Study of the product-services design and environment influence on the elderly's daily life

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Abstract

Purpose: *There is an ageing population, which represents an unprecedented challenge. Predictions for a near future, 2050, point to a larger proportion of elderly people, than young people. This fact requires a transformation and restructuring of the current model of our society. The impact can be seen in every area: consumption, pensions, health services, family care… As a consequence, we face a new challenge which demands a multidisciplinary action.*

Method: *Thereore, this paper Intends to expose the current state-of-the-art by reviewing: 1) Different methodologies to tackle this challenge by spotting factors to consider and design opportunities: by using Design Thinking, field studies, behavioural studies…action scenarios boundaries are set and parameters to consider in the design process are spotted. 2) Influential factors and design opportunities: behavioural habits, interaction with daily life objects and the surrounding environment, the emotional experience which it involves, the adaptation and integration matters, which most influence them in their everyday life. 3) Applications: Design for all, should be reflected in all products, environments and services.*

Discussion & Conclusion: *Potential lines of research are shown in order to face the challenge of sustaining and improving the current quality of life and adapting to our changing society.*

1   Introduction

There is an ageing population, which represents an unprecedented challenge. The increase in the life expectancy and decrease in the death rate, builds this new scenario. This fact requires a transformation and restructuring of the current model of organization of our society.
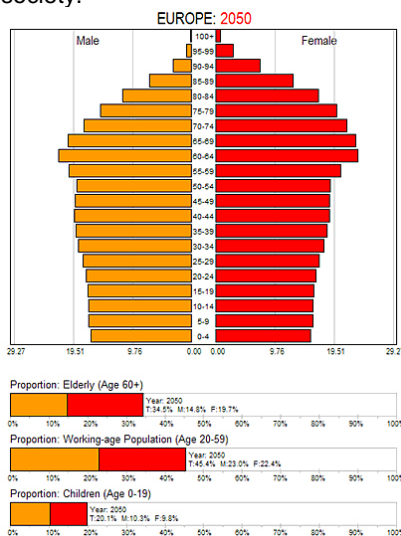

Fig. 1 Age pyramid for EU population 2050

Currently there is a 17.9 percent of population over 65 in Europe and 13.5 percent in US [1]. Some studies prevent a population pyramid inversion for 2050 [2]. In the Basque Country, during the last sixteen years, population over 65 has increased from 12.7 percent to 18.55 percent. [3]

Elderly peoples' care responsibility is partly taken by municipality which will be affected by the rise in elderly population percentage, which implies more elderly people being supported by less active population. In other words, there will be a need of greater investment in care with fewer resources. As a consequence, care services' quality may decline or become less accessible. The impact can be seen in every area: consumption, pensions, health services, family care… In order to face this problem, the alternative to centralized care systems and the design of possible solutions to improve the areas affected, is being explored and analyzed in this study.

Changes in family model have also affected the informal care approach. Houses and family model tend to become smaller. With time, family members tend to be more disperse, in different cities, even in different countries. As a result more elderly tend to live alone, which is another reason to demand and expand care systems for the elderly, as it is further explained in this study.

As a result, we face a new challenge which demands a multidisciplinary action. Design for all, should be reflected in all products, environments and services. Assistive technologies have been developed, however with many improvement and solution opportunities for design to overcome, especially regarding human centered design. Moreover, elderly constitute a still almost unexplored market niche with a high potential, whose demand will increase due to both increment of target users and

diversity of application fields regarding active ageing trend such as work or other services.

2 Methodologies

Designing products and services for the elderly users specific target group requires paying special attentions to certain factors: needs and desires. In order to spot and apply these factors the Human Centered Design seems to be the most appropriate approach.

Human Centered Design (HCD) is a design process intended to make equipment and systems easy to use, to understand, and worry-free from a user's view point [4]. This design methodology allows approaching design of products and services for elderly people, focused on the needs and desires from this target group, and then determine what should be done, based on experience and knowledge of users [5,6].

Moreover, HCD can benefit the company by providing a clearer vision of the market and enabling the identification of new market opportunities, it contributes to guarantee the acceptance, awareness and use throughout the product life cycle. As a result, HCD provides benefits in short and long run.

Human and social sciences are needed to support understanding of HCD. HCD is a multi-agent model of socio-cognitive interactions [7]. Engineering design is intertwined with both business and society to such an extent it should not be developed exclusively by engineers, focusing only in technical aspects [8]. As the development of information technology continues, the development of new technical services in the care of the elderly must be user-driven and must be based on elderly peoples' values of what constitutes the best care [9]. In fact, many projects' failures are not due to flawed technology, but rather due to the lack of systematic consideration of human and other non-technology issues throughout the design or implementation process [10]. However, contemporary HCD, strongly relies on the evolution and constant development of technology and interactive media (e.g. the internet), especially due to its interactiveness. Computer science and human-computer interaction are needed to guide design and development choices [7].

There is certain paradox concerning the HCD methodology systematization and application. All design process outcome implies some sort of innovation. People often try to program innovation, but that can lead to the invention of the same. As a consequence, what happens in HCD practices might differ from HCD principles [11]. HCD lacks formalism [12]. This lack of formalism may provide more flexibility to adapt the approach to each case more adequately [11].

HCD can be criticized for relying too heavily on the end-user's input. Activity Centered Design (ACD), as an alternative to HCD, can be seen as a better framework for analysing the consumer's needs in a human-centered way. Moreover, it is suggested that ACD Model can help to guide a team to more innovative solutions focused on user needs. ACD is based on activity systems theory, a.k.a. Cultural Historical Activity Theory [13]. The activities, after all, are human activities, so they reflect the possible range of actions, of conditions under which people are able to function, and the constraints of real people. A deep understanding of people is still a part of ACD. But ACD is more, it also requires from the users: a deep understanding of the technology, of the tools, and of the reasons for the activities. HCD asserts as a basic tenet that technology adapts to the person. In ACD, it is admitted that much of human behavior can be thought of as an adaptation to the powers and limitations of technology. To the human-centered design community, the tool should be invisible; it should not get in the way. With ACD, the tool is the way. But there are more-serious concerns: First, the focus upon humans detracts from support for the activities themselves; second, too much attention to the needs of the users can lead to a lack of cohesion and added complexity in the design [14].

When designers of several award-winning software packages were asked what they had done to achieve a good design. There was a surprising level of unanimity in their answers which some of them were:

− Pick a domain in which many people are involved and that is a constant source of breakdowns for them.
− Study the nature of the actions people take in that domain, especially of repetitive actions
− Deploy prototypes early in selected customer domains. Beta-test sites, individual follow-up sessions, hot lines, highly attentive technical and customer support staff, suggestion boxes, bug advisories, and the like.
− It is of central importance to stay in communication with users. [12]

The proposed model suggests an interpretation of design that is focused primarily on satisfying the customer rather than on satisfying the system's specifications [12]. Other interesting methodology can be the ' New user-centered design process', to fit projects: with realization date in the near future, with not currently available technology wishing to add new value, but having no specific ideas [15]. Another methodology is the 'Vision-proposal Design method, for designing in age of ubiquitous computing', which encompasses the entire HCD (Human-Centered Design) process, and presents a new vision with experiential value for both user and business from an HCD viewpoint [16].

3 Influential factors and design opportunities

With the age, people tend to spend an increasing amount of time at home. For this reason, the home environment has a very important role in the elderly's life. The home is seen as more than a physical location, representing familiarity, comfort and the presence of loved ones [17]. The concept of home overlaps with the concept of family and is valued as special, often connected with feelings of closeness and safety. The home is a place to develop close and deep relationships [9]. Leaving a spouse or partner was seen as the most difficult and upsetting aspect of moving from home to another care setting [17]. The home is highly valued as a place to live as long as control and close relationships are a part of daily life [9].

Care may be provided more efficiently in the home rather than in hospitals. The challenge is that people have different needs and provision by this decentralized system has to be tailored to individuals [18]. 'Hospitalization of death' has been criticized on the grounds that dying at

home is more 'natural', offers more autonomy to the dying person and provides family support [17].

3.1   Performance

With the age, some bodily and mental functions become affected: articulatory problems, muscular tone loss, fragility, lack of mobility, lack of equilibrium, senses inaccuracy, dementia, insecurity...

International Classification of Functioning, Disability, and Health model, posits four interconnected structures that affect health and human functioning:

1) The body (e.g., body systems and structures)
2) Activities (range of activities from simple to complex)
3) Participation (areas of life a person is involved in, has access to, or for which there are societal barriers or opportunities)
4) Environment. (These factors are defined as external to persons that can have either a positive or negative influence on performance.) Critical to the concept of personal control is the emphasis on the individual's engagement with his or her immediate environment [19].

On the one hand, freedom and independence are in the modern western culture seen as a goal of the human person with the right to make own decisions [15]. Moreover, living in the present and being able to handle life is found as important, for elderly people. Handling daily routines is important because it is in the small daily activities the elderly experience a zest for life (necessary part of being able to experience health, pleasure, joy of life, and spirituality). Besides a zest for life, it is necessary to have self-worth and the strength to overcome obstacles. Experiencing activities such as hobbies, which enables the elder person to master and enjoy the experience, are important to experience pleasure [20].

Moreover, the most difficult scenario seems to be loss of bodily function and in need of help with everything, but still be in good mental health. Both men and women could also consider the use of assistive technology as a possible way of compensating for the loss of bodily function [21].

In any case, the desire to be treated as a unique person and to maintain the self and being cared for with dignity no matter the illness, state of mental health or living situation becomes even more important, the more in need of care and the more vulnerable the elderly became [21].

Towards the end of life, capacity to make choices, especially for those who live alone, may gradually be undermined with age, incapacity and ill health, and a lack of information, informal care and other resources. As a result, independence, autonomy, and dignity may be lost. Social relationships, activities, and options, including the availability of relevant services on which choice depends, may also be eroded. The reality is that being a competent consumer is not easy and demands energy and experience.

Moreover, as the scenarios changes to a situation of lost bodily function and need of advanced care, the possibility of leaving their home for a nursing home or some sort of institutional care becomes important [21]. Preferences for hospital care increase as illness progresses [17]. When choosing a new place to move to in order to get care and live with other elderly people, the preferred option is the hospital, then healthcare centres and nursing homes. When lonely and severely ill, it is generally considered necessary to move to a nursing home [21].

3.2   Comfort and at-homeness feeling

The concept of home can be described from several points like, sociologic, psychological, physical and philosophic.

At-homeness can be described as being in the present, contact with others and a feeling of meaning and affinity with others. At-homeness is more described as a concept which is not always associated to the physical home but connected with a spiritual experience [21].

Home was seen as somewhere you could be comfortable and was contrasted with the 'discipline' imposed in institutional settings [17].

3.3   Self-recognition

Self-recognition or self-perception can be described as the recognition and identification of the own self.

There is a common concern about forgetting or losing the identity self-perception and the risk of not being seen as an individual person and becoming a nobody with any meaningful relations [21].

The home hosts a series of signs or objects which evoke stories and experiences lived, which are felt as reflection of the self-identity. 'Home is home, home is your life, your memories' [17].

Self-perception is also achieved through social interaction, which so often happens in the home environment, with other people [21].

For this reasons the home evokes a sense of belonging.

Care can be as well understood like a struggle for the existence: The person being cared for wants to show to be worthy of receiving care, because of the fear of being abandoned and on the other hand to be able to protect the self as a valuable human being [21].

3.4   Own material environment in terms of resources and associated costs

Health and social services are also faced with tensions as they confront the reality of financing and resourcing provision to meet the needs of an increasing population of older people, with progressively greater expectations and the need for a more diverse range of services, on a finite budget [22].

Permanent admission to a care home is an expensive way of providing care for elderly, most of whom would prefer to remain in their own home [23]. Some people live in poor material circumstances to afford the investments [22].

Reimbursement of the cost may be the most prominent determinant influencing elderly acceptance of technology. Private insurance companies may partially support health care costs [23].

3.5   Broader physical environment

The broader physical environment relates to the nature of housing available, neighborhood and availability and accessibility of essential services such as shops, pharmacists, and transport. Staying at home has positive benefits for mental health, but poor physical environments (quality of the housing environment and the wider neighbourhood)   can adversely affect people's physical and mental conditions [22].

3.6   Social environment

Social environment is not only considered by the persons who interact with the elderly, like family, but also a nonblood 'kin' who act as surrogate family, including friends, neighbors, former unmarried partners and ex-in-laws, volunteers, church members and professional health and social service providers [22].

Social support is essential in the care of the elderly because it promotes the cognitive abilities of the elderly and decreases the experience of loneliness among them. What is more, individual's social environment and their access to informal and formal care services can highly condition the elderly person's quality of life [20]. When people become increasingly aware that they gradually approach the end of life, it becomes more important to appreciate close social relations. They seem to be aware of making the right choices, give priority to goals like feeling satisfied, and for most people, such goals are connected to social relationships with highly familiar and emotionally close social partners [21].

Many elderly have fear of being trapped in themselves, with loss of human relations and facing terrible loneliness [21]. Greater vulnerability to loneliness is associated with: not being married (with the widowed most vulnerable), increased time spent alone, increased perception of loneliness over previous decade, poor health rating, health worse in old age than expected and impaired mental health [22].

3.7   Carer at home

The elderly often need significant care assistance of other types, including: transportation, homemaking services, nursing care and personal care provided by informal and formal carers [22].

Basic values about how to be cared for remain; however, if the social context changes, the values about how quality care should be administered will also likely change. Currently, there is considerable discussion about the scope for extending medical care in the home through remote monitoring or consultations by telecommunications [24]. Though now it very often involves smart device, PC, tablet, mobile phone, before it was through a person [6], which can provide more flexibility and broader range of attentions, programmed or not. As an example of what cannot be provided but by a human, is the imagination and adaptation to unexpected situations, the human touch and feelings involved or improvised use of humour. The use of humour can help the persons to allay their thoughts and at times the carer uses it for this objectives [16].

When care is administered at home, the carer has the opportunity to see the person as an individual with his or her own routines in an environment that is familiar to the person needing care [9]. While on the other hand, elderly think that if they are in need of extensive care, the best care was provided at nursing home [21].

When in need of extensive care, it seems important to be cared for by somebody who can assist them in maintaining their self, somebody who could recognise their spiritual, psychological and physical needs. The results indicate that the perceived possibility of maintaining their self is closely connected to how they are cared for. The best care for elderly is related to their home and their relationship to the partner [9]. The ethical demand, taking good care of each other, and showing respect and dignity, is something which the person can be familiar with from a long relation with the partner [21]. The human care involves someone to belong to and someone who can confirm that you are an important, loved and a very special person. To maintain and retain integrity, everyone must be seen as a unique individual [21].

3.7.1   Formal carer

Formal carer has a professional preparation to deal with elderly persons' care assistance. An example of formal carer could be: a nurse, or a doctor,…

Developing good care is dependent on the formal carer's ability to create good relationships.

Support in formal caring consists of mainly instrumental and emotional kinds of support. Instrumental support is of a practical nature such as providing support in relation to service, shelter, home help, or financial help, whereas emotional support consists of comforting activities. The comforting activities are not specified with the exception of social support that is described as the possibility of providing social contacts with relatives, friends, or social activities [21].

These supporting activities are not executed in accordance to a fixed program, but reconsidered each time. The reason is that the formal carer does not plan any supportive activities, because the formal carer rather tries to understand the patients' daily condition so that he or she can satisfy the patients' needs for the moment. On some occasions, a gap of support occurred and this coincided with the inability of the formal carer to identify the patient's inner needs, but sometimes the formal carer also chooses not to try to identify them [17].

There is a paradox in perception of professional health care: On the one hand, elderly can be doubtful that the professionals would be interested to know their life story and see them as individual persons [21]. When they are among strangers who do not know them and their life story, an outmost thread perceived by the elderly is not being able to express their needs and how, when and in which way they would need care and assistance. There is a paradox: They wanted to be taken care of, but they do not want to hand over their life to unknown staff who may fail to treat them with dignity (being seen as a unique person and relate to other persons they know) [17]. The elderly give importance to being cared for by well-trained staff that is competent to see their need of care [21].

There can be a fear of being abandoned for being alone when dependent of care from strangers. Many elder persons think that they would never manage being alone;

waiting for some staff to come for helping. There is a fear of being isolated, in being without the partner and friends, and having to spend many hours alone waiting for someone [17]. The elderly give importance to being cared for by well-trained staff, competent to see their need of care, and also are able to provide it all time around day and night [21].

However, being able to provide care can imply the presence of professional carer at home. There are mixed views about the presence of professional carers within the home. To start with, professional care can be seen as intrusive. Although professional carers presence in seen to provide much needed support, they can be seen as 'strangers', as intrusive or compromising the ideal of 'home' [17].

3.7.2   Informal carer

The informal carer, contrary to the formal carer does not have professional preparation to assist the elderly, but does have a close relationship. An informal carer could be for example someone from the family, like a partner, a brother/sister, a son/ daughter, a neighbor, or a friend,…

Having a partner as informal carer can be seen as ideal care. According to an interview carried out to healthy elderly couples, the ideal care, in case of bodily function loss and in need of assistance is the one provided by their partner, when in good conditions. In situations with limited need of care assistance, they were convinced that together, they could manage any situation and find a solution. When in need of limited help with personal hygiene and otherwise doing fine, all participants had a perception that the best care was provided in the private home with different kinds of support.

Having a partner or close relatives as informal carer can be considered a critical factor. The more caring needs, the more important the relation with the informal carer, especially if the informal carer is the partner, becomes and the relation seemed to be a guarantee for being treated well [21]. UK users' interview results show that 'Home care' is conceptualized within the project as a form of technology. Care provided by family at home is seen as an expression of love in contrast with care provided by 'strangers' in institutional settings [17]. Under the interviewed healthy couples' point of view, without a partner, there is no perception of trust and only fear, loneliness and anguish [21]. Participants who did not have close relatives, especially those who were widowed or separated, felt that this meant they were automatically excluded from the possibility of being cared for at home [17].

Informal carers can fail to provide adequate care according to some users' perception. USA study outcomes show that the elderly have concerns about the ability of their families to provide adequate care at home. While home was associated with 'love' and 'comfort' many participants felt that better quality care, in a technical sense, could be provided in hospital, because care requires specialist skills and knowledge that informal carers are unlikely to have [17].

Even if informal carers could provide an adequate care, when care is more demanding, some elderly persons do not want them to take such responsibility. When scenarios with more advanced care were presented, men as well as women expressed a wish that their partner could be freed from an obligation to take care of the other. They saw their partner as an independent person who needed an independent life. The consideration of being a burden for the partner (seen as old and weak,) was mostly expressed by the women [21]. Others do not want to be a 'burden' to family and friends, or were worried about these witnessing their suffering. Many reported that while it was 'right' or 'natural' that spouses cared for each other. Especially when it came to deliver care unduly/ immoderately intimate care, they did not want, and could not envisage, their children delivering this sort of care to them [17].

3.8   Accepting new technologies

New technologies have to be accepted both for the product/service buyer, the main user (elder) and the assistant (carer) in case interaction is needed.

There are many and diverse factors which can influence the acquisition and acceptance of new technologies in general. Some of the most significant are:

1) How the product/service communicates a clear benefit to match the users demand: physical, medical or emotional and the users perception needs that people perceive (safety may be the most important). There are examples of people not liking or using new technologies, because they don't feel a need for it [24]. Product offers and user demands are low for devices promoting disease prevention, and consequently, penetration into the public market is low [23]. Assistance solutions that solely tackle health problems are hard to sell due to negative associations [25].
2) Adapts to physical and mental condition.
3) Integrates in the environment. The acceptability of new technologies to an individual may depend as well on the extent to which it alters the character of their home.
4) Shows an appreciable benefit, its effectiveness, which can be influenced by the perceived usefulness of the new technologies whether the individual feels that use of the device either supports or undermines their sense of personal identity.
5) Balance between intuitive and practicable teaching methods [24]. Some elderly people experience trust in their relationship with their partner was a firm foundation for learning and handling new technology. Hesitation in their abilities to use Assistive technologies increased if they lacked a partner and their cognitive impairment increased. Hesitation turned to fear and revulsion against the use of new technologies if they were dependent for their care and they did not have a partner at home to assist them [9]. If special skills from the elderly people to handle the new technology are required, it might most probably fail. There are still some elderly persons with difficulty for late learning and afraid of using IT systems [25]. Even for example manuals and the need and complexity of them can affect the user in order to adopt a new technology. Elder persons: Need easier to see pictures and text, or tend to forget what they have just read [26]. In case of having a greater difficulty in learning (i.e. dementia cases) it could be possible to design new support devices completely invisible to the user, and users are not required to interact with such devices directly [27].
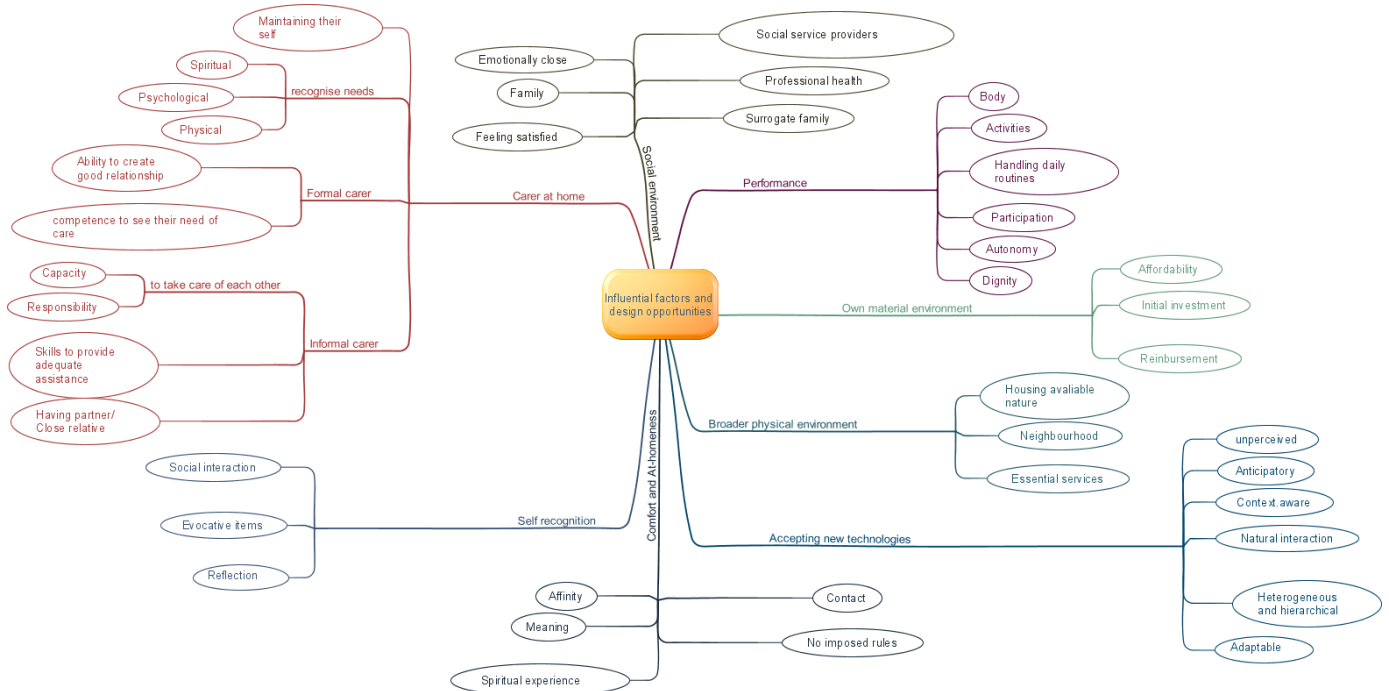
Fig. 1.Influential factors and design opportunities

4   Applications: Assistive Technologies services and products

The objective of Assistive Technologies (AT), products and services, is to improve the quality of life of the elderly by promoting greater independence: enabling people by providing an aid to match the living environment with the physical and cognitive abilities and limitations, to perform tasks that they were formerly unable to accomplish, or had great difficulty accomplishing, enhance performance and minimize the risk of illness, injury, and inconvenience [23]. The goal is to enable elderly people to live longer in their preferred environment, to enhance the quality of their lives and to reduce costs for society and public health systems. Effective AT living arrangements influences both the forms of help that elderly require with practical everyday living tasks and their social needs for safety and company [24].

General requirements for AT include new technology acceptance factors. Some desirable characteristics are:

1) Heterogeneous and hierarchical: different kinds of system nodes regarding their computational power and rendered functionality.
2) Context-aware: aware of their local environment and spontaneously exchange information with similar nodes in their neighbourhood.
3) Anticipatory: acting on their own behalf without explicit extrinsic requests.
4) Natural interaction and communication with users: Communication by voice and gestures instead of keyboard, mouse, or text on screens. And interaction with users: by means of devices they are used to (i.e.: clothing, watches, TV, telephone, household

appliances). To this end the devices will be equipped with some kind of intelligence. Ideally, the users can interact with the system as they would do with other humans.
5) Unperceived: When HCD is preferred to ACD it is preferred for the AT to be adapted to the user, so the user does not have to make an effort to adapt or learn. As a consequence it would be desirable for the AT to be invisible, or not so obviously perceived: embedded in clothes, watches, architecture, etc[24].
6) Adaptive: capable of reacting to all abnormal and exceptional situations in a flexible way, being able to learn. Adapt themselves to changing personal situations or capabilities of the individual and the environment to fulfil individual needs [25].

AT desirable characteristics	Acceptance factors
Heterogeneous and hierarchical	Integration with the environment
Context aware	
Anticipatory	Formal carers ability to 'identify the elderly's needs and how' need.
Natural interaction	
	Intuitive and practicable balance

Tab. 1 Relationship between desirable characteristics and some influential factors

Some interesting examples for the elderly using AT are:

1) Personal service robots: Cognitive prosthesis, safeguarding, systematic data collection, remote tele-medicine…[28].

2) Smart wearable systems: Based on microcontroller or other electronic device platforms systems, based on smart clothes, Mote-based body area network implantable devices, skin devices, other wearable devices or biosensors [23].
3) WSN based system for monitoring: inform the health care providers about the tendency of unusual behavior. It stores data into computer for elderly daily activity behavior, emotion recognition processing and simultaneously analyzes the wellness of the elderly to foresee unusual changes both physiologically and physical activities It is claimed to be low cost [29].
4) Exergames: Game-like fitness concept: Fitness gadgets and measurement systems (I .e.: Wii fit, Braintrainning) focusing on factors such as energy expenditure, heat rate, psychological outcomes, falls and balance [30].
5) Grocery shopping at to assist the shopping process at supermarket and could be possible to extrapolate to: e-tourist guide, intelligent office, smart educational medium,…[31].
6) Smart homes concept. Smart homes' AT systems should be capable of providing assistance without limiting or disturbing the resident's daily routine, giving him or her greater comfort, pleasure, and well-being. Remote management: data associated with energy (gas and power), water, and telecommunications expenses can now be transmitted to the utility company without anybody going on site. As for home comfort systems, heating, air conditioning, ventilation, lighting, and doors and windows can all be automated and manipulated by remote control [32]. Use of sensors, robotic devices and remote control devices. Home-networking (or "smart" technology) makes it possible to activate these and other household items from a remote computer [24]. The house should be able to act in a similar manner to a living carer, providing care for 24 h a day without becoming tired or frustrated. Of course, such technology could never replace human care and support, but it could augment such caring, and hopefully also provide some respite for personal carers [27].

There is a caveat and potential tension about the substitution of AT for human support and help. Important balances have to be struck between human and technical contributions to care. Technology however has the supreme advantage of emphasizing strategies to reduce task demand as opposed to the medical approach of improving capabilities [24].

Maintaining dignity, autonomy, and self-determination is a large task in the care of the elderly, and therefore it is necessary to continuously evaluate the consequences of using ATS in care from the perspective of dignity [9].

	Factors that influence AT design and acceptance	
Performance	− Body, activities, participation, environment − Handling daily routines capability − Making choices capability − Independence, autonomy and dignity	[15] Yanagida, K.; 2011 [16] Gott, M.; 2004 [17] Chan, M.; 2009 [18] Gitlin, L.N.: 2003 [19] Norell, M.: 2012 [20] Harrefors, C.; 2009
Comfort and at-home	− Being in the present contact with others, meaning and affinity feeling − Comfortable, free of imposed protocols	[16] Gott, M.; 2004 [20] Harrefors, C.; 2009
Self-recognition	− Home reflection and evocative items − Social interaction	
Material environment	− Afford initial investments − Reimbursement	[21] Rolls, L.; 2011 [22] Chan, M.; 2012
Physical environment	− Nature of housing available − Neighbourhood − Availability and accessibility of essential services	[21] Rolls, L.; 2011
Social environment	− Persons who interact with the elderly: family, surrogate family, professional health and social service providers. − Feeling satisfied, connected to emotionally close social partners.	[20] Harrefors, C.; 2009 [21] Rolls, L.; 2011
Carer at home	Extensive care need: somebody who could assist them in maintaining their self, recognise their spiritual, psychological and physical needs.	[16] Gott, M.; 2004 [20] Harrefors, C.; 2009 [21] Rolls, L.; 2011
	Formal carer − Having a partner or close relatives as informal carer − Skills of informal carer to provide adequate care assistance − Capacity of the informal carer to take care of the other and responsibility.	
	Informal carer − Ability to create good relationships − Being cared for by well-trained staff who is competent to see their need of care	
Accepting new technologies	− How the product/service communicates a clear benefit − Adapts to physical condition − Integrates in the environment − Shows an appreciable benefit − Balance between intuitive and practicable teaching methods − Unperceived: optimally adapted to the user. − Adaptive: to abnormal situations	[8] Harrefors, C.; 2009 [22] Chan, M.; 2012. [23] McCreadie, C.; 2005 [24] Kleinberger, T.; 2007 [25] Tsai, W.; 2012 [26] Orpwood, R.2005

Tab. 2 summary of influential factors and authors

5   Discussion & Conclusions

5.1   AT challenges

There are a number of current issues that must be considered to fully implement the use of AT in general related with: ethics, laws, privacy, freedom, autonomy, reliability, security, and service cost issues… [18, [25]

Ethical and legal issues of monitored living need to be established to improve acceptability before the technology becomes widely promoted [18]. The user's needs and privacy: There can be some tension between assistance and autonomy, or privacy and independence that characters the individual's judgment in using AT perception and acceptance.

Adaptability to the context and natural interaction: development of smart signal processing, data analysis and interpretation, size and weight limitations, energy consumption, sensor implementation and connectivity [23].

Legislation and interoperability: As health care develops from an organization-centred via service-centred towards an individual-centred system, information systems involved must be heterogeneous as well as homogeneous and interoperable by an interface that integrates the services of the different subsystems [20], process-related, decision-supportive, context-sensitive, user-oriented, and trustworthy [18]. Cooperation and communication between all agencies providing care must be maintained. Privacy and confidentiality need to be respected.

Many products and services have been developed for the home environment, however many other services and products provided to elderly people can be improved and adapted for them like for example: Banks (digital operations), telecommunications (telephone/ internet/…), mobility and transportation, shops (clothes/ furniture/ supermarkets/ kiosks), libraries, homemaking services (cleaning/ security / payments/ hygiene/ food/ rest/ free time/ social relations), free time services (sports/ cafes and restaurants/ hotels/ cinemas/ theatres/ …), urbanism, architecture and urban installations to integrate and adapt to all the new technologies for AT.

5.2   Research challenges

Previous Research on Home Environments recent studies have centered on:

1) Describing living arrangements and identifying housing needs and preferences.
2) Describing home modification and adaptive device use, including not only physical manipulations but also task-based strategies, or how the person interacts with objects and persons within the home to accomplish daily routines and self-care activities.
3) Examining environmental risk factors for deleterious outcomes (e.g., falls), and behavioral and cognitive adaptation strategies that occur within the home.
4) Evaluating the effectiveness of home-based interventions designed to enhance aspects of well-being.

For future research three main queries are presented:

1) What should we observe, measure and why?
2) How do older people and their family members use the home environment in health, illness, and caregiving?
3) What are the interrelationships between the home environment, psychological well-being, and daily functioning throughout the aging process? More needs to be known about the perspectives of older people who live alone. What is their experience, which services help maintain independence and support increasing dependence, and when should these be introduced, how, and by whom? [22]

The careful delineation and measurement of different dimensions and attributes of the home environment: The extreme variation in private living arrangements, variations in meaning attributions, object placements, and the tendency of individuals to underreport detrimental physical conditions highlights the need for a standard metric for use in homes to allow for cross-comparisons.

Measuring attributes that contribute to higher levels of everyday competencies remains relatively unexplored. Only the 'Enabler' tool which rates dimensions of the physical environment of the home in relation to the specific functional capacity of an individual, shows promise in this complicated area. Thus, several methodological issues persist in measuring home environments:

1) The identification of conceptual and operational definitions of environmental dimensions considered relevant to sample in the home.
2) The level of exposure necessary for adequate sampling to occur
3) The construct validity of selected dimensions the best strategy for measurement [19].

Environments need to direct focused attention to theory development to fully explicate core constructs and environmental-behavioral interactions in the home. One approach to understanding environment as process in the home is the examination of the task layer of the environment, or the way in which persons interact with everyday objects to carry out daily activities in the home [19]. Research focusing on relationship between patients, professionals and healthcare providers are needed.

Due to its interdisciplinary nature, a number of applications related to health care integrate biomedical engineering and medical informatics. Other knowledge in the fields of medicine, social sciences, psychology, economics, ethics, and law must be taken into account and be integrated into the development and deployment of assistive technologies [23]. To develop a holistic elderly care, more knowledge about psychological and spiritual needs is requested. Also a need for more knowledge of the factors forming the basis of the reasons why a carer would choose not to provide support on some occasions [20].

The AT's importance in contributing to older people's independence and autonomy is increasing, but there has been little research into the viability of extensive installations of AT [24].

References

[1] CIA, U. The World Factbook. Retrieved August 2010, 20, 2010.

[2] Jackson, R.; Initiative, C.G.A.; Plan, O.T. The Challenge of Global Aging. Center for Strategic and International Studies, National Press FoundationMay 2011, 22.

[3] MURASHIMA, J. Preface Special Issue on Human-Centered Design. Fujitsu Sci Tech J 2009, 45, 141-142.

[4] Matsumoto, K.; Tutaya, K. Fujitsu's Activities for Achieving Universal Design. Fujitsu (in Japanese) 2003, 54, 168-172.

[5] Kondo, A.; Kondo, N. Consideration of HCD Methods for Service Innovation Design. Human Centered Design 2011, 74-80.

[6] Boy, G.A. What do we Mean by Human-Centered Design of Life-Critical Systems? Work: A Journal of Prevention, Assessment and Rehabilitation 2012, 41, 4503-4513.

[7] McCarthy, J.M. Engineering Design in 2030: Human Centered Design. Journal of Mechanical Design 2005, 127, 357.

[8] Harrefors, C. Elderly People's Perceptions about Care and the use of Assistive Technology Services (ATS).; Luleå University of Technology, 2009.

[9] Teixeira, L.; Ferreira, C.; Santos, B.S. User-Centered Requirements Engineering in Health Information Systems: A Study in the Hemophilia Field. Comput. Methods Programs Biomed. 2012, 106, 160-174.

[10] Steen, M. Human-Centered Design as a Fragile Encounter. Design Issues 2012, 28, 72-80.

[11] Denning, P.; Dargan, P. Action-Centered Design. Bringing design to software 1996, 105-119.

[12] Beaumont, C. Science Design Art| Writings on Design Research.

[13] Norman, D.A. Human-Centered Design Considered Harmful. Interactions 2005, 12, 14-19.

[14] Itoh, Y.; Hirose, Y.; Takahashi, H.; Kurosu, M. A New User-Centered Design Process for Creating New Value and Future. Human-Computer Interaction.Interaction Design and Usability 2007, 108-116.

[15] Yanagida, K.; Ueda, Y.; Go, K.; Takahashi, K.; Hayakawa, S.; Yamazaki, K. Vision-Proposal Design Method. Human Centered Design 2011, 166-174.

[16] Gott, M.; Seymour, J.; Bellamy, G.; Clark, D.; Ahmedzai, S. Older People's Views about Home as a Place of Care at the End of Life. Palliat. Med. 2004, 18, 460-467.

[17] Chan, M.; Campo, E.; Estève, D.; Fourniols, J.Y. Smart homes—Current Features and Future Perspectives. Maturitas 2009, 64, 90-97.

[18] Gitlin, L.N. Conducting Research on Home Environments: Lessons Learned and New Directions. Gerontologist 2003, 43, 628-637.

[19] Norell, M.; Ziegert, K.; Kihlgren, A. Dealing with Daily Emotions—supportive Activities for the Elderly in a Municipal Care Setting. International journal of qualitative studies on health and well-being 2012, 7.

[20] Harrefors, C.; Sävenstedt, S.; Axelsson, K. Elderly People's Perceptions of how they Want to be Cared for: An Interview Study with Healthy Elderly Couples in Northern Sweden. Scand. J. Caring Sci. 2009, 23, 353-360.

[21] Rolls, L.; Seymour, J.E.; Froggatt, K.A.; Hanratty, B. Older People Living Alone at the End of Life in the UK: Research and Policy Challenges. Palliat. Med. 2011, 25, 650-657.

[22] Chan, M.; Estève, D.; Fourniols, J.Y.; Escriba, C.; Campo, E. Smart Wearable Systems: Current Status and Future Challenges. Artif. Intell. Med. 2012.

[23] McCreadie, C.; Tinker, A. The Acceptability of Assistive Technology to Older People. Ageing and Society 2005, 25, 91-110.

[24] Kleinberger, T.; Becker, M.; Ras, E.; Holzinger, A.; Müller, P. Ambient Intelligence in Assisted Living: Enable Elderly People to Handle Future Interfaces. Universal access in human-computer interaction.Ambient interaction 2007, 103-112.

[25] Tsai, W.; Rogers, W.; Lee, C. Older Adults' Motivations, Patterns, and Improvised Strategies of using Product Manuals. International Journal of Design 2012, 6, 55-65.

[26] Orpwood, R.; Gibbs, C.; Adlam, T.; Faulkner, R.; Meegahawatte, D. The Design of Smart Homes for People with Dementia—user-Interface Aspects. Universal Access in the Information Society 2005, 4, 156-164.

[27] Roy, N.; Baltus, G.; Fox, D.; Gemperle, F.; Goetz, J.; Hirsch, T.; Margaritis, D.; Montemerlo, M.; Pineau, J.; Schulte, J. Towards Personal Service Robots for the Elderly. In Workshop on Interactive Robots and Entertainment (WIRE 2000); pp. 184.

[28] Suryadevara, N.; Quazi, M.; Mukhopadhyay, S. Intelligent Sensing Systems for Measuring Wellness Indices of the Daily Activities for the Elderly. In Intelligent Environments (IE), 2012 8th International Conference On; pp. 347-350.

[29] Väätänen, A.; Leikas, J. Human-Centred Design and Exercise Games. Design and Use of Serious Games 2009, 33-47.

[30] Tamura, H.; Sugasaka, T.; Horikawa, S.; Ueda, K. Designing Ubiquitous Shopping Support Systems Based on Human-Centered Approach. Universal Access in Human-Computer Interaction.Ambient Interaction 2007, 218-227.

[31] Chan, M.; Estève, D.; Escriba, C.; Campo, E. A Review of Smart homes—Present State and Future Challenges. Comput. Methods Programs Biomed. 2008, 91, 55-81.