Design for Health

Publisher: Gower & Ashgate Publishing,

Editors: Emmanuel Tsekleves, Rachel Cooper

Thematic Unit: Part 2: Design for Ageing Well (Behaviours)

Proposed Title: **Behavioral strategies of older adults in the adoption of new technology-based products: the effects of ageing and the promising application of smart materials for the design of future products.**

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Abstract
In a world that is ageing fast technology can really make a difference to keep people independent, healthy and socially connected. While the physical and sensorial signs of ageing have to some extent been considered in the design of technology for older people, much work is still needed to understand the impact of cognitive and emotional changes in the adoption, deferral or rejection of technology devices. Understanding the behavioral strategies of older people when dealing with technology-based products can help designers as well as marketers to reconsider product' attributes and market communication, respectively. A novel set of smart computational materials suggests application opportunities for the design of more immediate and intuitive technology products.

1. The Ageing Market

We live in an ageing world. The world's population of those aged 60 years and older has doubled since 1980 and is forecast to reach 2 billion by 2050 (World Health Organisation, 2014). People are living longer, remaining more active into older age, and desiring to stay in their homes longer before finding the need for 'assisted living' arrangements (Fisk et al., 2009). While this would release the pressure that nursing homes experience and reduce healthcare costs, yet it generates great pressure on informal carers, such as spouses, children and other family members and friends (Mulvenna et al., 2010). Longevity is also associated with significant deterioration in the human physical and cognitive capabilities, such as hearing and vision loss, osteoarthritis, memory problems, mobility impairments and general frailty (Metz, 2000). As a result of these changes, one of the main challenges for the ageing population involves understanding how to keep older adults independent in their daily activities. Older adults would need everyday products that place a relatively low level of demand on their cognitive and physical capabilities in order to ensure they can interact with the product to achieve their desired goal (Elton and Nicolle, 2015).

In addition to the change in demographics, there has been a major change in what current technology can offer for the design of product functionalities, the way, the look, act and react to people who use them. With an unprecedented change in the worldwide population structure, increasingly more attention is focused on the design of technology products for older people (Peacock and Künemund 2007). One of the major caveats for any project that aims to develop assistive devices for older adults is indeed ensuring that the final product will be adopted by intended users and meet real needs. There is a large amount of research (Walters et al., 2000, Blyth et al., 2005, Dröes et al., 2006) which brings evidence that involving target users in the design process, with the goal of developing a device, whose design supports only functional needs seems not to be the best way forward for designing for the older adults. Aside from physical problems (such as loss of eyesight and hearing and incontinence), the most frequently identified unmet needs for products or services are in the areas of information (on health condition, treatment, care and support possibilities, etc.), memory problems and communication and psychological distress (anxiety). Research (Hancock et al. 2003), suggests that technology adoption among older people falls short of satisfying very fundamental needs such as the feeling of autonomy. To support autonomy technology could reinforce one's orientation in space and in time, topographic memory and one's ability to maintain contact with their social environment.

Advancements in Information and Communication technology (ICT), computing and monitoring sensors (Harrison et al. 2009) have led to progress in areas of ubiquitous and pervasive computing and enhanced awareness in their application in the role of assistive technology in the home context for older people. However, research (Blyth et al., 2005) suggests that the adoption of technology in the home of the older person should be approached from a *socio-emotional* aspect, whereas instead most of the current research performed to date concentrates mainly on the usability of the screen device or interface design. Blyth et al. (2005) draw attention to the evidence gathered in the interviews conducted in their studies; they find that personal contact was very important to the older person. They also highlighted that the wearing of a device was perceived as a diminishment of the older user's independence rather than a facilitator of independence as intended.

Ho et al. (2005) found in their studies that older people in the field of monitoring medication intake had less confidence in their own judgment and so were more reliant on the decision made by the technology. Thus they suggested that this trait in the older user should be included into the design process. Experimental research performed by Bickmore et al. (2005) into relational agents defined as 'computational artifacts designed to build and maintain long term social-emotional relationship with the users'. They have found that the relationship built up between the person and the agent has a beneficial result in having the technology system accepted by the older person and being also beneficial in motivation and in reducing loneliness for the older person.

2. Technological products for the everyday life of older adults

The design of products for the ageing market is encompassing multiple technological innovations that are improving the way older adults experience their everyday life. The growing pervasiveness of these products across all domains of life is facilitating how older people perform independently specific tasks; such as health monitoring and medicine management but their acceptance is still a challenge. Albeit older people appear willing to use technological products to support their safety at home and promote their personal wellness and health (Mitzner, Boron et al., 2010), still a *digital divide* between those who do and those who do not adopt technology-based product is widely observed (Czaja, Charness et al., 2006).

The perceived benefit deriving from the adoption of products is a fundamental aspect that leads older adults to purchase and fully use a new product. Although cost is widely recognized as a barrier to technology adoption (Age UK, 2013), more likely the inability to clearly comprehend the perceived benefits of a technology-based product prior to purchase is the key hindering factor. The study of Mitzner, Boron et al. (2010) with 113 community-dwelling older adults and the data collected by Melenhorst et al. (2006) are consistent in emphasising that perceived benefits are decisive in older adults' choice for the purchase of a new product. It is reasonable to assume that with growing age, and a consequent reduced life-time horizon, personal resources are deemed precious so any investment of energy and time represents a worthless effort unless benefits are unequivocally clear.

The growing difficulty in performing Activities of Daily Living (ADLs), often caused by decreased mobility, reduced muscle strength and limited stamina, affects the perception, cognition and the control of movements (Fisk et al., 2009; Blaschke et al., 2009) and consequently may impinge on the adoption of complex technological products. As individuals grow older, there is increasing variability in haptic control and increased limit for temperature and vibration perception compared to younger adults. Age-related changes in audition and vision are also considered as basic factors that restrain older people to use products that barely consider these changes in sensorial perception. In addition to changes in perception, reduced cognitive skills, mainly related to an age-related decline, ought to be considered. Working (short-term) memory refers to the capability to temporarily store information while we use it and this affect greatly the information one may retain about a product one wishes to purchase and the necessary instructions that facilitate the learning of products. Long-term memory seems less affected by the ageing process. This type of memory consists of the semantic memory, defined as the store of factual information gathered through a lifetime of learning and the procedural memory, a set of scripts of how to perform activities and tasks (Fisk et al. 2009). This is the reason why automated tasks and activities learned prior to senescence remain intact while older adults encounter difficulties in retaining information and developing automatic processes for new tasks. The use of products that require significant learning instruction not comparable to previous experience may therefore be reduced (Blackler and Hurtienne, 2007). In the attempt to design familiar and intuitive devices, several stand-alone products exclusively conceived for older people, are often designed with commands, features and redundant controls aiming to enhance the appropriate communication of their function. Not always these attempts are reported as successful; often these products end up to magnifying the physical and cognitive weaknesses of the user that perceive them as demeaning and stigmatizing. As reported by Forlizzi (2007) this failure broadens the gap between the elders and their environment, sometimes resulting in frustration and isolation. More successful are products that support elders' values of self-confidence, dignity, and that re-establish or maintain one's identity, possibly in defeating the stigmatisation of ageism. Achieving a goal is for older people a fundamental way to still appreciate them as respectful and worthy and technology could help to facilitate activities, mediate social interactions, and evoke experiences that contribute to a sense of self (ibid). Intelligent products and systems for older people could be effectively conceived in a way that they understand the users' behaviour, predict the users' wishes and needs and act accordingly without imposing to the user overwhelming procedures. This would reduce the load of learning that new models and interfaces generally require (Sadri 2011). The advantage in the adoption of these new technologies is to allow old, frail people to remain in their homes longer with increased levels of independence and change the focus of healthcare toward wellness.

3. The effect of the Ageing process on Decision Making

Ageing has significant consequences for information processing because it underpins the decision making we exercise when making choices in any aspects of our life. Decision making is, in turn, fundamental in the choice we operate to adopt and use products and services around us. Information is processed in two ways during decision making: affective-experiential and deliberative (Epstein, 1994; Reyna, 2004). These two ways are also referred to as system one and system two respectively (Kaheneman, 2003). Both systems are equally important in decision making and effective decisions are said to be the results of choices operated by the two systems concertedly (Damasio, 1994). However, the two systems work in fundamentally different ways; while system 1 operates in unconscious, effortless, intuitive and spontaneous ways, system 2 acts consciously, requires efforts, it is explicit and analytical (Epstein 1994). Scholars claim that the deliberative system applies some sort of quality control to the instinctive outputted decisions operated by the affective system (Kaheneman, 2003). Moreover, research has ascertained that the two systems are interdependent (Epstein 1994) and that at times they compensate and influence each other. In some cases it has been observed that the affective system may have a greater influence on decisions when the cognitive load is higher or the deliberative skills are lower (Hammond, 1996; Peter and Slovic, 2007). Alhakami and Slovic (1994) have also ascertained that under time pressure, the affective system has a higher influence on the deliberation. These findings have stronger implications on how consumers enact their choice in relation to the point and channel of sale.

The relation between ageing and systems one and two respectively has been evidenced in several studies. Age seems to be unequivocally linked to a decline of deliberative skills due to a less effective information processing (Salthouse, 1992), learning deficit (Kausler, 1990), inability to filter out irrelevant or false information (Hasher and Zacks, 1988), deterioration of the executive functions (Amieva, et al., 2003) and numeracy skills (Kirsh et al., 2002). Less clear are the effects of ageing on the affective system. The most significant theoretical contribution explaining the role of emotions in decision-making among older adults is the socio-emotional selectivity theory (Cartstersen, 2006). This perspective argues that older adults are more aware of their nearing end of life and consequently they rely more heavily on the affective system in order to achieve positive outcomes. Studies have provided evidence that greater recall of positive advertisements and of emotion-laden information take place among older people (Cartstersen and Turk-Charles, 1994; Cartstersen, 1993).

The implications determined by the ageing process on decision making, especially in the realm of technological products, can be summarized in two points:

a. as the older adults have been exposed to technological products for a relatively short period in their life, their decisions are based predominantly on deliberative skills rather than experience and emotions. The former, as discussed above, are cognitively demanding. Consequently older people may be vulnerable and prone to information overload.
b. Older adults' vulnerability is exacerbated by social-economical circumstances whereby they have: i) less time and, on average, less financial resources to recover from poor quality decisions (Peters, Hess, Västfjäll and Auman, 2007), ii) less access to knowledgeable members of the family due to geographically dispersed family (ibid) and iii) less opportunity to benefit from online services and reviews of technological-based products due to their relatively lower lack of experience with Internet technologies (Selwyn et al., 2003).

Whilst it has been claimed that decision-making and access to appliances such as microwaves, washing machines and electric gardening tools, is a matter of personal choice, hence unproblematic (Peacock and Kunemund, 2007), the inaccessibility to digital technologies represents a more challenging issue. Abundant research has taken place to explain why older people are laggards in the adoption of technological products and the reasons offered range considerably: usability issues, product price and the high cost of learning. This composite set of barriers informs the behavior of people in all three stages of the technology adoption process; the formation of consideration set, the selection of point of purchase and eventually usage. Both affective/experiential and deliberative systems have a fundamental part to play in the three stages listed above, hence ageing will affect the way that older adults will consider, approach and use technology-based products. It would be too vague a generalization to attribute the behaviors and choices of older adults when it comes to technology-based products only to their chronological age. Studies have found out that higher education attainment and labour force participation are positively related to the adoption of technology (Korupp et al, 2006). Technology usage is observably different among genders as well with women displaying a lower uptake of technological products. This may possibly be due not to gender differences but simply to a higher level of education more frequently accessible to men in the past (Peacock and Kunemund, 2007).

Ageing and ageing-related socio-economical factors have a profound impact on how information is processed, decision are made and behaviour is enacted. To some extent the impact of ageing is exacerbated when it comes to technology-based products as they are less known to the ageing population and are also characterized by a fast pace of change due to continuous technological advancement and consequent reduction in costs. In the following section the behavioral strategies adopted by older adults when dealing with technology-based products are discussed.

4. Behavioural strategies in adoption of technology products

Some attempts have been made in gerontology studies to create a taxonomy of the technologies available (Mollenkopf 2005). This classification includes *compensation technology*; those used to make up for sensory losses and other physical or cognitive limitations, *daily life technology*; artefacts used to rehabilitate individuals who have suffered of temporary conditions/disabilities and a cluster of *low and high tech devices* that are chosen to enhance the wellbeing of individuals who have no condition to cater or compensate for. In contrast with the first two types, this latter set of technology is freely chosen and consists of mainstream technology purchased and accessible to people of all ages. However in light of the changes determined by the ageing process and discussed above, the behavioural strategies leading to the selection and adoption of technology-based products are worth special attention.

Research has already established that older adults consider selection sets at pre-purchase that contain fewer items (Roedder and Cole, 1986). This can be explained by:

- a lesser ability to retain and process analytical information about a larger number of products;
- a more developed preference for some products/brands achieved through past experience (Lambert-Pandraud and Laurent, 2010) and
- a generally higher cost in searching for product information (Johnson, 1990).

This is particularly important in the selection of technology-based products, as the brands known to the older population are fewer and the familiarity with the product category less developed. Other crucial aspects considered by older adults in purchase decision are staff availability and knowledge of the products at the point of sale and products extended warranty (Shekarriz and Spinelli, 2013).

In the consideration of older adults' behaviour towards technology-based products it is important to take into account research regarding decision making. An attempt to group the behaviour of older adults as consumer of technologies leads to the identification of four strategies; these are: i) Denial, ii) Deferral, iii) Delegation and iv) Adoption. While extant literature has already considered decision avoidance (Anderson 2003) across the life span, the account that follows is specific to decision making regarding observed behaviour of older adults around technologies. It is important to stress that decision avoidance is a class of behaviour usually attributed to a complex set of antecedents and that occurs across life age. This class of behaviour includes inertia, delay, defensive avoidance and omission bias (Tykocinski et al, 1995; Dhar, 1996; 1997).

- Denial

This represents the decision of not considering an action, or in other words, the choice to retain the *status quo*. In such events the decision maker prefers to not consider other alternatives available, therefore settling for the current state of affairs (Schweitzer, 1994). In such cases, the *status quo* is considered less threatening and the avoidance to consider alternative decisions is associated with the prevention of negative emotions that would derive by choosing 'something new'. In choosing to ignore alternatives, the decision makers deny themselves the opportunity to consider the perceived benefits that a technology may bring to their life, while also preventing to feel frustrated, anxious or regretful if technologies proved to be difficult to use. Older adults may disregard the benefits that smarts phone or Internet-based technologies may bring to their life by stating that their current set up (e.g. communicating by letters with remote family and friends) is more personal and that technologies would bring a style of communication that they would consider disrespectful (e.g. texting is considered by some older adults as a nuisance, abrupt and unfriendly). Such denial strategy may be explained by the inability of the older adults to recognize the opportunities that technologies could bring to their life, making them prefer a known state, the present, which present no negative surprises for them.

- Deferral

Still in the attempt to avoid negative emotions, older adults may consider the deferral of decision as a good way to resolve decision-making situations. Finucane et al. (2002) observed that older adults were more likely to prefer not to feel responsible for choosing their own medical plan. The study of Tversky and Shafir (1992) suggests that it is the compound complexity of choice dimensions that may cause deferral. When overwhelmed by the choice alternatives and by the relevant attributes to consider in the evaluation of the selection set, older adults may postpone their decision and this may lead to irretrievable consequences. When dealing with technologies older adults may link the adoption of new products to events that may never occur so as to attributing the cause of their postponement to external factors outside their control (e.g. save money to purchase a device, prolong search for alternatives or the accessibility to a family member who could teach them to use the device). It is generally accepted that deferred choices are the symptoms of conflicting experience by the decision makers either because they are overwhelmed by the options or because they are unable to focus on relevant attributes to operate the choice (Anderson 2003). Both cases seem highly relevant to older adults and technology adoption given the relative underdeveloped familiarity with this product category.

- *Delegation*

This is another strategy in the avoidance behavior class and it is observed when the decision is passed in full or in part to another agent. In older consumers who seek to adopt technology, delegation occurs often between spouses, with usually a gender prevalence where males are delegated the responsibility to purchase, set up and indeed use technologies. Differently from the previous two strategies, here the perceived benefits of technology are somehow understood, hence the decision makers do not wish to prolong the *status quo* but they feel unable to be leading such decision. The strategy of delegation also occurs between generations where older adults invest their offspring with the responsibility to select the technology they may use. Partial delegation may occur when for lack of confidence in their technology skills; older adults may delegate crucial tasks, such as initial set up and privacy management, to those whom they believe to be more expert.

- *Adoption*

This is not just the purchase of technology products but also its use. Often technologies are purchased or received as gifts and abandoned for a set of reasons that in part overlap with those analyzed in the strategies for decision avoidance, e.g. lack of confidence, unfamiliarity with the product, conflict in the choice, fear of regret, high cost of learning. However when technology adoption takes place among older adults it is the outcome of a much more complex process that involves other social resources in support of this choice. Adoption is supported often when the older consumer is within a supportive social group and can access peer- or structured learning.

5. Technologies for an ageing population: Design considerations

Nowadays, commercially available products for the ageing market use a broad range of modern technology such as necklaces with emergency buttons and fall sensors integrated in mobile phones with wireless notification functionality to care givers. These are mainly stand-alone systems, often too difficult for older people to operate (Kleinberger, Becker et al., 2007). Ubiquitous input/output devices, such as smart-phones or blood pressure machines, are then particularly affected by a low adoption rate, since they involve an interaction with the cognitive and sensorial system of the user, systems that as we discussed earlier on undergo significant changes with age (Gamberini, Raya et al. 2006). Regardless of such changes, some older people show a vivid curiosity to discover new products but often they rely on their social network or formal training courses to understand the usefulness of a laptop computer (Pushing the Right Buttons, 2013) and overall support technology adoption. Designing for the ageing population should entail specific consideration for changing the behavioural, cognitive and emotional pattern of the users. Fisk et al. (2009) considered usefulness as the sum of *usability* -the possibility to have access to a product- and *utility* -the capability to provide the functionality the product possesses-. Usefulness in the design for the ageing population can be embedded through five characteristics:

- *Learnability*: how easy it is to learn to use the device;
- *Efficiency*: how technological applications satisfy users and how the user's needs are met avoiding fatigue and dissatisfaction within a reasonable a amount of time;
- *Memorability*: minimize the effort to remember how a device works after a period of non-use;
- *Errors*: minimize the amount of errors while interacting with the device and allow retrievable errors;
- *Satisfaction*: create pleasurable interactions with the product.

Often a barrier to an enjoyable and effective use of a technology-based product is its interface. Designing for older people challenges standard and traditional input/output modality because of the older adults changes in sensory and cognitive skills as well as the lack of familiarity with new interaction languages. In this view, the combination of multiple sensory input and output channels for the interaction with technology (multimodality) could have the benefit to let the user choose the interaction modality that is most suitable to his/her own capabilities and to make a redundant message that if communicated in a multi-sensorial way, could be more effective. Blackler, et al. (2012) found that the performance of older people when interacting with various interfaces is affected by decline in cognition and familiarity with the product features. Consequently the emerging factor that contributes to making a product more immediate for the older adults is managing the transfer of the user's existing schema of products to the new device (Moreau et al, 2001; Blackler et al., 2007).

One approach that has been proposed to design more effective technology for the older adults is to include them in the design process from the requirement stage, and ideally throughout the development phase. Kurniawan (2008) through a multi-method investigation identified how older people need to personalize the interface of the mobile phone and how some of the functionalities of the device could be dramatically improved to support the cognitive decline in later life. Using design methodologies that enable the direct observation of the user is also effective to understand the older adults' psychological and socio-emotional needs that may conflict with the functional benefit of elderly-related products (Bright et al., 2013). This misunderstanding of the user needs often causes the users to abandon the technology, resulting in a reduced sense of self-confidence. Bright et al. (2013) identify guidelines to avoid embedding negative age stereotypes and the resulting reluctance to engage with them. The researchers propose that assistive technologies should not be considered as medical devices but they should rather stimulate the users' curiosity and interest so as to facilitate early adoption and personalisation of the technologies so that they could enter the lifestyle of older adults without signalling disability.

When considering the behavioural strategies adopted by the ageing users and the challenge to bridge the digital divide that still characterise this growing segment of the population worldwide products development teams may wish to consider the following practical suggestions:

- Despite being incredibly effective and useful, technologies are perceived differently by the ageing population. Consequently the pervasiveness of technology-based products may not be seen by older people as the ideal solution to achieve an independent life in older age. Sometimes interventions devoid of technology may be better received.
- In the adoption of technology its perceived benefit must be significantly bigger than the learning resources associated with the use of the same. As results the marketing communication of the technology products are a key factor.
- In designing for the older people technology must consider the evolution of the user, hence be adaptable to a number of co-present conditions and developing consequences.
- The ageing market is far from being homogenous and requires a landscape of products and services that reflects such diversity in conditions, taste, attitude to technologies and aspirations.
- The discovery and application of smart and computational materials in everyday life activities should be considered as means to simplify current activities performed in interaction with technological devices rather than just provide further functionalities.

6. Discussion

Research has established that ageing impacts our cognitive skills, emotions and social needs. In turn these changes modify our everyday behavior making older adults somehow more vulnerable when choosing and adopting technology-based products. However in a world that is ageing, designers cannot refrain from considering the imperative of designing for the human, regardless of his/her conditions and disabilities. So far the debate on technology for the ageing population has been dominated by the concept of assistive technologies. This in part has skewed the debate and, most of all, has reduced the efforts made by the ICT sector to produce mainstream products that can adapt to the changing needs of people, rather than focusing on the impairments emerging with ageing. Considering behavioral changes as consequence of cognitive and physical impairments has damaging consequences on the design rationale and philosophy that is applied to develop products, systems, services and experiences for the older population. If living well, with dignity and independently for as long as possible is a societal goal, researchers and practitioners are invested with the role to make transition to older age as acceptable as possible; an evolution rather than a segregation to a group of impaired and frail individuals.

The current advancement in materials and technologies has started to shift the discourse on technology adoption among older people and we observe more applications made to enable people rather than to compensate for their changing skills. For example products such as Ref, a wearable device[1] that monitors changes in the user pulses and by communicating them through haptic signal onto the user's wrist, it relaxes or enhances the user behaviour. This demonstrates that supporting the awareness and understanding of correct breathing and emotional patterns has great impact on the overall health and self-confidence of the user while also improving his physical condition.

While the researchers strive to understand more about the ageing mind and body, design efforts in the last two decades have rightly made a case for inclusive design; that is designing for audiences with a wider set of skills and aspirations. This special effort to design inclusively though has often produced products that are 'assistive' making the impairment they try to support more evident, hence more stigmatizing. With the introduction of materials that are smart and can adapt and respond to users' needs and desires, technologies are promising us a truly new horizon of products that evolve with the individuals.

An additional challenge is posed by how marketing can communicate the potentials of technologies without disenfranchising older adults who invest in products when the perceived benefits are clear and substantial for their life style. Categorization literature has argued that available mental models developed through past experience can help in transferring knowledge to new products and facilitating the comprehension of how new technology work (Hoeffler, 2003). However there is still ambiguity on how such insights can become guidance for designers and marketers. The fast pace of technology turn over on the market further confuse older adults by making purchased products obsolete very quickly and demanding high cost of learning to stay abreast. In the next section the future of technology-based products is discussed considering the application of the so-called 'smart material'.

7. Future directions and Conclusions

Evidence based research (Hancock et al. 2003; Mulvenna et al., 2010; European Commission 2010) report that more than 60% of people over 50 years of age feel that their needs are not adequately addressed by current Information and Communication Technologies (ICT) equipments and services. One of the main reasons is due to the lack of the *socio-emotional engagement* the older adults have with such technology (Bright and Coventry, 2013). The changes in technology can lead to less than desirable interactions with products or services. Despite recent advancements in ICT and growing sales numbers, the industry has been rather reluctant to standardize access technology and to implement them in a 'Design for All

[1] http://www.dyvikdesign.com/site/portfolio-jens/ref.html#sthash.aoswm1af.dpuf

approach'. Most often, the design and implementation of appliances using modern ICT are driven by the ambition to satisfy users that are already engaged in modern technologies. Thus many people with disabilities, in particular people with cognitive disabilities and older persons, are excluded from their use. Moreover, modern ICT based products and services for coping with behavioral and psychological changes in people's disabilities and personalized information on the person's condition (Yasuda 2006) are relatively disregarded as yet, while support for social contact seems currently to be effectively realized, for example, through simplified mobile phones or videophones (Reinersmann et al., 2007).

Emphasis in the literature for many years points to the need for more flexible, personalized care and support due to the fact that the individual needs of older adults and carers can considerably differ because of a number of personal and contextual factors, such as the symptoms of the person with disabilities, carer characteristics and utilized coping strategies, the relationship between the carer and older people, and the perception of the quality of the relief that is offered (Burns, 2000; Clare, 2002).

The field of Wellbeing and Health Care highlights the need of products and services that are effective in the way they can track and enhance the wellness of the user, provide information and entertain rather than merely operate when a disease is in progress. Research areas such as Pervasive and Ubiquitous Computing (Weiser, 1991), Internet of Things (Atzori et al., 2010) and Ambient Intelligence (Ducatel et al., 2001) foresee the environments of the future as intelligent in a way that it can unobtrusively understand the users' behaviour, predict the users' wishes and needs and act accordingly.

In this perspective, "smart objects" are defined as autonomous physical/digital objects augmented by sensing, processing, and network capabilities (Kortuem et al., 2010). These objects can sense and interpret what is occurring within them and are aware of the surrounding world, communicate with each other, act on their own and exchange information with people.

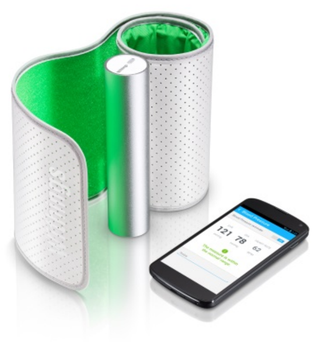

Fig. 1 Wireless Blood Pressure, designed by Withings

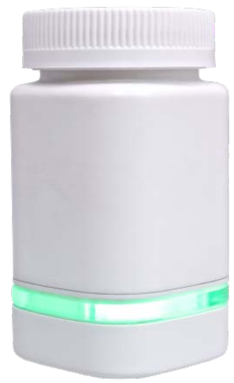

Fig. 2 Smart Wireless Pill Bottles, designed by AdhereTech

For example, Withings[i] has recently commercialized a Wireless Blood Pressure Monitor (fig. 1) that shows to the doctor the value of blood pressure of his patients. Data is communicated directly to the doctor so as to unload the user from recording and remembering the information; this result in an easier routine for the patient hat is not taxing on his memory. Another example is Vessyl, a Smart Mug designed at Mark One[ii] that automatically knows and tracks everything the user drinks and that displays nutritional information via Bluetooth to a smartphone. AdhereTech[iii] also designed another smart object, a Smart Wireless Pill Bottles (fig. 2) currently used by patients in pharmaceutical and research engagements. These bottles automatically analyse information and if doses are missed, patients can receive customizable alerts and interventions - using automated phone calls, text messages, and more. In these products, the user can perform his ordinary activities (run, walk, drink) while objects seamlessly track his wellbeing status as a hidden care givers. What the user perceives is exclusively the result of his performance, not needing to be concerned of the technology behind the product.

The growing diffusion of computational features in everyday products has blurred the boundaries between materials, interactive technologies and human-computer interaction (Vallgårda and Redström, 2007). Mickael Boulay designed "Measure less to feel more"[iv], a diabetes reader that reduces the stress of the user while measuring blood sugar level by creating an emotional and engaging experience. Current devices focus strictly on quantifying the blood level with numbers with no room for personal feeling and sensation. In the vision of the designer this aloof activity is made personal by the use of a changing LED light to literally express how high/low the blood sugar level is instead of using numbers.

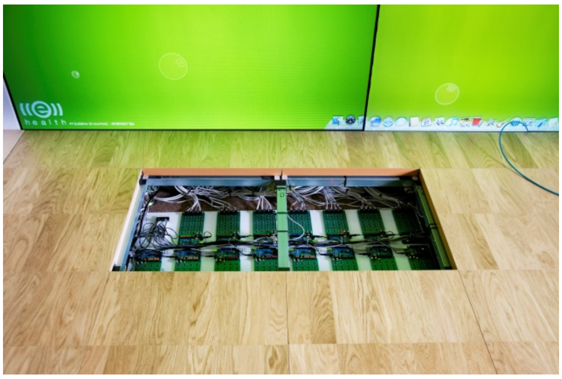

Fig. 3 Future Care Floor, photo courtesy of Kai Kasugai

Another interesting composite interaction is provided by Future Care Floor (Klack et al., 2011) that shows an instrumental integration of the Smart Materials into the home environment (fig. 3). This sensor floor seamless integrates piezoelectric sensors to support old and frail persons living independently at home. The purpose of this application is to detect abnormal behavioural patterns of the inhabitant and activate rescue procedures in case of falls or other emergency events.

"Smart Materials" (SMs) is a relatively new term for materials that have changeable properties and are able to reversibly alter their shape or color in response to physical and/or chemical influences, e.g. light, temperature or the application of an electric field (Ritter, 2007). The Knowledge Transfer Network defines SMs as materials that display smart behaviours. In their view a smart behaviour occurs when a material can sense a stimulus from its environment and react to it in a useful, reliable, reproducible and usually reversible manner. SMs incorporate also features such as sensors and actuators, which are either embedded within a structural material or else bonded to the surface of the material (Gandhi and Thompson, 1992) the control capabilities permit the behaviour of the material to respond to an external stimulus according to a prescribed functional relationship or control algorithm. The development of "smart" or "intelligent" materials, systems and structures shows how products can actively monitor and optimize themselves and their performance emulating biological systems through their adaptive and responsive capabilities (Schwartz, 2002).

Designers and engineers are starting to deploy the properties of materials to enhance the experience unleashed by products and unlock design opportunities for creative applications. Such attempts are proceeding by trial and errors and despite the promising attempts described above, there seems to be no rationale that can robustly account for the specific matching of SMs to users experiences/needs. These attempts demonstrate that we still lack a clear understanding of how the users perceive, respond and maximize their experience with engineered materials embedded in everyday products. The quest to truly embed SMs in new products cannot transcend from the understanding of the users and their contexts of use.

In this perspective it is reasonable to think that materials *per se* are neutral and are invested with intelligence only within the framework of the user's experience, hence the need to focus on the latter. Benefits from SMs are not only as add-on interfaces in product development, but as integral constituents of the product. It is instrumental therefore to understand the users' goals and necessities in the continuous agency they perform in everyday tasks. This helps to conceptualize the sensorial and interactive qualities that can become the 'language' of interaction between the users and the immediate products that in this logic don't require interface, to achieve smart experiences.

Summary

Designing technologies for the ageing population is a challenging issue. The challenge is represented by an ever moving goal post in technology advancement that is not an easy match for the relative inexperienced older users who, generally speaking, are still uncertain and unconvinced that technology can improve their lifestyle in older age. The chapter has reviewed the behavioural strategies displayed by older people when selecting, purchasing and using technology-based products. Such strategies rely not only on the individual's skills and characteristics but also on the social support group that can intervene to make the technology adoption process less demanding. The pressure on social and health care systems posed by an ageing society is relentless and Smart Materials are emerging as a promising opportunity for the design of more intuitive technology-based products. This, combined with a more advanced understanding of the ageing process, may help in the find solutions for a changes in demographic structure that are set to stay.

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