistive robots and telehealthcare systems.

Background: Societies in most developing countries are facing a growing demand for innovations to adjunct current healthcare systems. This is due to expanding older populations and a shortage of healthcare professionals. Innovations such as social assistive robots and telehealthcare systems are (if adopted) likely to change the meaning and nature of ageing, as well as introduce novel practices of homecare for older people. Older people's expectations most likely will affect how they imagine, desire and value the potential utility of social assistive robots and telehealthcare systems in eldercare.

Theory: The underlying philosophy is social constructivism. It argues that expectations are social constructions by humans (Brown & Michael, 2003; Lente & Rip, 1998). Expectations are ways of making sense of the world, and their meanings are based on past experiences; they alter our future behaviour toward other human or non-human actors (Latour, 2005).

Methods: The empirical studies presented are based on fieldwork carried out before social assistive robots and a telehealthcare system were introduced into the domestic environment of older people. The research draws upon participatory design to explore older people's expectations of social assistive robots and telehealthcare systems through activities such as workshops, questionnaires and in-depth interviews with older people and informal caregivers.

Results: The findings indicate that the expectations of older participants are affected by three variables: the seductive power of technology, the motivational effect, and devaluating of other old people by older people. Evidence suggests that expectations are both performative and retrospective. Performative since the older participants in the lab trials amended their behaviour in order to accommodate the robot in the robot-human interaction. Retrospective since experience and memories from the past caused the older participants to perceive telehealthcare systems and social assistive robots as

being “good for others but not themselves”, “a social assistive robot as a machine not a friend”. Their relatives and informal caregivers also perceived a robot as “not for my relative but for other older people”.

Conclusion: At a more universal level, the thesis challenges the technological deterministic approach that characterises mainstream technological-innovation development and argues that ageing is a social construction as well as an open-ended process with no clear boundaries. This in turn means that older users’ expectations are situated in a social context. The thesis points out the need for research on the interplay between telehealthcare systems and/or social assistive robots, older people and everyday life in the domestic context.

Acknowledgement

First of all I would like to thank all the older people who participated in my research; without you this research would not have been possible. The knowledge that emerged from my research is a conjoint venture between the older people who participated and myself as the researcher. Thank you for welcoming me into your homes, for taking your time and effort to share your most inner thoughts about robots, telehealthcare systems and innovations.

I also would like to thank Professor Britt Östlund, my main supervisor, for encouraging support, help, and guidance in the "scientific jungle", but most of all for her positive attitude and trust in me. Thank you for giving me the opportunity to do something I truly enjoy and love doing! I would like to also thank Dr Mattias Wallergård for his valuable and insightful comments on an earlier version of the thesis.

I am a very lucky and privileged person with loads of fantastic friends, former and present colleagues as well as a great big family. All of you have given me great encouragement, support and help in difficult, as well as, good times. I sincerely thank you all. Particularly, thanks to my Mum and Dad.

Last but not the least, I would like to thank my husband, Niklas Gustafsson, for your love and support. My love and thanks to my three children – Julia, Jonathan and Johanna for keeping me grounded and showing me what a good life is really all about!

List of Publications

The research presented in this licentiate thesis is based on the five papers listed below. Descriptions my contributions and those of my co-authors are also included. At the end, there is a list of six other peer-reviewed papers I have authored.

Paper 1

Review: Seven Matters of Concern of Social Robots and Older People

Susanne Frennert, Britt Östlund

Submitted to International Journal of Social Robots

The research included reviewing, interpreting and critically evaluating existing literature on social robots and older people from a science and technology perspective. The first author independently planned and carried out the literature review. Britt Östlund critically reviewed the text.

Paper 2

Would Granny Let an Assistive Robot into Her Home?

Susanne Frennert, Britt Östlund, Håkan Eftring

Lecture Notes in Computer Science, Volume 7621, 2012, pp. 128-137

All three authors jointly planned and conducted the workshop on which the article is based. The first author independently initiated and developed the card-method used in the workshop, analysed the data that was collected, and wrote the article. Britt Östlund and Håkan Eftring equally contributed to critically reviewing the manuscript.

Paper 3

Elderly People's Perceptions of a Telehealthcare System: Relative Advantage, Compatibility, Complexity and Observability

Susanne Frennert, Anette Forsberg, Britt Östlund

Journal of Technology in Human Services, Volume 31, Issue 3, 2013, pp. 218-237, DOI: 10.1080/15228835.2013.814557

The usability trials on which the article is based were planned with Britt Östlund and conducted with Anette Forsberg. The first author independently analysed the data that was collected concerning elderly people's perceptions of a telehealthcare system, while the second author collected and analysed data concerning the users' physical capabilities. The second author wrote the text on the users' physical capabilities while the first author wrote the rest. Britt Östlund and Anette Forsberg equally contributed to critically reviewing the manuscript.

Paper 4

What Older People Expect of Robots: A Mixed Methods Approach

Susanne Frennert, Håkan Eftring, Britt Östlund

Lecture Notes in Computer Science, Volume 8239, 2013, pp. 19-29

The partners in the HOBBIT project jointly planned the methods used in this study. The first author independently conducted the focus groups and interviews and distributed the questionnaires in Sweden. The results were assembled and analysed by the first author who also wrote the text. Britt Östlund and Håkan Eftring equally contributed to critically reviewing the manuscript.

Paper 5

Older People's Involvement in the Development of a Social Assistive Robot

Susanne Frennert, Håkan Eftring, Britt Östlund

Lecture Notes in Computer Science, Volume 8239, 2013, pp. 8-18

The first and second authors jointly carried out the workshops. The first author independently planned and analysed the findings from the workshops and mock-up study on which the article is based. The first author independently wrote the text. Britt Östlund and Håkan Eftring equally contributed to critically reviewing the text.

Other peer-reviewed work by the author

1. **Social Companion Robots in Eldercare – Who Gains and Who Loses?**

   Proceeding of ICSR2013, Workshop on Social Companion Robots, Bristol, UK, October 2013.

2. **Using Attention Cards to Facilitate Active Participation in Eliciting Old Adults' Requirements for Assistive Robots**

   Proceedings of RoMan2013, Gyeongju, Korea, August 2013.

3. **STS-inspired Design to Meet the Challenges of Modern Ageing. Welfare Technology as a Tool to Promote User Driven Innovations or Another Way to Keep Older Users Hostage?**

   Co-authors: Britt Östlund, Elin Olander & Oskar Jonsson. Submitted to *Journal for Technological Forecasting & Social Change*, April 2013. Britt Östlund wrote a greater part of the text while I contributed paragraph 4.2.2. "Going from a laboratory context to real-life settings".

4. **Old Adults and Robots**

   Proceeding of NordiChi2012, Workshop on Elderly, Copenhagen, October 2012.

5. **Capturing Seniors' Requirements for Assistive Robots by the Use of Attention Cards**

Proceedings of NordiChi2012, extended abstract and poster presentation, Copenhagen, October 2012.

6. **I Want One Too! Domestication of Assistive Robots**

   Proceeding of PDC2012, PhD Consortium, Roskilde, August 2012.

Introduction

The trend of a growing ageing population and shortage of healthcare professionals has increased the demand for technological solutions that can provide help and monitoring of the older population (Bouma, Fozard, Bouwhuis, & Taipale, 2007; Fukuda, 2011; Lesnoff-Caravaglia, 2007). Social assistive robots and telehealthcare systems have become predominant buzzwords in this context. The discourse proposes technical solutions to take care of older people in their own homes (Ekholm, 2012). It is believed that these innovations will transform the way we live when in old age and provide novel practices in caring for older people. The discourse has been met with both utopian and more dystopian perspectives. The utopian one promises to help older people become more self-sufficient and autonomous with the help of robots and telehealthcare systems; the dystopian one warns that older people will be isolated in their own home, their only company being a robot, and that their privacy will be invaded because they will be monitored around the clock. Both perspectives are rather speculative since to date no entirely autonomous social robot exists in the sense that it reacts to its environment without any human intervention (via preprogramming) or control (Winfield, 2012). In fact, the introduction of new innovations in healthcare seldom leads to reduction of work but instead to redistribution of work – often to other workers but sometimes to machines (N. Oudshoorn, 2007). This is further emphasised by Bijker who states: "Because actors or components in a system are functionally related, changes in one or more cause imbalances or reverse salients in the advancing system front until the other components cascade and adjust to achieve an optimal interaction" (W.E. Bijker, 2009). In this regard, seeing social assistive robots and telehealthcare systems as solutions to "the problem" of an ageing population can be misleading. In the context of solving the "problem" of an ageing population, most often new innovations do not solve problems but transform them into something else (Lehoux, 2006). In the traditional, deterministic "black box technology" perspective, the configuration of the older user is not

questioned; innovations are seen as neutral and the technology is taken for granted. But social assistive robots and telehealthcare systems will most likely have different meanings and consequences for older people in different situations, such as social, economic and cultural contexts (Lie & Sørensen, 1996; MacKenzie & Wajcman, 1999; Silverstone & Haddon, 1996). Thus, it becomes ever more important to focus and understand how older people's everyday lives can be formed by the use of innovations such as telehealthcare systems and social assistive robots. From a technological deterministic point of view, technology change is often seen as a beneficial and forward-thinking solution; however, when explored from an elderly person's point of view, this image of technological changes becomes more complex.

An improved understanding of how older people's expectations mediate and transform the adoption process is important. It is important because expectations affect how older people imagine, desire and value the potential utility of social assistive robots and telehealthcare systems (Borup, Brown, Konrad, & Van Lente, 2006; Brown & Michael, 2003; Lente, 1993).

The analysis of older people and technology usage is central to the entire discipline of gerontechnology. Two important concepts can be distinguished in such an analysis: technology acceptance and technology adoption. Technology acceptance concerns the user's attitude towards a specific technology, while technology adoption focuses on the process of making a specific technology part of the everyday life of the user. Technology acceptance and adoption have been extensively studied (Kohlbacher & Herstatt, 2008; Lie & Sørensen, 1996; Silverstone & Hirsch, 1992) and several models to describe technology acceptance and adoption have been generated and verified (Davis, 1985; E. M. Rogers, 1995; Silverstone & Haddon, 1996). The general conclusion in the literature is ambiguous: the process of technology adoption can either be successful or unsuccessful (Davis, 1985; E. M. Rogers, 1995; Silverstone & Haddon, 1996). Thus we need more knowledge about the factors that affect technology acceptance and adoption. One can be the expectations older people place on technology in general, and social assistive innovations in particular. To date, far too little attention has been paid to the impact of older people's expectations on

innovations such as social assistive robots (Bemelmans, Gelderblom, Jonker, & de Witte, 2012). Traditionally, older people are often an excluded group in product development, despite demographics showing that the 65-plus age group is the fastest growing segment in most developed societies (Fukuda, 2011; Lesnoff-Caravaglia, 2007).

Expectations are interpersonal and the expectation of innovations exists in a social and cultural context (Lie & Sørensen, 1996; MacKenzie & Wajcman, 1999; S. Wyatt, 2003). Hence, to understand old people's expectations of robots and telehealthcare systems, these have to be placed in a social and cultural context. The social and cultural settings include micro level (situational context, individual values and emotions), meso level (organisations, institutions, workplaces, policies) as well as macro level (cultural, social and environmental patterns and forces) (Fig. 1).

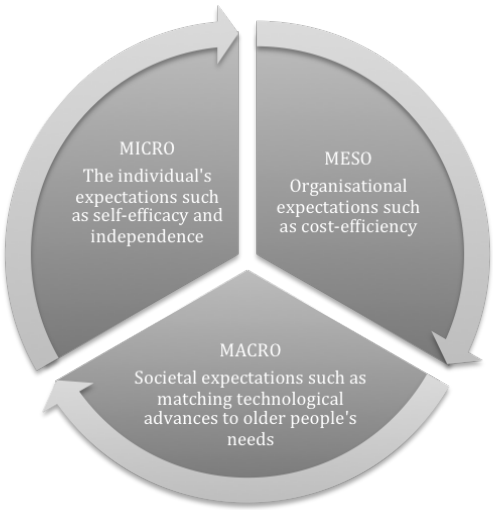

Figure 1: The social construction of expectations – how the individual's expectations (micro) are affected by the expectations of the caregiver organisation (meso) and the expectations of society (macro).

How older people's expectations of social assistive robots and telehealthcare systems are viewed and understood may have practical implications for how such innovations are developed and introduced to older people. Too often a specific technological innovation is developed first and if older users are involved in the development, they are often given the passive role of evaluating the usability and acceptability of the predesigned innovation (Newell, Arnott, Carmichael, & Morgan, 2007; Rodeschini, 2011). Past research shows that older users often only become involved post-implementation, once it is recognised that the use or the outcome of the innovation has become problematic or has had unexpected consequences (Kohlbacher & Herstatt, 2008; Lehoux, 2006). When it comes to any technological innovation, it exists in relation to its use-context and to a broader cultural context (Borup et al., 2006; Lente & Rip, 1998). Based on one's expectations, innovations will be embedded differently according to some set of culturally constituted values and activities. I believe that the adoption of a technological innovation depends on being able to match the users' expectations. In agreement with other authors (Brown & Michael, 2003; Lente & Rip, 1998), I argue that expectations are socially constructed by humans. Expectations are ways of making sense of the world, and their meanings are based on past experiences and alter our future behaviour toward other human or non-human actors (Latour, 2005). This means that expectations are both retrospective and performative (Brown & Michael, 2003; Lente & Rip, 1998). While Brown & Michael and Lente & Rip have investigated the expectations of innovations throughout society (macro level), the research presented in this thesis focuses on expectations of innovations on a micro level (the individual elderly user). Thus, at the micro level, the retrospective aspect of expectations suggests that memories and experiences of the past form the construction of expectations, and the performative aspect of expectations suggests that expectations shape actions (enabling or constraining actions).

In order to estimate how older people will (or not) adapt social assistive robots and telehealthcare systems, we need to start by investigating and exploring their expectations of such innovations.

Definitions

This section defines the words “innovations”, “older people”, “telehealthcare systems”, “robots”, “social assistive robots” and “expectations”.

Innovations

It makes sense to start by defining what “innovation” means. Rogers defines it as “an idea, practice or object that is perceived as new by an individual or other unit of adoption” (E. M. Rogers, 1995 , p. 11). The word “innovation” refers to something new, that if adopted may alter the goals and needs of existing technology and can be explored as a catalyst of change in everyday practices (MacKenzie & Wajcman, 1999). The reason I use the word “innovation” when referring to social assistive robots and telehealthcare systems is because these technologies are unfamiliar and are not part of the everyday knowledge and practices of older Swedish people. If adopted, they will provide new practices and change their everyday lives. If older people adopt social assistive robots and telehealthcare systems, these emerging technologies will be part of their social interactions and communication, and thus change the nature of traditional care of older people. However, one has to keep in mind that innovations are not developed in a vacuum, detached from familiar and embedded practices (MacKenzie & Wajcman, 1999). The negotiation of the symbolic meaning of a specific innovation is related to existing technologies, social practices and the user’s previous experience of similar innovations (Silverstone & Hirsch, 1992). Often innovations emerge from new combinations of existing technology, or are the result of a gradual change of existing technology (MacKenzie & Wajcman, 1999). The meaning of innovations is created through a complex network of users, engineers, designers, manufactures, mass media, etc. (Brown & Webster, 2004).

Older people

The phrase “older people” implies that old people belong to a homogeneous group. The phrase implies that older people are seen as objects and that they are made passive. The intention here, however, is actually the opposite. The older people who participate in this research are valued as co-researcher or

co-designers. During the research process they co-construct their own identities as users of robots and I study what happens during that process – it is very dynamic and iterative. In theory there are no agreed definition of "older people" (Victor, 2005, p. 6) since the group is so heterogeneous. Older people as a group, differ considerably in individual abilities, skills and experiences (Czaja & Lee, 2007). Age is likely to increase the differentiation within the "group" more than most other "groups" due to life experiences and physical conditions. "Older people" is not a satisfactory expression, but for want of a better one, it will be used throughout the thesis to refer to older individuals with different life narratives. The thing they all have in common is that they are retired and over the age of 65. In the beginning of the research process, the selection criteria were wide to get a broad idea on older people's expectations of social assistive robots and telehealthcare. During the progress of the research process, the selection criteria narrowed to involve age-related incapacities such as mobility, hearing and visual problems.

Telehealthcare systems

There is no common definition of telehealthcare and the terms "telecommunication", "telecare", "telerehabilitation", "telehealth", "health informatics" and "eHealth" are used interchangeably (Melander Wikman, 2012). Charness et al. propose: "A short definition for the field would be: the remote provision of healthcare services and education by the means of information and communications technology" (Charness, Demiris, & Krupinski, 2011 , p. 1). Telehealthcare systems are technological solutions for providing healthcare at a distance, such as via telepresence and sensors. With the help of virtual interaction (teleprecence) and monitoring devices (door usage sensors, electrical usage sensors, bed occupancy sensors, and fall sensor), healthcare professionals can monitor and follow up diseases or health changes, access medical data for diagnosis or interact with the patient in her own home without being physically present.

Robots and social assistive robots

Another word that needs to be defined is "robot". Winfield alerts us to the difficulty of defining robots and determining what they do, given their ubiquity (Winfield, 2012, p. 8). In spite of the diversity of robots, most can be analysed as consisting of one or more of following components depending on what they are supposed to do: sensors, cameras, microphones, motors, a battery and grippers. The concept of a robot is that it is a manufactured artefact which can "sense its environment" via its sensors and "purposefully act on or in that environment" (Winfield, 2012). Winfield also notes that a robot should be useful and autonomous. He emphasises that robots are not autonomous like humans, but they can be perceived as autonomous if they are able to do preprogrammed task without continual help from humans. To date no social robot is entirely autonomous in the sense that it reacts to its environment without any human intervention (via preprogramming) or control but some behave as *if* they were autonomous and intelligent (Winfield, 2012).

Figure 2. Example of what an assistive robot may look like.

Social assistive robots are being designed to assist older people in their homes by supporting them with daily activities, providing household help, maintaining safety (e.g. fall detection, safety reminders, alarms) and monitoring (Chan, Campo, Estève, & Fourniols, 2009). The field of social assistive robotics is also evolving and with no unified definition. Breazeal defines them as robots that are "designed to interact with people in a socio-emotional way during interpersonal interaction" (Breazeal, 2004). The promises of social assistive robots are not only to perform household tasks and monitoring, but to also interact with the older users and induce positive feelings (Bouma et al., 2007). I will use the phrase "social assistive robots" since the robot I am studying is supposed to interact and help the older users.

Expectations

Expectations are notions of the individual's belief of certain intentions, goals and hopes to come into being in the future (Borup et al., 2006). Theories of expectations in regard to technology acceptance attempt to explain what motivates people to adapt to specific innovations (Davis, 1985; R. Eisma et al., 2003; E. M. Rogers, 1995). The expectation theory of innovations is seen as a cognitive process of motivation. It is based on the idea that people believe there is a connection between the effort they put into having and using an innovation, and the benefits they receive in return (Davis, 1985; R. Eisma et al., 2003; E. M. Rogers, 1995). In contrast, according to social constructivism, innovations are not viewed as neutral or as tools of human purpose but as a result of the latent power the particular innovation has in relation to the complex of possibilities open to the human involved (Suchman, 2006b; Turkle, 2011). For example, when a robot moves into the home of older people, they become objects of surveillance and are indirectly or directly influenced by the "public policy" form of power. The significance is in the context in which the robot operates. This suggests that innovations such as social robots and telehealthcare systems are culturally embedded and variants of cultural traditions will come into play in the human-robot (or any other technological innovation) interaction relationship (Suchman, 2006a; Turkle, 2011).

Why do older people's expectations of innovations matter?

As mentioned before, innovations can refer to abstract objects such as ideas but also more tangible objects like artefacts and new technologies. The research in this thesis focuses on innovations such as social assistive robots and telehealthcare systems. The research on expectations examines older people and their association to assistive robots and telehealthcare systems. How these expectations are generated and how they are negotiated and changed will be analysed. As Lie and Sørensen eloquently describes it: "When we bring technology, the assumed catalyst of change, into everyday life we need to modify our notion of both – perceiving everyday life to be not so stable and technology not so revolutionary" (Lie & Sørensen, 1996 , p. 3). Too often, analyses of innovations are limited to the likely and actual effects of technology on humans (Lehoux, 2006). Putting older people's expectations of robots and telehealtcare systems front and centre is important for several reasons. Firstly, it provides an insight into the nuanced view older people have of robots and telehealthcare systems. Older people are too often represented as a homogeneous group of less adaptable, lonely and frail people (Brownsell, Blackburn, & Hawley, 2008; Neven, 2011). Secondly, older users are experts on their lives and the activities the assistive robot or telehealthcare system for eldercare is designed to support. They can teach us a great deal about the challenges and highlights of growing old and what the social assistive robot or telehealthcare system must be able to do to positively meet their expectations and as a result, become adopted by older people. Thirdly, my hypothesis is that expectations are what mediate the adoption process and shape the relation between the older person and her experience of a specific innovation. By addressing the actual roles expectations play in the adoption process of innovations in older people's lives, I hope to contribute to practical design issues and methodological issues that have to be addressed in order for a successful adoption process. Fourthly, old age means continual changes of the character and context of the older individual's activity and also his or her outlook on life and expectations of innovations. Capturing older people's expectations of social assistive robots and telehealthcare systems can explain current conditions, challenge attitudes that are taken for granted, reveal overlooked circumstances and discover alternative possibilities. Older people's

experiences in the past and their expectations of future innovations can inform how they experience an existing social assistive robot and an existing telehealthcare system.

It is often difficult to capture the user's expectations of innovations since users have no prior experience of the specific innovation. One cannot help asking: Can an early fruitful discussion on the pros and cons of the specific innovation effect its development in the "right direction"? Can such a discussion enable a more sociotechnical perspective, taking into account how the meaning of the specific technology is developed and how it affects the self-identity of the users?

Aims and objectives of the research

This licentiate thesis is the first summary of my research, which investigates older people's expectations on how they perceive social assistive robots and a telehealthcare system. To achieve this objective, arguments were drawn from theories on older people and ageing, the philosophy of technology, as well as from empirical work in two EU-funded research projects: HOBBIT and GiraffPlus.

In the discussion section I will present the broad implications of my research results as they relate to the way in which older people and innovations are presented. However, I will first describe the background of my research, the theoretical framework on which the analysis is based, the research methodology and results of my studies. I will conclude with a summary and suggestions for future research.

Background

The fieldwork on which my research is based was carried out in two user driven design projects: HOBBIT and GiraffPlus. In this section, I describe the objectives of the projects, the target users and the research approach. Both projects comprise engineers, doctors, physiotherapists, psychologists, gerontologists, computer scientists and cognitive scientists. These research groups are constructive by nature and the model of research and knowledge production had to be negotiated in the projects and among project members. The limitations of such collaborations are that some assumptions are not questioned, such as the biomedical model of ageing and which technical requirements to implement. On the other hand, knowledge is gained on how artefacts are developed and how user findings and user requirements are negotiated and redefined by different, more senior researchers.

The empirical fieldwork presented in this licentiate thesis consists of data from questionnaires, workshops, in-depth interviews with users and informal caregivers, and user-trials in the lab. The data have been collected before the innovations – a social assistive robot and a telehealthcare system – will be introduced into the domestic environment of the older people. The next step will be more fieldwork in 2014, and the focus will be on the adoption of these innovations in domestic settings. Let us take a brief look at the design projects in which the fieldwork was carried out before we move on to analyse older people's expectations of social assistive robots and telehealthcare systems.

The HOBBIT project

The HOBBIT project is funded by EU's Seventh Framework Programme (www.hobbit-project.eu). The aim of the project is to develop a robot system that assists and enables older people to continuing living in the own homes for a longer period of time. Several assistive robot projects have focused on developing robot systems to assist older people and support independent living (Bemelmans et al., 2012; Broadbent, Stafford, & MacDonald, 2009; Broekens, Heerink, & Rosendal, 2009), but the uniqueness of the HOBBIT project is the focus on bonding and mutual care between the older user and the robot. Mutual care is considered as a framework for facilitating a mutual relationship between the user and an assistive robot. The hypothesis is that "mutual care" will increase the acceptance of robots by older people. The question is: What kind of functions, appearance and behaviours should a robot have in order to facilitate a mutual relationship with older users? And if successful, does it enable acceptance?

The primary target group is older people, seventy years of age or older, who in the near future will need assistance in order to stay in their own home. The selection criteria also include minor, moderate and severe vision, hearing and/or mobility impairments. People who are in regular contact with the involved older people, such as relatives, are considered as secondary users.

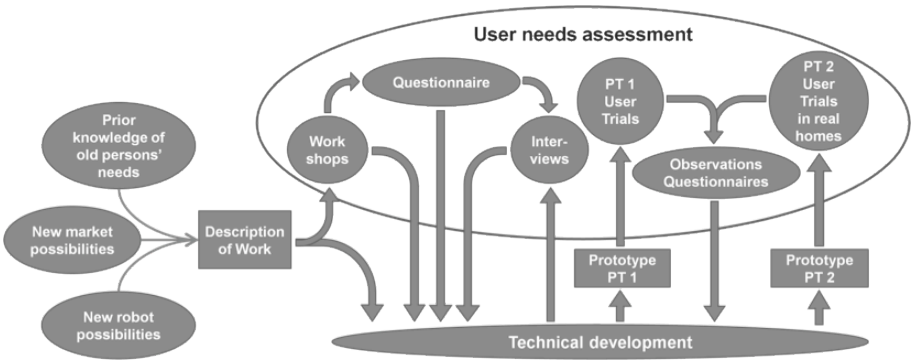

Figure 3: The user-centred approach in the HOBBIT project

The user-centred approach in the HOBBIT project consists of involving older users in workshops, a questionnaire and interviews (Fig. 3). The findings and lessons learnt from one method are fed into another. The pre-study focus groups identified expectations of assistive social robots. A workshop was then organised to verify the findings and to identify major themes that were addressed in the questionnaire. The results from the questionnaire and workshop were verified in interviews with older prospective users and relatives. Thereafter, a first prototype was developed and tested in a usability lab. Further work will include testing a second robot prototype in older people's homes.

The GiraffPlus project

The aim of the GiraffPlus project is to prolong independent living for elderly people in their own homes (www.giraffplus.eu). The promises of the system are to fulfil older people's wishes to stay in their own homes as long as possible, as well as to address the economic perspective of residential care, which views it as being equivalent with decreased costs of caretaking for older people. The issues addressed in the project are: (1) early detection of possible deterioration of health in order to identify problems and remediate them at an early stage, (2) providing support in coping with age-related impairments, (3) enabling social interaction with relatives and caretakers. The GiraffPlus system collects daily behaviour and physiological data from sensors, performs context recognition, and in particular, long-term trend analysis. The system consists of a network of non-invasive wireless home sensors and a semi-autonomous telepresence robot (Fig. 4). The sensors can measure blood pressure, bed/chair occupancy and detect when somebody has fallen down. At the centre of the system is a unique telepresence robot: the Giraff.

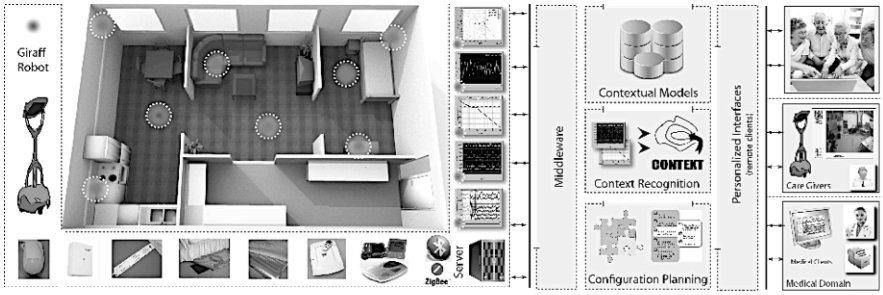

Figure 4. The GiraffPlus system

The primary users are people who are 65 years of age or older. This selection criterion is according to the Eurostat definition of older persons (Eurostat, Retrived 1st June, 2013). The person should be living on his or her own home. The selection criteria also include frailty when walking, instability and risk of falling, feelings of insecurity, having at least one chronic condition, and receiving medical treatment. Secondary users are family, friends and healthcare professionals. Relatives and friends are those appointed by the older participants; healthcare professionals are those who have regular contact with the older users concerning their health.

The development of the GiraffPlus system is driven by a participatory design approach that focuses on collaboration with intended users throughout the whole development cycle (Koskinen, Zimmerman, Binder, Redstrom, & Wensveen, 2011). The primary and secondary users are actively involved in determining the user requirements and functional specifications of the system by participating in focus groups, workshops and usability testing in the lab. Future fieldwork includes evaluating the GiraffPlus system in the domestic environment of older people.

Underlying theories, frameworks and concepts

The research presented in this licentiate thesis is situated at the intersection of older people, technology, and the innovation-adoption process. Thinking theoretically about older people's expectations of social assistive robots and telehealthcare systems requires micro, meso and macro perspectives in which emerging ideas from the empirical framework can be analysed and evaluated on the basis of if they converge with or contradict exiting theories, frameworks and research findings. In this section, the following key concepts will be outlined: (a) notion of technology; (b) notion of adoption of innovations; (c) notion of older people. A discussion will then follow on how these notions are connected. The notion of technology will help us understand the underlying values that guide expectations of innovations. The section on notion of adoption of innovations briefly describes different traditional models of technology acceptance and diffusion theories. This section highlights the importance of expectations. The notion of older people cannot predict their expectations, adoption and acceptance of certain technologies, but it can help us identifying factors that may underlie older people's expectations of innovations. I rely on the constructionist view, the thinking of which is to "treat technical concepts and things in relation to, not apart from, the social world" (Kaplan, 2009 ,p. xviii).

Outline of the underlying theories, frameworks and concepts

Research on technological innovation has portrayed innovations as the product of multiple variables such as social context, cultural context,

political context and economical context (Akrich, 1992; Brown & Webster, 2004; Haddon, 2007; Latour, 2005; Law & Hassard, 1999; MacKenzie & Wajcman, 1999; Silverstone & Haddon, 1996) in contrast to merely a result of engineering efforts. Adoption and diffusion theories provide a framework for how innovations evolve and are adapted by users (E. M. Rogers, 1995). Silverstone and Haddon propose various dimensions to explain how an innovation becomes a part of the user's everyday life, and as a result the innovation becomes domesticated (Silverstone & Haddon, 1996). Their model provides a way to analyse how information and communication technologies play a role in the everyday lives of users. The stages (i.e. commodification including expectations, appropriation including objectification and incorporation, and conversion) are not fixed and the domestication of new technologies is not considered to be a linear process (Berker, 2006). As mentioned in the background section, the empirical fieldwork consists of empirical studies carried out before a social assistive robot and a telehealthcare system were introduced into the domestic environment of the older people. Future fieldwork will focus on the adoption of a social assistive robot and a telehealthcare system in users' domestic settings. If one accepts that expectations are both mediators of and mediated by the adoption of social assistive robots and telehealtcare systems, emphasis needs to be placed on the commodification of specific innovations and their emergence in relation to current notions of technology, adoption of innovations and older people, and the context in which expectations occur, and what they socially symbolise (Fig. 5).

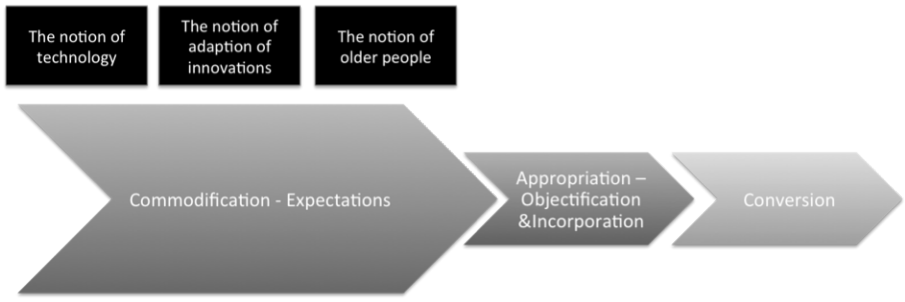

Figure 5: Underlying theories, frameworks and concepts

The notion of technology

There are many different definitions of technology, but according to Mackenzie and Wajcams, the description of technology compromises: (1) artefacts and technical systems, (2) knowledge about these systems, and (3) practice of handling these systems and artefacts (MacKenzie & Wajcman, 1999). The interpretation of technology in relation to society can been seen from different perspectives: as neutral, as deterministic, as autonomous, and as socially constructed (Kaplan, 2009). Since expectations are enabled and constrained by the different actor's knowledge, beliefs and values, it is of importance to understand how technology and innovation can be viewed.

The *neutral perspective* refers to technology only being a tool with no purpose or values (Kaplan, 2009). A human uses the technology as an instrument for his or her activities. The human can use the technology for a bad or good purpose, but the technology itself is believed to be neutral (Kaplan, 2009).

In the *deterministic perspective*, technology is seen as the driving force of social change. In short, it is believed that society responds more to technology than technology responds to society (Kaplan, 2009). In this view, "technology is the primary agent of change, not humans" (Kaplan, 2009 , p. xvii). As Wyatt points out:

> The simplicity in this model [technology as deterministic] is, in large part, the reason for its endurance. It is also the model that makes most sense to many people's experience. For most of us, most of the time, the technologies we use every day are of mysterious origin and design. We have no idea whence they came and possibly less idea how they actually work. We simply adapt ourselves to their requirements and hope they continue to function in the predictable and expected ways promised by those who sold them to us (Sally Wyatt, 2008 , p. 169).

Wyatt identifies four reasons for technical determinism: justification, description, methodological and normative. She proposes that technical determinism is used: (1) to justify reorganisations and downsizing; (2) as a description such as the industrial revolution, the information age or the robot era; (3) as a methodology to understand diffusion of innovations and the history of technology; and (4) as normatively affecting human behaviour while technology is too complex, ambiguous and too big to fully comprehend (Sally Wyatt, 2008). She argues that technological determinism cannot be ignored and that there is a need to study explanations of things and people. Bijker uses the concept of "technological momentum" to describe a technological system that grows in a certain direction and speed due to the investments in people, technology and money (Wiebe E Bijker, 2010). He argues that the bigger the technological system grows, the harder it is to change its course; hence, the system will have an increasing impact on its sociotechnical environment. Similarly, Collingridge argues that the "paradox" of the development of innovations is that early in the development, we know too little about the specific technology to influence its development; when it is diffused into society and we can see the consequences of its application, it is too late to make any impact on the development (Collingridge, 1980).

The *autonomous technology perspective* argues that machines act without human input (Winner, 1977). Technology is the primary agent of control and change, not humans – "Technology shapes technology" (MacKenzie & Wajcman, 1999 , p. 7). Technology is believed to be ubiquitous in our lives and controls us instead of us controlling it (Kaplan, 2009).

In the *social construction theory of technology perspective,* emphasis is on the mutual shaping of technology and society. Technology is made and used by humans and therefore reflects human values and ideas (Kaplan, 2009). We as humans design technology to achieve certain goals and to satisfy our needs. Social constructivism has developed as a critique of technical determinism, arguing that humans socially construct technology. An example of this is that during the development of innovations the developer configures the users into the product (Latour & Woolgar, 1979). The user may be either represented by the developer's personal image of future users

or based on the developer's own preferences, needs or wants. Bandini and August Horvath (1995) call the user configuration "the reflexive user" and consists of "future real users in the mind of the developers" (Bardini, 1995; S. Wyatt, 2003). The notion of the configuration of the user is also mentioned by Akrich as the I-methodology and is defined as "the personal experience of the designer (engineer) and is used to make statements on behalf of future users" (Akrich, 1992). Latour and Woolgar argue that new technology tries to configure the user by setting the constraints on what the user is able to do (Latour & Woolgar, 1979). The focus in a constructivist analysis is both on how technology impacts society and how society impacts technological development (MacKenzie & Wajcman, 1999). Technology from a constructivist perspective is seen as "artefacts, knowledge and practices" (Wiebe E Bijker, 2010 , p. 73). A specific artefact possesses different meanings for people in different situations and opening the "black box of technology" enables an understanding of the "interpretive flexibility" of technical artefacts and their use (W. Bijker & Law, 1994). In this perspective, the "black box of technology" refers to the fact that technology and the configuration of technology is not questioned and that technology is seen as neutral and taken for granted. Instead, the constructivist argues that we need to reflect critically and appreciatively on technology and our relationship to it (MacKenzie & Wajcman, 1999). The social constructivism stance proposes that we ask questions about: What are the alternatives? What are the comparative outcomes of multiple standpoints? What is true, necessary, essential and right when it comes to technology (in this case social assistive robots and telehealthcare systems)?

The notion of adoption of innovations

I will briefly outline the different theories of technology adoption and acceptance and show how differences in expectations affect how an innovation is perceived (Brown & Webster, 2004; Lehoux, 2006; MacKenzie & Wajcman, 1999). Some people are more open and willing to change, while others are more hostile (Giddens, 1991). The reason for hostility to innovations may be a fear of losing control or being viewed by others as incompetent (Bandura, 1993; Giddens, 1991).

The different models of diffusion of innovations and technology acceptance demonstrate a correlation between expectations and acceptance of technology. The technology acceptance model (TAM) (Davis, 1985, 1989) suggests two determining factors linked to the user's expectations that affect the his or her attitude towards a specific innovation: *perceived ease of use* and *perceived usefulness*. Davis argues that "people tend to use or not to use an application to the extent they believe it will help them perform their job better" (performance expectancy) (Davis, 1989 , p. 320), and "the degree to which a person believes that using a particular system would be free of effort" (effort expectancy) (Davis, 1989 , p. 320). TAM was developed during the 1980s in a context where computers there considered as tools to conduct work. Venkatesh et al. developed a unified theory of acceptance and use of technology (UTAUT) from reviewing TAM and seven other models, which explained information systems usage and behaviour (Venkatesh, Morris, Davis, & Davis, 2003). The UTUAT model focuses on performance expectancy, effort expectancy plus social influence and facilitating conditioning. The UTUAT model reinforces that it is not only one's own expectations that affect the acceptance of a specific technology, but also the expectations of other people and the social norm. Venkatesh et al. argue that social influence has a considerate impact especially for older women in an early stage of experience of a system (Venkatesh et al., 2003). They also argue that training, support and technical infrastructure affect the expectations and adoption of new information systems. Similarly, Rogers' diffusion of innovation theory argues that innovations are likely to be successfully adopted if: (1) the innovation is perceived as better than the idea/product it succeeds – relative advantages; (2) the innovation is perceived as being consistent with exciting values, past experience and the person's needs – compatibility; (3) the innovation is perceived as easy to use – complexibility; (4) the person can try it out before buying it – trialability; and (5) the use of the system is visible and liked by others – observability (E. M. Rogers, 1995).

While TAM and UTUAT investigate technology acceptance on a micro and meso level (the individual and the social context she or he belongs to), Rogers' diffusion of innovation theory, investigates the spread of

innovations throughout society (macro level). He claims that innovations seem to follow a general process each time they are successful. Rogers perceives diffusion of innovations as a process of social construction, and that innovations present a new alternative and means to solve a problem. He argues that information about an innovation is often sought from peers and their subjective evaluation of the innovation. The diffusion of an innovation is dependent on: 1) the specific innovation; 2) how it is communicated through certain channels; 3) time; and 4) the social system it belongs to (E. M. Rogers, 1995). In the diffusion of innovation theory, expectations can be seen as a doubled edge sword: on one hand, expectations are crucial for painting a vision of the future, and the promises of innovations often need to be extravagant in order to generate interest and investments; on the other hand, user expectations of a specific innovation that are too high can lead to disillusion (Brown, 2003). The idea of dynamics of expectations suggested by Lente (Lente, 1993) points out that expectations are most often performative in the sense that the expectations "design" the problem and the solution. As Brown and Michael argue "representations of the future are both potent resources in constituting the present and the future, but also highly unreliable – the past is littered with failed futures" (Brown & Michael, 2003 , p. 7).

As mentioned, the social constructivist approached was developed as a critique to technical determinism and argues that humans socially construct technology (W. Bijker & Law, 1994). In a similar fashion, one can also argue that expectations are socially constructed. Expectations can be seen as a configuration or "script" of the interaction between ourselves and other humans and innovations (artefacts). The human-technology relationship will be reciprocal and what Bruno Latour's called "symmetry between humans and non-humans" (Latour, 1999). In a similar fashion, expectations that are shared by many actors (engineers, researchers, users, lay people, etc.) will become instrumental and shape the diagnosis of the problem and the solution may be applied in the form of innovations (Berkhout, 2006). As mentioned in the introduction, the problem of an increased ageing population has increased the demand for technological solutions that can provide help and monitoring of the older population. The discourse opens up discussions: multiple positions and views focused on an ageing population, social assistive robots, telehealthcare systems, and modern ageing (Ekholm, 2012).

This discourse might be understood as change due to the expectations of and on the older ageing population, as Lente and Rip argue, "…expectations of innovations are based on the *promises* of the specific innovation" (Lente & Rip, 1998, p. 205). These promises become trajectories that demand action and as a consequence, the expectations turn into requirements that have to be transformed into reality or it can lead to disillusions about the specific artefact (Lente & Rip, 1998).

The expectations and promises of social assistive robots and telehealthcare systems

There is an underlying political and economic interest in the development of innovations such as social assistive robots and telehealtcare systems, given an increasing demand for health and social care services due to an ageing population (Nelly Oudshoorn, 2011). Low fertility has led to fewer children being born and low mortality has ensured that those who are born have a 60% chance of living beyond the age of 75 (Victor, 2005). The prediction is that the average age will rise and an increased percentage of the population will be older people (about 25% by 2025) (Bouma et al., 2007). The growth of an older population and shortage of caregivers have spurred the development of matching technological advances to human needs. The promise of social assistive robots and telehealthcare systems is to solve the challenges created by an increased older population and shortage of healthcare providers. This will be done by enabling older people to take care of themselves (with the help of domestic robots) and by being socially engaged with friends, family and their community (by the use of internet and telepresence). Often the early expectations of innovations do not equal the future results, and with time, expectations have to be adapted to become more realistic scenarios (Brown, 2003). Brown and Webster argue that "while expectations appear to be essential to mobilise activity, early hopes are rarely proportionate to actual future results" (Brown & Webster, 2004 , p. 180). They point out that the hype – the media and the work of imagination – can be counterproductive and result in lasting damage to the trustworthiness of the specific innovation.

The notion of older people

In my research I look at older people and their expectations of the use of social assistive robots and telehealthcare systems. This section provides key ideas on theories of older people and ageing, and links them to technology expectations. Demography provides a picture of the current older population while the theories of ageing provide an indication of how the experience of ageing can differ. In this section, theories of ageing will be used to provide a framework for the analysis of older people's expectations and acceptance of innovations.

Theories of ageing

On hearing the word "older people", a range of images spring to mind such as a grey, wrinkled woman or man, older relatives or perhaps walking aids, hearings aids, etc. In theory, there is no agreed definition of "older people" (Victor, 2005, p. 6) since the group is not homogenous. Suggestions for defining old age have been to use calendar age or life stages but as Pirkl (Pirkl, 2008) puts it, "Young people grow old. Disabled people grow old. Young people can be disabled. Old people can be disabled". Defining old age by calendar age and life stage is too simplistic an approach to old age, since old age is defined in its cultural and historical context (Moody, 2006). The literature on the process of ageing mirrors the dynamic and varying nature of ageing by means of different perspectives, varieties and interpretations. The central themes, values and interest assign older people different identities. The biological dimension of the ageing human body focuses on the constant physical effects over people's lifespan. The human body is likened to a machine, which over time eventually wears out (Moody, 2006; Victor, 2005). The human body is believed to have a "set" lifespan that is affected by how we live our lives. The biological perspective concentrates on dysfunction and decline of the older body. The social dimension focuses on understanding ageing on a microscale (i.e. understanding the individual experience of ageing) and macroscale (i.e. understanding how society's values, public policy and community norms shape older people's experience of ageing) (Rodeschini, 2011; Victor, 2005).

The psychological dimension of ageing focuses on the notions of self and identity, personality and mental function (Moody, 2006; Victor, 2005).

Theories of ageing are often concerned with how to age successfully. Examples of this are disengagement theory, activity theory, continuity theory and geotranscendence. Disengagement refers to a decrease in the individual's involvement (i.e. retirement, politics) and a reduction in activity level (i.e. physical and social) with age. Positive ageing, according to this theory, concerns people who desire or accept the withdrawal process (Nussbaum, Pecchioni, Robinson, & Thompson, 2000). Activity theory, in contrast, advocates high social involvement and physical activity throughout one's lifespan (Nussbaum et al., 2000). "Connect, be active, take notice, keep learning and give" (Brey, Briggle, & Spence, 2012: p 104) is seen as a mantra for positive ageing. Both disengagement theory and activity theory constitute continuity theory, which emphasises a person-centred approach and an understanding that we are all individuals with different needs and wants (Nussbaum et al., 2000). To age successfully according to the continuity theory, we need to preserve our habits, lifestyle and wants during the ageing process. In contrast, gerotranscendence theory focuses on positive ageing and perceives ageing as a shift of meta-perspective (Tornstam, 2005). Human ageing is seen as a continuing process into old age, which leads to new qualitative perspectives of life. The individual redefines the notion of self and identity, relationship to others as well as gaining a new understanding of existential issues (Tornstam, 2005). In this theory, ageing is seen as normal transition in an individual's lifespan where the older individual is constantly redefining and evolving his or her sense of time, space, life, death and self.

Theories of ageing in relation to older people's expectations and acceptance of new innovations

An easy assumption is that innovations such as social assistive robots and telehealtcare systems can enable older people to be autonomous, primarily by enabling the same quality of life by means of social connectivity via a telepresence and support via robots that execute activities in the domestic environment (Forlizzi, DiSalvo, & Gemperle, 2004). Citing Blaschke et al.,

the promises of assistive innovations and information and communication innovations are:

> "improved quality of life, extended length of community residence, improved physical and mental health status, delay the onset of serious health problems and reduce family and care-giver burden" (Blaschke, Freddolino, & Mullen, 2009, p 641).

The question is: Can social assistive robots and telehealthcare systems support modern ageing and wellbeing of older people?

If we assume that one objective of developing social assistive robots and telehealthcare systems is to support the wellbeing of an older population, then studies on wellbeing are relevant for understanding older people's expectations of such innovations. Ryff has identified six criteria of wellbeing when growing older by reviewing the literature of the ageing process (Ryff, 1989, p 41-44). The first is a positive attitude towards one's self and one's life (*self-acceptance*) (p. 41). Accordingly, acceptance of oneself, including both good and bad qualities, can lead to happiness. Similarly, gerotranscendence theory argues that the self gradually develops and changes and that people in their older days discover and accept both positive and negative sides of themselves (Tornstam, 1997). Ryff's second criterion is a lifetime of positive interpersonal relationship (*positive relations with others*) ((Ryff, 1989, p. 42) However, according to gerotranscendence theory, a redefinition in older age regarding the meaning of relationships to other people occurs; older people become more selective in what they like to do and with whom (Tornstam, 2005). Ryff's remaining criteria of successful ageing are: 3) being independent and being able to function on one's own (*autonomy*); 4) adapting one's environment to one's needs (*environmental mastery*); 5) having achievable goals and intentions that contribute to a feeling of meaningfulness in one's life (*purpose of life*); and 6) individual growth and achievement (*personal growth*) (Ryff, 1989, p. 42-44). Furthermore, in light of the gerotranscendence theory, everyday experiences such as music, technology or nature may have an increased significance for older people's practices and purpose of life (Tornstam, 1997). Belk argues that music is a way of transcending from the here and now to the past or being "re-born" to another life (Belk, 1988). He believes that old people are past oriented and that our past makes up a greater part of who we are the

older we become, while young people are future oriented (Belk, 1988). He suggests that older people are past oriented in the sense that they treasure possessions that are remembrances of happier times, such as photos, furniture, etc. In sum, we feel happy if we understand the purpose of being alive and have important ties between the past, others and ourselves.

In contrast to the stereotypical view of the elderly, evidence indicates that older people are far from passive consumers but technogenarians: individuals who creatively adapt and utilise technological artefacts to fit their own needs (Joyce & Loe, 2010). Tornstam's gerotranscendence theory implies that ageing is a normal transition in one's life that involves selectivity in the choice of social and other activities (Tornstam, 2005). As a consequence, older people choose to adopt technologies that they perceive as beneficial (Melenhorst, Rogers, & Bouwhuis, 2006). "Older people do adopt innovations. …older people will generally not just buy things for their newness, they are likely to be more critical and make comparisons with competitive offerings" (Szmigin & Carrigan, 2000, p 510). In summary, the usage of assistive technologies such as social assistive robots and telehealthcare systems is not dependent on a single variable but on multiple ones such as: 1) individual variables (e.g. personal evaluations of disability and devices, perceived needs and functional status); 2) environmental variables (e.g. the social and physical characteristics of the usage context); 3) device variables (e.g. ease of use, the design of the device and the person-task fit) (Gitlin, Schemm, Landsberg, & Burgh, 1996) (Fig. 6).

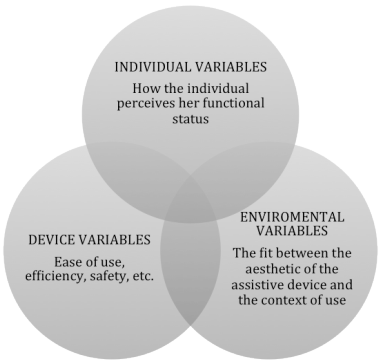

Figure 6: Variables that affect assistive technology acceptance

To sum up, social assistive robots and telehealthcare systems promise new types of connectivity between older users and others (e.g. relatives and healthcare professionals), but the specific technology itself is less likely to matter; instead, it is important that it is perceived by the older user as beneficial: easy to use, durable, adaptable and having aesthetic qualities that fit into the domestic environment (Rodeschini, 2011).

The notion of technology, the notion of the adoption process, and the notion of older people yielded a set of factors that can influence and predict older people's expectations of social assistive robots and telehealthcare systems (Fig. 5). Findings from research on the adoption process of assistive technology have also been presented. These findings will be verified by the empirical results. The next section describes how the research was conducted on older people's expectations of social assistive robots and telehealthcare systems.

Methodology

In this section, we journey through the fieldwork that constitutes the empirical findings on which the licentiate thesis research is based. First, I explain how and why I involved users and present methodologies for how they can be involved. This is followed by a presentation of the study context, the participants, the methodology, data collection, and data analysis.

Why involve users?

The aim of my research is two-fold: 1) to explore and investigate older people's expectations of social assistive robots and telehealthcare systems, and 2) to develop a useful social assistive robot and a usable telehealthcare system as a member of two research teams. In my fieldwork, I like to give older users an active role in the design process of a social assistive robot and a telehealthcare system. This is done for ideological and scientific reasons. *Ideological* since I believe if we are designing and developing products for older people they should be involved. Thus, innovations such as social assistive robots and telehealthcare system, if adopted, can affect and change older people's everyday lives. New technological developments are often perceived as if they were autonomous and the development unstoppable, instead of us controlling the technology development and transforming the technology to suit our needs (Silverstone & Hirsch, 1992). If I am to contribute to and impact changes in older people's everyday lives, the innovations have to be perceived as positive and enhancing by the prospective older users – in my opinion it is about democracy. *Scientifically*, since participatory design is as much about research as it is about design as explained by Spinuzzi:

> In this methodology, design *is* research. That is, although participatory design draws on various research methods (such as ethnographic observations, interviews, analysis of artefacts, and sometimes protocol analysis), these methods are always used to iteratively construct emerging design, which itself simultaneously constitutes and elicits the research results as co-interpreted by designers-researchers and the participants who will use the design (Spinuzzi, 2005, p. 164).

To date various methods have been developed and introduced to involve users in the development process (Battarbee et al., 2005; Koskinen et al., 2011; Y. Rogers, 2012). This is in contrast to the deterministic view of technology, where older users, if involved in the development, often have the passive role of evaluating the usability and acceptability of predesigned specific technologies (Rodeschini, 2011). Traditionally the idea of involving users in the development of innovations has a long history in the field of human computer interaction (HCI), although the activities on how to do it have changed (Y. Rogers, 2012). The development of HCI has been transformed from the 1970s and 1980s, drawing on cognitive theories to understand the users' capabilities and limitations while interacting with computers to perform tasks. In the late 1980s and into the 1990s, the transformation moved the studies out of the lab (decontextualised experiments) into "the wild" (situated actions) by drawing on multidisciplinary theories such as ethnomethodology and ethnography; and in the 2000s drawing on cultural theories and social sciences that consider human values and user experiences (McCarthy & Wright, 2004; Y. Rogers, 2012). The developments in the field of HCI reflect societal change: In the 1980s computers were used primarily at work, while in 2000s computers have become ambiguous and part of everyday practices. The view of the user has transformed from being a worker who has to carry out her job with great efficiency and speed (e.g. usability), to a customer who wants a great user experience (Lazar, Feng, & Hochheiser, 2010; McCarthy & Wright, 2004). As a consequence, the context of use has changed from a specific workplace to almost anywhere. As Sanders points out, the usability aspect of a specific technology is not enough; it also has to fulfil unmet needs (be useful) and be something people want to use (desirable) (Sanders, 1999). Human values are seen as being incorporated in the user's experience (Sanders, 1999), and as Belk argues,

> We cannot hope to understand consumer behaviour without first gaining some understanding of the meanings that consumers attach to possessions. A key understanding what possessions mean is recognizing that, knowingly or unknowingly, intentionally or unintentionally, we regard our possessions as part of ourselves" (Belk, 1988 , p. 139).

In sum, the users reconstruct their identities as users of a specific innovation and knowingly becoming the object of the gaze of others (Goffman, 2002). When it comes to social assistive robots and telehealthcare systems, the older user may need to reconstruct her identity to being a user of the specific social assistive robot or/and telehealthcare system.

Study context

This licentiate thesis is the product of two larger EU-funded intervention projects: HOBBIT and GiraffPlus. Carrying out research in EU development projects is both advantageous and disadvantageous. In the projects the product development is linear. The work is embedded in a linear sequence: 1) project proposal (in the proposal the problem is identified and a solution is proposed); 2) project acceptance (based on the work being carried out in the sequences described in the proposal); 3) users involved to evaluate the problem and its proposed solution; 4) development of the "product"; and 5) users involved to evaluate the solution (Fig. 7).

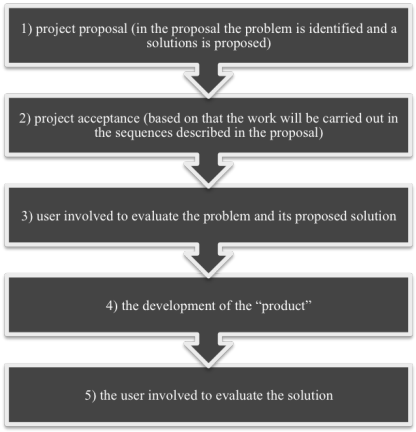

Figure 7: Outline of a linear project

The research projects on which the empirical findings are based are user-centred in the sense that prospective users are involved in the design process, but the problem definition and parts of the solution were already set before users were involved. The reductionist view of users in the projects consists of seeing them through the lens of numbers (statistics), "ideal" scenarios and personas. The focus is often on people with "special needs" and disabilities instead of inviting prospective users to participate in the projects as equals. The prospected users are seen and treated as sources of information while the experts (engineers and healthcare professionals) make all the decisions. For example, the robotic solution and telehealthcare system technology were already defined before the project started and the users were involved to specify the behaviours, functionality and appearance of the solution and system.

The linear project development differs from the more iterative and dynamic research process of exploring and investigating older people's expectations of social assistive robots and telehealthcare systems (Fig. 8). It is an on-going process where the users reconstruct their expectations the more they learn and the more experience they have of the technological innovation. Would the outcome differ if they were involved in the problem definition as well as the choice of technology to solve "the problem"? Or is it first after they have tried the specific technology in their own homes (what E. M.

Rogers (1995) refers to as "trialability") they will be able to provide feedback about its usability, usefulness and desirability since it is a new innovation of which they have no prior experience?

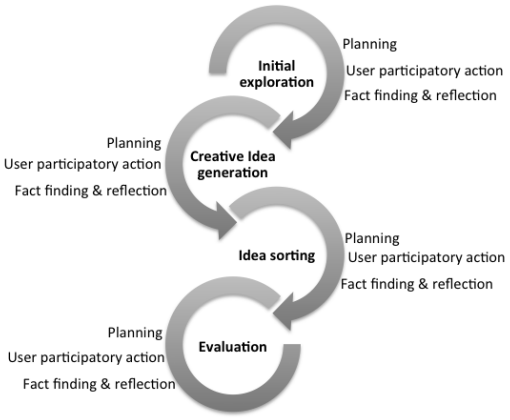

Figure 8: Outline of a user participatory project

Participants

In order to identify older people's expectations of social assistive robots and telehealthcare systems, a rolling process was used when requiting participants for the different methods. In the beginning of the research (during the focus groups and initial workshop), the selection criteria were wide to get a broad idea of older people's expectations of social assistive robots and telehealthcare systems. During the research process and progress, the selection criteria narrowed down to involve special age-related incapacities like mobility, hearing and visual problems (in the user evaluations in the lab). The rolling sample strategy was selected to generate as rich information about older people's expectations of social assistive robots and telehealthcare systems as possible (Curtis, Gesler, Smith, & Washburn, 2000). One could argue that I used a convenience sample for my research. However, I would argue that I used, what von Hippel calls "lead

users". When recruiting participants for "innovation studies" the researcher needs to have an understanding of the needs and behaviours of potential users. Von Hippel developed the term "lead user" (Von Hippel, 1986), the characteristics of which are:

- Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them.
- Lead users are positioned to benefit significantly from obtaining a solution to those needs.

The lead user method is different from traditional market research in that the approach is to identify lead users and by the use of observations and interviews identify how they solve the problem that the innovation addresses today (Von Hippel, 1986).

The controversy about using the word "users" has raged unabated for over a century (Kuutti, 2001). The word "user" configures the role of the individual to being defined by using a specific innovation. Rogers suggests that users can be categorised as early adopters, followed by the early majority, then the majority and lastly by the laggards (E. M. Rogers, 1995). So far, however, there has been little discussion concerning that the adoption and usage of innovations is a process that does not have clear boundaries since it is open-ended. I would argue that it is even more so for older people as ageing is an open-ended process with no clear boundaries. Kuutti suggests that we need to consider users as learners and in the process of the adoption of an innovation, the user becomes someone else who changes and shapes their environment to fit the construction of their "new identity" (in this case, as users of robots) (Kuutti, 2001).

The users involved in the different studies were recruited to match the profile of prospective users of future social assistive robots and telehealthcare systems. The profile of the users matched the criteria that identified the target users in the research projects. For the social assistive

robot, the target users were seventy years of age or older who in the near future would be in need of assistance in order to continue living in their own homes. The selection criteria also included minor, moderate and severe vision, hearing and/or mobility impairments. For the telehealtcare system, the target users were people 65 years or older, according to the Eurostat definition of older persons (Eurostat). They were single and lived in their own homes. The selection criteria included frailty with walking, instability and risk of falling, feelings of being insecure, having at least one chronic condition and receiving medical treatment. In total the sample size consisted of 149 (9 of whom were involved in more than one study) older people.

Prior to commencing the studies, ethical approval was sought from the Swedish ethical review board. The older people were recruited through contacts with senior organisations in Lund, Sweden and the municipality of Örebro, Sweden. Advertisements in senior magazines were also used, in order to recruit volunteers that mirrored the diversity of the older user population. In the sampling process for the user evaluations in the lab, we ensured that particular characteristics such as poor balance, decreased vision and hearing were included.

Outline of the methodology

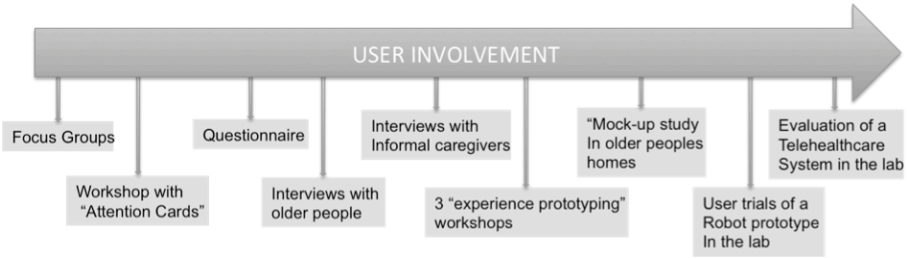

Figure 9: Overview of all the methods used

Several methods were used during the fieldwork (Fig. 9 & 10). The findings and lessons learnt from one method would feed into another. The quantitative findings from the literature were triangulated with the

qualitative findings from the empirical fieldwork. The crucial issue has been to understand the participants' expectations of social assistive robots and telehealthcare and to accumulate these expectations through workshops, questionnaires and in-depth interviews with older people and informal caregivers, and in lab trials (Massimi & Baecker, 2006; Newell et al., 2007; Svanaes & Seland, 2004).

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Data Collection	Literature review	Workshop Follow-up questions	Pre-interview Scenarios Post-interview	Focus groups A workshop A questionnaire Interviews	3 Workshops Mock-up in the participants' home
Participants	Number of publications 345 Key Publications 32	7 women & 7 men Age 65 to 86 Mean age = 75	6 men & 5 women All of the participants had one or more medical disorders, such as chronic obstructive pulmonary disorder, heart failure, diabetes and stroke.	88 + 6 (88 older people 70+ and 6 informal caregivers (3 men & 3 women)	23 +7 (22 women & 8 men) Mean age = 76
Analyses	Annotated bibliography	Qualitative content analysis	Deductive qualitative content analysis, guided by E. M. Rogers' framework (E. M. Rogers, 1995).	Qualitative content analysis	Qualitative content analysis

Table 1: Overview of data collection, participants and analyses included in papers 1-5

Data collection

The fieldwork was carried out as an iterative process in 3 steps:

1. Initial exploration

Initially, all available data and facts about social robots and older people were reviewed. An understanding of what had previously been done in the field of robotics was needed. We also organised two focus groups (8 + 7

participants, age 70+) to get older people's view and expectations of social robots. The focus group approach was chosen because it is useful to generate hypothesis and exploring aspects, feelings and beliefs (Silverman, 2011). However, there are certain drawbacks associated with the use of focus groups: social pressure may result in agreeing with others in order to reach a consensus view instead of representing the individual's personal view (Stokes & Bergin, 2006). The consensus view may represent a view that nobody really supports, nor totally disagrees with (Stokes & Bergin, 2006).

Figure 10: Some of the prospective users participating in the workshop

Thereafter we organised a workshop (14 participants, mean age 75) (Fig. 10). In the workshop we used hands-on activities including "attention cards" to portray alternative actions the robot could take. The situations visualised on the cards were our interpretations of what was said during the prior focus groups. These concrete situations gave the old adults a chance to offer their views and provide input about these situations (Fig. 11). For example, a photo illustrated someone lying face down on the floor and the text on the card stated: "If I had a robot, I would like it to detect if I had fallen..." and presented alternative actions such as, "Ask if I need help; Call a relative;

Call 112". There was space for the participants to fill in other actions they would like the robot to take.

Figure 11: Samples of attention cards

The objective of the attention cards was to encourage imagination and to facilitate discussions on what the participants would like a robot to do. The attention cards made abstract ideas more concrete, encouraged reflective discussions, and triggered what-if questions regarding prospective scenarios. The attention cards were used to identify the range of tasks, goals and activities that needed to be considered. Field notes were taken during the focus groups and workshop. The field notes were analysed for recurring themes and issues. Preliminary analyses were fed back to "prospective users" panels, giving older people an opportunity to comment and make further contributions. The workshop approach was chosen because it is a good way to bring together users and more than one researcher at the same time. As with focus groups, the main disadvantages with workshops is that the participants may agree, at the same time as privately disagreeing with the consensus view (Stokes & Bergin, 2006).

2. Creative idea generation

Once the knowledge base had been constructed, the next stage was to generate ideas about desired behaviour, functionality and appearance of social robots. A questionnaire was constructed in order to gain an

understanding of how older people perceived a prospective robot to behave, what is should look like, and what functionality was desired. The questionnaire approach (36 respondents, mean age 78 years) was chosen to see the extent to which the small sample of participants in the focus groups and workshops was representative of older people in general (Silverman, 2011). A major drawbacks with questionnaires are the low response rate and that questions can be interpreted by the respondents in ways we do not intend (Lazar et al., 2010).

In addition to the questionnaire, interviews were conducted to gain an understanding of how a robot should be introduced to an older person. Informal caregivers (6 in-depth interviews) and older people (14 in-depth interviews, age 65 to 86) were interviewed. The interview approach was used to allow prospective users to talk unreservedly and to enable them to express feelings and beliefs in regard to social assistive robots (Bradley, 1993). In contrast to focus groups, workshops and questionnaires, the main advantage with the use of in-depth interviews is that it is possible to address the view of individual respondents and build a higher degree of trust between the researcher and the respondent, which hopefully increases the quality of the data (Lazar et al., 2010). On the other hand, adoption of technology is influenced by social pressure (Davis, 1985; Haddon, 2007; E. M. Rogers, 1995; Y. Rogers, 2012), which is often the results of focus groups and workshops.

The basic principles of content analysis guided the analysis of the interviews (Graneheim & Lundman, 2004: 107-109). Qualitative content analysis has been defined as "a research method for subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes and patterns" (Hsieh & Shannon, 2005: 1278). The interviews were transcribed, then read and reread several times to get a sense of the whole. Texts regarding the participants' perceptions and expectations of assistive robots were extracted and assembled in one document, which constituted the unit of analysis. The text excerpts from the document were divided into meaning units that were condensed descriptions of the excerpts, but which preserved the core meaning (Graneheim & Lundman, 2004: 106). The condensed meaning units were grouped together under sub-categories

that were compared based on differences and similarities and then sorted into new categories, which constituted the manifest content.

3. Idea sorting and evaluation

The findings from the focus groups, workshop, questionnaires and interviews formed the foundation for the sketches produced by an industrial designer, Johan Rosberg. Concept generation activities (19 participants, between the ages of 69 to 84) were organised around the appearance of a prospective robot, challenges of growing older, and what kind of help was desired and needed. These ideation activities were facilitated by experience prototyping (Buchenau & Suri, 2000) and participatory workshops. Buchenau and Suri define experience prototyping as "any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system we are designing" (Buchenau & Suri, 2000 , p. 425). Sketches of different appearances, colours and forms of robots were shown to prospective users and they selected the ideas they thought were the most interesting for a future robot (Fig. 12). It was decided that the best methods to adopt for investigating the older users' tacit knowledge of growing older were concept workshops and experience prototyping (Buchenau & Suri, 2000). "Tacit knowledge is implicit rather than explicit, holistic rather than bounded and systematized; it is what people know without being able to articulate" (Spinuzzi, 2005, p. 165). The advantage of using this approach is that it constitutes a way to explore older people's tacit knowledge of growing older and their expectations of social assistive robots, so that the robots can fit into their everyday practices (Spinuzzi, 2005). A second advantage of using concept workshops is that the older participants can learn about robots and the current state of robotics so that they have basic knowledge of how a robot is built and functions (Y. Rogers, 2012). The participatory design approach used encourages mutual learning – the researchers learn about the older people's tacit knowledge while, the older participants learn about social assistive robots.

Figure 12: Prospective users participating in the concept workshops

As a complement to the concept workshops, two mock-ups were created and left in older people's homes (6 senior households) for a week (Fig. 13). After one week, the participants provided feedback through in-depth interviews. The design of the mock-up study was based on Design Noir – The Placebo Project (Dunne & Raby, 2001). Dunne & Raby conducted the placebo project as an experiment to test their ideas on electronic technology and its aesthetic meaning. They design project has its origin in critical theory and their design is aimed to challenge people's expectations and provoke new ideas of thinking about an electronic artefact (Koskinen et al., 2011). Critical design uses form language, such as mock-ups, to provoke reflections about underlying assumptions and values in society (Boer & Donovan, 2012: 389). To the author's knowledge, no existing empirical research has used critical design in the development of a social assistive robot. The aim of the mock-up study was to explore and investigate the older users' experiences, perceptions and expectations of robotic assistance that a robot mock-up evokes when present in their homes for an extended period of one week.

Figure 13: Prospective users with the mock-ups in their homes

All the findings were fed into the development of a first prototype, which was tested in a usability lab (21 older users). The evaluation allowed the users to try and complete tasks on their own, although they were given prompts if they got stuck. The advantage of this approach was that I could assess how well the prototype supported the user; it also provided an opportunity for the user to give feedback. In the lab trials the prospective users analysed different functionalities connected to their everyday activities, and produced detailed suggestions for changes of the robot functionality, behaviour and appearance. In conjunction with the lab trials a pre- and post-interview with the participants was conducted (Fig. 14). Post-interviews are one way of capturing the subjective impression formed by the participants based on their experience of the prototype (Lazar et al., 2010).

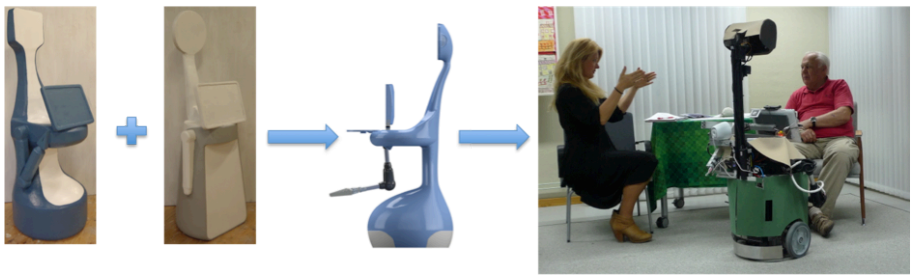

Figure 14: From mock-ups to user trials

A telehealthcare system (GiraffPlus) was also tested in a lab setting (11 participants with one or more medical disorders) (Fig. 15). A set of prospective scenarios of future use was demonstrated. The prospective users provided feedback on which scenarios were of importance and useful for future development. The aim of the evaluation was also to identify obstacles and conceptual incomprehensibilities. Pre- and post-task interviews was also held with the participants. Post-task interviews are an effective way of obtaining subjective feedback from the participants based on their practical experience of using the telehealthcare system (Lazar et al., 2010). The design of the post-interviews was based on the System Usability Scale (Brooke, 1986).

Figure 15: Prospective users evaluating the GiraffPlus system

Data analysis

The fieldwork consisted of several methods that were used to supplement each other. The strength and perspective of each method has been carefully considered. The findings and lessons learnt from one method would feed into another. The quantitative findings from the literature were triangulated with the qualitative findings from the empirical fieldwork. The qualitative analysis used in the papers focuses on categories and themes on the expectations older people have of social assistive robots and telehealthcare systems.

Graneheim and Lundman (Graneheim & Lundman, 2004: 106) point out that approaching a text (transcribed interviews) always involves multiple meanings and some degree of interpretation. It is therefore important to address the trustworthiness of the findings in qualitative content analysis (Graneheim & Lundman, 2004: 106). Bradley (Bradley, 1993: 436-437) states four aspects of trustworthiness: credibility, transferability, dependability and confirmability. Credibility refers to how well the data and process of analysis address the intended focus (Graneheim & Lundman, 2004: 109). Transferability refers to if sufficient details of the context of the study are presented for the reader to be able to decide whether the findings can be applied to another setting (Bradley, 1993: 436-437). Dependability refers to if the process in the study is presented in sufficient enough detail to enabling other researchers to repeat it (Bradley, 1993: 436-437). Conformability refers to the internal coherence of the data: if the findings, the interpretations and the recommendations are closely linked (Bradley, 1993: 436-437).

The main strength of the fieldwork is that it is conducted with older people who fit the criteria for the prospective end users of social assistive robots and telehealthcare systems. The credibility of the research findings was verified by the fact that the criteria for the sub-categories, categories and themes were mentioned more or less in all the interviews and workshops. The participants were also involved in an on-going dialogue (member-checking, (Cresswell, 2003: 199) regarding the interpretations of their expectations of

the specific innovation and they found the findings recognisable. Another strength was the use of mixed methods and the involvement of multiple prospective users. Some of the methods were used in other European countries, which had a similar aim and findings. The data gathering, analysis and interpretations were carried out by the author, but the decisions on which methods to use and the findings were scrutinised in on-going dialogues with my supervisors, Britt Östlund, Håkan Eftring, and anonymous reviewers (for the articles and conference proceedings). A limitation might be that the findings could be biased since all the participants had an interest in innovations and in the development of assistive robots; however, they did fit Von Hippel's notion of lead users (Von Hippel, 1986: 102-115). The perspectives and views of the participants should therefore not be adjudged as representative for all persons above 65 years of age. Tables have been presented in the papers to facilitate the descriptions as well as participant quotations to make the qualitative content analysis process more concrete.

Ethical considerations

The researcher has to reflect on his/her own role when carrying out interviews and participatory design. By being in the participants' homes, they might feel intimidated or want to impress the researcher (Kvale & Brinkmann, 2008). The researcher's presence may affect the outcome. They participants could alter their behaviour to match what they think you are looking for. Just by being "researched" or studied might alter the participant's behaviour. This is normally referred to as the "Hawthorne effect" (Mayo, 1949).

It is a significant likelihood that social robots will impact older people's practices and change the way they live their lives in the future. Technologies are never simply present as instruments, but as meditating objects between human and human and humans and artefact (Latour, 2005). Future social robots will never be neutral but will come with inscribed and embedded values. This means that during the development of new technologies, developers will continue to configure the users into the product (Latour & Woolgar, 1979). Latour and Woolgar argue that new technologies try to

configure the user by setting the constraints on what the users are able to do (Latour & Woolgar, 1979). The user may be either represented by the developer's personal image of future users (which the developer already has in mind) or based on the developer's own preferences, needs and wants (S. Wyatt, 2003).

The future role of social robots and telehealthcare systems in older people's lives will depend on how the specific innovation is designed, and the context in which it is used as well as cultural habits, the users' skills and knowledge. Social robots and telehealthcare systems can either enhance or degrade the older person. Verbeek argues in his book, *What Things Do*, that we need to focus on the question – How to live? (Verbeek, 2005). When it comes to social robots for older people, we need to ask: How to live when you are old? What are the social and human dimensions of the specific social robot in question? There is a need to explore the implications that specific robots and/or telehealthcare systems have on older people and their everyday lives. Are the impacts of the specific innovation for better or worse? Is the innovation good for some older people but not for others? An understanding of why people resist using social robots or/and telehealthcare systems is also important because "non-users also matter" (S. Wyatt, 2003). Older people are active consumers who selectively adopt technologies (Essén & Östlund, 2011). According to Foucault, resistance might be seen as a way of combating subtle forms of power (Foucault, 1982).

Results – summaries of publications

The papers are briefly described in this section. They were chosen to build up an understanding of older people's expectations of social assistive robots and telehealthcare systems. The papers also show how older people can be involved in the design process by using the tools described in papers 2-5 that address the issues identified in the literature review (paper 1).

Paper 1

Review: Seven Matters of Concern of Social Robots and Older People

Background: The arrival and rapid pace of robot development in the last twenty years towards robotic caregivers and companions has led to an escalation of new opportunities for monitoring and supporting human activities in the home and in public places. The focus of robotic research has moved from autonomous industrial robots that work in well-defined, structured environments doing dirty, dull and dangerous jobs to social robots with an increasing ability to co-operate with humans. Due to developments in medicine and technology, people are living longer than before and the older population is gradually increasing. As a consequence, the likely future of social robots is that they will share and become an integral part of the everyday lives of older people. Still, little is known about how multifunctional social robots or humanoids will change older users' practices and how older people will change social robots.

Aim and objectives: The review addresses how social robots and older people are portrayed and described in the framework of Science and Technology studies.

Methods: The review is based on publications in peer-reviewed journals and conferences.

Results: The analysis of the literature on social robots and older people showed: 1) that there are too few studies on how older people are represented as "social robots" users; 2) we need to redefine the perceptions of older people in order to fairly represent who they are and to avoid stereotypical views of them as a homogenous group of weak and passive people; 3) more studies are needed of the positive and negative long-term effects of how social robots are perceived by older people with different values. An understanding is desirable of the situations, contexts and groups of older people where different types of social robots will inhabit or enhance their abilities or well-being.

Conclusion: The perceptions of elderly people need to be re-examined and perhaps redefined in order to fairly represent who they are. More research on elderly people as "social robotic users" is also needed.

Paper 2

Would Granny Let an Assistive Robot into Her Home?

Background: Assistive robots have received considerable research attention due to the increase of the senior population around the world and the shortage of caregivers. However, limited attention has been paid to involving seniors in the design process in order to elicit their attitudes and perceptions of having their own robot. This study addresses this issue.

Aims and objectives: The aim of the study is to elicit Swedish seniors' attitudes, wishes and needs towards having their own robot by involving them in the design process. The key questions are: What should the robot look like? What would seniors like the robot to do? How would they like the

robot to behave? Where in their homes would they allow the robot to take part in their daily lives?

Methods: The method consisted of two parts: a full day workshop and a follow-up questionnaire.

Result: The findings indicate that: (1) the functionality of the robot is far more important than the appearance; (2) usefulness will determine the acceptance of a robot; (3) seniors feel it is important to keep up to date with new technological developments; (4) seniors did not perceive assistive robots to be intrusive and considered it acceptable to have one in their bathrooms and bedrooms.

Conclusion: These findings suggest that seniors are prepared to give assistive robots a try if they perceive them as useful.

Paper 3

Elderly People's Perceptions of a Telehealthcare System: Relative Advantage, Compatibility, Complexity and Observability

Background: The GiraffPlus system promotes independent living for elderly people by combining social interaction and long-term monitoring of daily activities and health status. The system consists of a network of non-invasive wireless home sensors, which can monitor trends in behaviour and physiological parameters, as well as a semi-autonomous telepresence robot that can be moved around in the elderly person's home, remotely steered by family, friends or caregivers.

Aims and objectives: In the paper we present findings from an initial user lab test of a telecare system (GiraffPlus). The primary aim was to examine how elderly people perceive a telecare system (GiraffPlus) and being monitored.

Methods: The methodology consisted of a pre-interview, scenarios of specific situations in which the system can be used and a post-interview. The data analysis was deductive, guided by Rogers' framework of perceived attributes (relative advantage, compatibility, complexity and observability)

of an innovation that influence the individual's decision to adopt or reject an innovation(E. M. Rogers, 1995).

Results: The findings from the evaluation of a telehealthcare system (GiraffPlus) demonstrate: 1) that elderly participants were in favour of face-to-face interaction with family and friends and they could imagine communicating with healthcare professionals via the telepresence robot; 2) the participants expressed preferences for as few devices as possible and the ability to integrate functions into devices they already have; 3) the non-intrusive sensors were perceived as safe and reassuring, while the self-monitoring equipment was perceived as a way to be in control of one's health. It was mentioned, though, that such a system may cause anxiety and stress, especially if they worry about the results and cannot contact a healthcare professional immediately; 4) confidence in their current healthcare was high when it came to storage of personal data, but the participants felt ambivalent about being monitored. They could imagine being monitored as a temporary solution to identify health related problems or when de-hospitalised but not on a daily basis in their everyday lives; 5) a common opinion was that a telehealthcare system and social robots should be considered more of an addition rather than a substitute to the current healthcare system and other human help.

Conclusion: Our research implies that the relative advantage of the GiraffPlus system is dependent on how well integrated the system becomes in the current healthcare system. The potential relative advantage expressed by the participants is the wish for more contact with healthcare professionals.

Paper 4

What Older People Expect of Robots: A Mixed Methods Approach

Background: The growth of an older population is predicted to drive the development of domestic assistive robots that match technological advances to human needs. Older adults as a group are very heterogeneous and age is

likely to increase the differentiation within the "group" more than most other "groups" due to life experiences and physical conditions (Czaja & Lee, 2007). The findings will feed into the EU-funded HOBBIT Project (www.hobbit-project.eu), which aims to develop a socially assistive robot that helps seniors and old people at home.

Aims and objectives: To explore older adults' expectations of social assistive robots. Key questions: What do older people expect of assistive robots? What perceived impact do social assistive robots have on older people and their everyday practice?

Methods: The data collection involved mixed methods including focus groups, a workshop, a questionnaire and interviews. The findings and lessons learnt from one method would feed into those of another. The pre-study focus groups were used to identify the expectations of assistive robots; after that a workshop was organized to verify the findings from the focus groups and to identify major themes in the creation of the questionnaire. Fourteen qualitative interviews were held with potential users in order to gain more detailed information about how they imagined the potential role, or lack of one, of robots in their life. The interviews focused on how the old users could imagine they would like certain functions and scenarios to work. Six interviews were also held with relatives/ informal caregivers of elderly people.

Results: The findings from the interviews regarding the expectations of robots of older people and their relative demonstrated: 1) that they would like to be able to phone a helpline if something went wrong or if they needed help managing the robot; 2) that they would like to be able to speak to the robot. Some said that they also would like a screen that showed the text at the same time as the robot spoke. One participant sometimes felt it was difficult to hear and interpret when someone is speaking and would prefer to be able to read it at the same time; 3) that the participants found it difficult to believe that they would form any kind of relationship with the robot. A majority said it is a tool that would make everyday life easier for them, but it would not be a friend; 4) most wanted a cheerful and happy robot. They emphasised that the robot should be passive in the initial phase and wait for them to give it "orders" but after they were used to having it around, it could be more proactive and come up with suggestions for activities and exercises; 5) all of the informal caregivers thought that their relative (elderly mum or

dad) would not be able to learn how to use a robot. The relatives could see the benefit of having a robot looking after their parent, but they did not believe it was feasible, since they perceived their parents as having difficulties learning new technologies. The majority also thought a robot would scare their elderly parents or relative.

Conclusion: The results indicate that the expectations of robots are multi-dimensional and ambivalent. Ambivalence can been seen in the tension between the benefits of having a robot looking after them and others, helping or carrying out tasks they no longer are able to do, and the parallel attitudes, resilience and relational inequalities that accompany it. The participants perceived that having a robot might be "good for others but not themselves", "as a machine not a friend" while their relatives and informal caregivers perceived a robot as "not for my relative but for other older people".

Paper 5

Older People's Involvement in the Development of a Social Assistive Robot

Background: Identifying needs and wants in respect to future technologies is particularly difficult since they may evolve and change over time in relation to the technology being developed. Therefore, a need for participatory design became apparent in which users were included at the early stages of social robot design and iteratively during the design process.

Aims and objectives: We present a critical design approach as a methodology to create a dialogue with older people in order to understand the cultural values embodied in robots. We use sketches and mock-ups of robots at an early concept design stage to explore the challenges involved in co-designing with older people. Key questions: Is it possible to extract the underlying meanings and values social assistive robots have for older people by the use of sketches and robot mock-ups? If so, what do older people want from assistive robots?

Methods: The study consists of three participatory workshops followed by evaluating older people's experience of having a robot mock-up at home for a week.

Results: Despite the small sample size, a sketch framework emerged for understanding older people's values that underpin their attitude toward robots. The results indicate that for a robot to be perceived as meaningful to older people, it has to support age-related decline in physical and cognitive activity. Concerns of robots fostering inactivity and laziness as well as loss of human contact were repeatedly raised.

Conclusion: The results of the mock-up pilot study indicate that product mock-ups can be used as tools to broaden the knowledge base of the user's personal goals and device needs on a variety of dimensions.

Identified reasons for participating in the studies

The findings from all of the above studies demonstrated that the three most common motives for participating in the studies included: (a) curiosity about robots and new innovations; (b) desire to add value and share experiences and knowledge of how it is to be old; and (c) desire to make an impact on the development of welfare technology and prevent the future for older people from becoming too machine-driven without human contacts.

Detailed information about these findings can be found in the papers. In the next section the findings will be discussed and their impact will be problematized.

Discussion

This thesis presents my research on older people's expectations of the use of social robots and telehealthcare systems. Such research calls for "interpretive flexibility" of innovations in relationship to older people, and for the recognition of the relationship between technology and society. This issue has grown in importance in light of that the age group is the fastest growing segment in most developed societies (Fukuda, 2011). Social assistive robots and telehealthcare systems are not just tools that deliver care but sociotechnical innovations that comprise a network of people, organisations, artefacts, culture and meanings (W. Bijker & Law, 1994; Latour, 1991; Law & Hassard, 1999; MacKenzie & Wajcman, 1999). The present research confirms previous findings and contributes additional evidence suggesting that expectations are both *retrospective* and *performative* (Brown & Michael, 2003; Lente & Rip, 1998). While Brown & Michael, Lente & Rip have investigated expectations of innovations throughout society (macro level), my research focuses on expectations of innovations on a micro level (individual elderly users). Thus, at a micro level, the retrospective aspect of expectations suggests that memories and experiences of the past form the construction of expectations and the performative aspect of expectations suggests that expectations may shape actions (enabling or constraining them). The individual's expectations are likely to change the more the older person becomes familiar and gains experiences of social assistive robots and telehealthcare systems. It is a dual process in which older people's expectations and innovations are reciprocally constructed. Innovations such as social assistive robots and telehealthcare systems are prone to change the meaning and nature of ageing, as well as introduce novel practices of homecare for older people. However, first I will discuss the retrospective and performative aspects of expectations in regards to social assistive robots and telehealthcare systems, and then the seductive power of technology and whether the results can be affected by the motivational effect of partaking in the research projects.

Retrospective aspect of expectations

The results of the research indicate that the expectations of robots are multi-dimensional and ambivalent. Ambivalence can been seen in the tension older people have between the benefits of having a robot look after them and others, help them or carry out tasks they no longer are able to do, and the parallel attitudes, resilience and the relational inequalities that accompany it.

An interesting finding was that at first, most of the older participants were sceptical towards the idea of robots but after an hour or so during which they had found out more about the robots, some changed their minds and thought robots might be "good for others but not themselves". They perceived technological solutions for solving the "problems" of the increasingly ageing population as inevitable, even though they themselves did not consider they would need innovations such as social robots. Perhaps the unwillingness to imagine oneself as using a specific innovation, such as a social robot and a telehealthcare system, is due to their reluctance to accept the physical and cognitive effects of ageing, or the fear of being perceived by others as fragile, dependent on a machine and lonely. Or it might be because it was something they did not need or want. That is, the notion of one's self seems unchanged while the notion of other elderly people is that they become more fragile and in need of innovations that support and care for them as they age. It also became clear that the participants did not want to become a burden to the healthcare system and relatives, while they perceived other elderly people as societal problems.

However, in the workshop and questionnaire (but not in the focus groups), we obtained one contradictory result: Most of the participants stated that they would gladly show their robot, if they had one, to family and friends. Their willingness to show the robot instead of hiding it might be seen as an indication that robots are perceived as a "status symbol". As shown in Rogers' theory of diffusion, one motivation for many individuals to adopt an innovation is the desire to gain social status (E. M. Rogers, 1995).

There are a few explanations for this contradictory result. It may be due to pre-knowledge of the research focus – the participants in the workshop, questionnaire and interviews knew they were going to talk about robots while the focus groups did not (only that they were going to talk about healthcare innovations). Another explanation could be that in the workshop we spent an hour showing different kinds of robots and explaining what modern robots are able to do, while the focus groups did not get any information about robots. It has been shown that remaking technology to something close and familiar increases the adoption rate (Weiss, Igelsböck, Wurhofer, & Tscheligi, 2011). Perhaps by raising the awareness of what robots can do might decrease the participant's fear of robots and imagining robots in one's life might feel less unfamiliar or strange. Another possible explanation might be that in workshops and focus groups, social pressure resulted in agreeing with others to reach a consensus view, instead of representing the individual's personal view (Stokes & Bergin, 2006). The drawback is that the consensus view may be one that nobody really supports nor totally disagrees with (Stokes & Bergin, 2006).

Another interesting finding is that the informal caregivers thought that a robot might be good for other older people but not their elderly relative. Contrary to expectations, there did not seem to be a stigma attached to wanting one's relative to have a robot, but a belief that one's relative would not want a robot or be capable of operating one. However, with a small sample size (6 informal caregivers), caution must be applied, as the findings might not be judged as being representative for all informal caregivers of persons above 65 years of age.

The findings suggest that most of the participants could not perceive a robot as being a social companion for themselves, but for others who were lonely, fragile and disabled. This finding has important implications for developing social assistive robots, since it can thus be suggested that there is a stigma attached to having a robot as a "friend". The unwillingness of seeing a robot as a companion may show concerns about the stigma of being dependent on a machine. Having a robot as a social companion seems to be perceived as affecting the individuals' self-image and signals to others that they are lonely and fragile. In contrast to having a robot as a "friend", the results indicate

that having a robot as a servant, which could do monotonous and challenging chores, was perceived as somewhat acceptable and satisfactory, which confirms to some extent the findings of Dautenhahn et al. (Dautenhahn et al., 2005; E. M. Rogers, 1995).

Experience, media and memories from the past indicate that older people perceive telehealthcare systems and social assistive robots as "good for others but not themselves", "a social assistive robot as a machine not a friend" while the relatives and informal caregivers perceived a robot as "not for my relative but for other older people". These findings have important implications for developing robots and telehealthcare systems for older people. The findings indicate that as long as possible, older people would to like to have the same innovations as everybody else. The findings also indicate that by getting a telehealthcare system or a social assistive robot, the older person feels like she is signalling to others that she is lonely, sick and fragile. These findings provide further support for the hypothesis that the perception of self is as important as you grow older as at any other age (Blaschke et al., 2009; Featherstone & Hepworth, 2005; Joyce & Loe, 2010; Moody, 2006). This is an important issue for future research.

Performative aspects of the older user's expectations of social assistive robots

Are older people's expectations of social assistive robots performative? Indeed, indications were found in the fieldwork that there is a performative aspect of expectations, in the sense that older people alter their behaviour to the one of the robot in the human-robot interaction. More precisely, the older user's expectations of social assistive robots (i.e. that robots are intelligent and autonomous) prompt the older user's actions and interaction in the human-robots interaction. As an example, in the lab usability studies, where the older users had a chance to try out a robot prototype, they were slightly sceptical in the beginning but mostly positive by the end of the trial. They expressed interest and wanted to explore the robot prototype, and when something did not turn out as they expected, they blamed themselves, and not the robot. They expressed feelings of self-consciousness when

interacting with the robot since the difficulties they experienced were perceived as their inadequacies rather than due to the robot's incapability. One participant even stated, "Maybe it does not like me," and moved closer to the robot, repeating in a louder voice the commands over and over, before giving up and trying the touch screen. The poor performance was due to the inabilities of the speech recognition systems and not the user performance. The users never blamed the system, though, but instead tried to adjust their behaviour to the robot's capabilities. The performative aspects of expectations can thus have several effects:

First, in the discourse of innovations to help and assist users in their daily lives, what happens with the older individual's autonomy and self-efficiency when she amends her behaviour in accordance to the feasibility of the technology instead of the other way around? One cannot help but think that if the older person alters her behaviour to accommodate the behaviour of the robot, this may cause anxiety, increase her feeling of inability and technophobia instead of fulfilling the intend purpose of such innovations, such as increasing the older person's self-efficacy and autonomy at home.

Second, older adults as a group are very heterogeneous and their individual abilities, skills and experiences vary considerably (Kohlbacher & Herstatt, 2008). Age is likely to increase the differentiation within the group more than in most other groups due to life experiences and physical conditions. However, age-related changes in the perceptual, cognitive and psychomotor abilities are well known, such as the decreased ability to perceive fine details, decreased hearing acuity, slower information processing, decline in fine motor control, etc. (Drolet, Schwarz, & Yoon, 2010). If the older users of social assistive robots are seen as patients instead of capable individuals, they may become "objects and made passive" (Mol, 2008, p. 7). As patients they will be in the hands of healthcare professionals, who often rely on the biomedical model, which focuses on expected problems of ageing and the identification and diagnosis of age-related diseases. As a consequence, the medical professionals may focus on the cause of ageing and ignore the environmental and social factors that affect the use of innovations such as social assistive robots and telehealthcare systems.

Third, Associating ageing with disease affects how older people are perceived by others and themselves (Featherstone & Hepworth, 2005). Often people do not identify themselves with their actual age (Gunter, 2012) but perceive themself as younger (Featherstone & Hepworth, 2005; Gunter, 2012). Past research shows that for an innovation to be successfully adopted, it has to correspond to the intended end users' self-image (Drolet et al., 2010). When it comes to assistive technologies the "felt" need may not correlate to the professionally assessed need (McCreadie & Tinker, 2005). Determining, what is and what is not a need can be highly problematic. The subjective perception of one's needs has to be balanced with the assessment of the "objective" needs and the user needs to understand how their different needs can be addressed (McCreadie & Tinker, 2005). The acceptability of assistive technologies depends on the extent to which they alter the individual's self-image and the nature of their home (McCreadie & Tinker, 2005; Melenhorst et al., 2006). The old adults are not passive objects but people who themselves, like anyone else, construct ways of living their lives. If social assistive robots are designed with a specific understanding of what the problem with ageing is and how it can be measured, addressed, and dealt with to produce the desired outcome, the main focus might be on the biological processes of ageing and not the context of use and how the technologies are given utility and value for the older person. New technology and innovations could offer opportunities for older people as means to better life but the ageing population is often seen as a "problem" that need to be addressed and solved (Bouma et al., 2007).

Fourth, Foucault has shown in his work that people are willing to subject themselves to a discourse or disciplinary regime and thereby become objectified to that discourse or regime (Foucault, 1982). For Foucault, institutions such as prisons, schools and hospitals use classifications, codes and languages to form practices. These practices generate languages of descriptions and explanation of the self as ill or healthy, able or disable, normal or abnormal, etc. In doing so, the institutions constitute a form of power over the individual. This form of power, "governmentality" as Foucault calls it, labels and explains different groups in society and the individuals start to identify themselves as part of this group without questioning; it then becomes a norm. People become engaged in the discourse by using the classifications in their daily life, for example, by

talking about themselves a being old. This indirect power can also have positive effects on the individual since the categorisation can provide them with explanations such as, “I am too old to learn how to use new technological innovations; they are not for me”. This gives them a sense that they are not personally responsible for their problems and can put their faith in the hands of other people (such as homecare nurses, health professionals and doctors) who indirectly influence this kind of power (Foucault, 1982). On the other hand, the classification may also be infantilising. When a social assistive robot moves into the home of older people, they might become objects of surveillance and might be indirectly or directly influenced by the “public policy” form of power. This form of power or surveillance can be degrading or enhancing for the older individual.

Fifth, the development of robots is a doubled-edge sword (Norman, 1992). Feeling safe in one’s home, being able to interact with healthcare professionals, friends and family from a distant, getting help from robots with household tasks and having their company around the clock may be beneficial for some older people, while for others it will have negative consequences such as invasion of privacy, feelings of losing control over one’s life, loss of the self, etc.

Sixth, by the help of the biomedical model, healthcare professionals can advise older people to adapt to social assistive robots by presenting the positive effects through a “professional eye” but the ethical question is if the “professional view” is from the necessities of the older individual or if it is the perceived needs of society to lower care costs for the elderly? This raises the question: Will older people feel forced to agree to innovations such as social assistive robots since it is perceived as being a must in order to participate and to be part of society?

Despite its exploratory nature, this research offers some insight into older people’s expectations of social assistive robots and telehealthcare systems. The present research confirms previous findings and contributes additional evidence that suggests that expectations are both *performative* and *retrospective* (Brown & Michael, 2003; Lente & Rip, 1998). However, with

a small sample size and only one kind of social assistive robot prototype, caution must be applied, as the findings may not be transferable to different kinds of social assistive robots, and all human-robot interaction and older people. Further research regarding the role of the performative aspects of expectations would be a great help in understanding and predicting how and why humans interact with robots.

The "seductive power" of technology

So far a constructivist approach has been taken. This approach argues that the users' expectations affect the development of innovations. From this point of view the development of innovations reflects reciprocity between human and non-human actors (Latour, 1999). But one can easily argue that we are being seduced by the promises of new technologies. As Lehoux puts it, "Technology sounds modern. It also evokes time. Technology most be about the latest. It is also supposed to be better" (Lehoux, 2006 ,p. xii).

Are the elderly participants seduced by innovations (i.e. technological determinism, which assume that technology is always beneficial and "a good thing") (Selwyn, 2003)? Indeed, indications were found in the fieldwork that there is a "seductive power" or force of technology, making older people feel that they have to keep up to date, fearing that they will be otherwise left behind. Young people are often portrayed as being interested in the latest technologies and as eager to learn how to use them. The stereotype of older people portrays them as uninterested in technological change, having difficulties in learning new technologies and low physical and cognitive ability (Belk, 1988; McMillan, Avery, & Macias, 2008). However, the three most common motives (by the older people) for participating in the fieldwork included: (a) curiosity about robots and new technological innovations; (b) wanting to add value and share experience and knowledge about how it is to be old; and (c) wanting to make an impact on the development of innovations for homecare and prevent future for older people from becoming too machine-driven and lacking human contacts.

The older participants in the fieldwork maintained that they were willing to participate in the research since they were "interested in new technologies" (their own words). On the other hand, most of them had old cell phones and stationary PCs, not smart phones and iPods, although some did. There are several possible explanations for this. The participant show that they are willing and interested in participating in the development of new technologies, but often they do not perceive a need for owning the latest technological devices. This is not equivalent, however, to being uninterested in technological innovation. It may instead indicate a voluntarily selective choice of which technological innovation they want to adopt. This would be in line with Tornstam's development theory of gerotranscendence, which claims that older people become more selective with age (Tornstam, 1997). A possible explanation might be that older people have a lifetime of experience of different innovations, and self-knowledge; they may actually be pickier than younger people when choosing technological devices to buy and adapt. Another explanation of their reservations is that older people's perceptions of the mental and physical investment needed to use the specific technology is greater than the expected benefits (Melenhorst, 2002). Bouma et al. show in their literature review evidence indicating that older people, to a higher degree than younger people, compare immediate costs such as financial ones or efforts for mastering the specific technology, with the future benefit of the promised functionality (Bouma et al., 2007). Another possible explanation for this is as Eisma et al. suggest that older people have negative self-efficacy and negative beliefs regarding their abilities to handle new technologies (Rosine Eisma et al., 2004).

These possible explanations show that the adoption of social assistive robots and telehealthcare systems will depend on how well older people and such innovations co-evolve. It is a dual process where the innovations as well as people may change (Lie & Sørensen, 1996). Wyatt emphasises the importance and need of understanding non-use (S. Wyatt, 2003). She and her colleagues have identified four different categories of non-users: resisters (people who do not want to use the innovation and who have never tried to use it; rejecters (people who do not use the innovation since they have alternatives, or are not interested in using the specific innovation); the excluded (people who do not use the innovation since it is not available to them); the expelled (people who involuntary do not use the innovation

because they cannot afford it or do not have institutional access). Instead of reinforcing the stereotypical view of older people as past oriented, laggards or not interested in innovations, we need to consider which category of non-users they belong to (if they decide not to adopt a specific social assistive robot or telehealthcare system) since this might have implications for the future development of such innovations.

The "motivational effect" of taking part in a research project

Lastly, one question that needs to be asked, is whether there is a motivational effect behind the research findings: Is the older users' willingness to change their behaviour an exception in the lab due to the so-called Hawthorne effect? The Hawthorne studies were conducted at an electric factory (Hawthorne works) to establish how the level of light effected the workers' performance (if it increased or decreased due to the level of light) (Adair, 1984; Diaper, 1990). The workers' performance improved both in the control group and the experimental group, whereby the researchers concluded that subjects modified their behaviour because they were being studied. The productivity gain at the factory may have been due to the motivational effect of the interest shown in the subjects and their work. However, the Hawthorne studies have been criticised due to the many independent variables (Adair, 1984; Diaper, 1990).

The "Hawthorne effect" may be the wrong concept to use, but indications were found on the motivational effects of partaking and being listened to by the older participants in the fieldwork: "I think life is an adventure and a challenge. I would like to find out how I can continue to live independently as I get older or sicker (lady born 1928)," and, "If you are able to help out I think you should. It is nice to be able to have something to say and that someone listens (lady born 1931)".

Going back to the theories of ageing and wellbeing that indicate that having achievable goals and intentions contributes to a feeling of meaningfulness in one's life, individual growth and achievement might come into play (Ryff, 1989, p 41-44). By being part of the design process, and having a say, affects

the older participants' self-image and how they reconstruct their identity. They are not just older people, but older people who are involved in research on new technologies. They are given a voice but one has to keep in mind that in the laboratory context the users only reveal what they want to reveal. On the other hand, in the home environment (i.e. situated actions) they will actually show what they do in the interaction with a specific social assistive robot or telehealthcare system. In the home environment the actual commitment is longer and the motivational effect of partaking in the development of new technologies might fade if the specific technology does not turn out to be something the users want or need. At home is harder to "fake" the actual usage since it can be monitored and in that way we can learn more about the actual use of a specific innovation.

Summary and suggestions for further research

The present licentiate thesis provides additional evidence showing that innovations such as social assistive robots and telehealthcare systems that older people perceive as useful, easy to use and desirable are considered as beneficial. It also shows that innovations are considered as a threat, if they violate the individual's values and beliefs, and may have a negative effect on older people's perception of self. This violation can be due to perceived difficulties in learning and using the artefact (feeling unable to operate the artefact), assigned usage (forced usage that is not the older person's own decision), if the artefact is perceived as patronising (e.g. telling the older person when to exercise or what to eat), stigmatising, and invasive (e.g. violating privacy and safety).

At a more universal level, this research challenges the technological deterministic approach that characterises mainstream innovation development and argues that ageing is a social construction as well as an open-ended process with no clear boundaries. This in turn means that the older users' expectations, needs and wants are continuously changing. A reasonable approach to tackle this issue could be to involve older people in the problem definition and involve them as equals throughout the product development. It would also be interesting to compare the expectations of social assistive robots and telehealthcare systems of individuals across different age groups.

There is abundant room for further progress in determining older users' role in product development. In further investigations it may be possible to use a different user-centred approach in which the older users have a bigger

impact on defining the problem and identifying the technical solution. Perhaps a more "user-controlled approach" would enable early user involvement in the identification of technological issues and their social consequences. In that way, best practices may become more apparent at an early stage for the engineers, designers and older users. Involving older people in the design process of social assistive robots and telehealthcare systems could foster ownership of the specific technology, but one needs to keep in mind that the domestic context in which most social assistive robots and telehealthcare systems are supposed to be used are very diverse. The heterogeneity of the use context and the user population challenge the possibilities of fitting the technological opportunities to the users' demand (Nahuis, Moors, & Smits, 2012). Engeström proposes an approach to address the issue, *co-configuration*, where the specific artefact continues to be adapted to the changing needs of the user after its initial customisation (Engeström, 2007). He argues that co-configuration relies on a combination of product services that can be intelligently adaptable. He also argues for the need for active user involvement and input into the customisation and configuration of the specific artefact, as well as continuous, long-term configurations and customisations that are a result of dialogues between users and producers (Engeström, 2007). The co-configuration approach seems to be suitable for the development of social assistive robots and telehealthcare systems since ageing is a dynamic process by nature and the user's needs and wants will be continuously changing. A major challenge is to design a sufficient range of interdisciplinary methods to enable a holistic "co-production" among all actors. This would include the older users, informal caregivers, engineers, scientists, healthcare providers, designers and manufacturers involved in the innovation process of social assistive robots and telehealthcare systems for older people. In such a working atmosphere, all interdisciplinary methods must attune all variables to each other, while attending to everyone's strengths and limitations and not being determine by technological choices.

Plans for the PhD thesis

In this licentiate thesis the focus has been on the early stages of the innovations process. Further studies, which will be presented in my doctoral thesis, will examine how older people's expectations can foresee and predict the adoption of social assistive robots and telehealthcare systems. The research will focus on *why* and *what* actually happens when social assistive robots and telehealthcare systems enter the homes of older people – how do such innovations become embedded (or not) in everyday life?

The hypothesis is that neither the adoption process of innovations nor the expectations are absolute, but each determines the other. Further fieldwork will involve looking at later stages of the innovation process such as objectification, incorporation and conversion of innovations, examples of which are an assistive robot (HOBBIT), robotic vacuum cleaners and a telehealthcare system (GiraffPlus). The analytic approach in the further research will be inspired by Silverstone and his colleagues' theoretical framework of the concept of domestication, where the user is seen as an active consumer, taming new technologies by defining its nature, scope and function (Silverstone & Hirsch, 1992).

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