Care robots for the supermarket shelf: a product gap in assistive technologies

Journal Item

Care robots for the supermarket shelf: a product gap in assistive technologies

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Abstract

The literature on the development of assistive robots is dominated by technological papers with little consideration of how such devices might be commercialised for a mass market at a price that is affordable for older people and their families as well as public services and care insurers. This article argues that the focus of technical development in this field is too ambitious, neglecting the potential market for an affordable device that is aleady in the realm of the ‘adjacent possible’ given current technology capabilities. It also questions on both ethical and marketing grounds the current effort to develop assistive robots with pet-like or human-like features. The marketing literature on ‘really new products’ has so far not appeared to inform the development of assistive robots but has some important lessons. These include using analogies with existing products and giving particular attention to the role of early adopters. Relevant analogies for care robots are not animals or humans but useful domestic appliances and personal technologies with attractive designs, engaging functionality and intuitive usability. This points to a strategy for enabling mass adoption - which has so far eluded even conventional telecare - of emphasising how such an appliance is part of older people’s contemporary lifestyles rather than a sign of age-related decline and loss of independence.

Introduction

Technological responses to the increasing care needs of ageing societies have been gaining traction in recent years, with the promise of containing rising health and social care costs while supporting independent living in the community (Coughlin *et al*. 2007; Doughty 2010; Wanless *et al*. 2006). Many governments and care funders are promoting telecare and telehealth for these reasons (Clark and Goodwin 2010; World Health Organization 2009). Telecare has developed from the community alarm infrastructures that now exist in many countries to home sensors able to monitor dangers such as gas leaks, falls or a person not getting up in the morning when expected, with two-way communication enabled between the user and a care centre. Telehealth describes the closely related but distinct technologies for remote monitoring and management of a person's health condition, tracking vital signs and disseminating advice. In the UK, the leading provider of telecare and telehealth products and services now operates in over thirty countries, with an annual turnover of £190m, making assistive technologies big business (Tunstall 2011).

UK governments have been among the most enthusiastic promoters of these technologies, including funding the largest randomised control trial of telecare and telehealth in the world, which recently reported striking results for reducing health care expenditure and mortality (Department of Health 2011). Although significant barriers to wide adoption and diffusion remain, innovation continues apace. However some of these innovations, such as video monitoring and tagging and tracking devices, have started to raise ethical concerns about threats to older people's autonomy, privacy and quality of life (Clark and Goodwin 2010; Ganyo, Dunn and Hope 2011). At the frontier of innovation are care robots, where these concerns have been especially strongly voiced because of claims that developments in robotics are ‘potentially threatening the very nature of what it means to care and to be human’ (Ganyo, Dunn and Hope 2011: 1351). Others welcome the application of robot technology to care needs, writing of a future in which ‘sociable robots’ become as commonplace as their industrial counterparts, achieving ‘the continuous availability of sense-ful close support and cognitive engagement of the elderly ... a far cry from the depressing vista we often assume, of robots only encouraging social isolation’ (Paterson 2010: 124).

Care robots already exist but they are experimental or expensive with small markets. The barriers to the wider adoption of telecare and telehealth generally that are identified by Clark and Goodwin (2010) apply particularly to these machines: a lack of robust evidence of cost-effectiveness, implications for new ways of working by professionals and care organisations, a lack of interoperability and minimum technical standards, and the lack of a consumer market. There are also behavioural and attitudinal barriers reflecting the general ethical concerns raised about assistive technology, especially the spectre of machines substituting for human contact. Yet if the knowledge that we already have about older people’s preferences - to stay in familiar environments, to keep their home clean, to be able to communicate and if necessary raise an alarm, and to receive support in a way that is available when and where needed, as far as possible under their own control and in a way that is not intrusive - then the service that potentially meets much of that specification is robotic. Furthermore, the limitations in what robots will be able to do in the foreseeable future, at least at an affordable price for users or their families, mean that they will inevitably have to complement rather than replace people.

The aim of this paper is to discuss the potential of care robots not as an expensive and high-tech end of telecare, or as dehumanising and ethically suspect, but as a useful and above all marketable addition to telecare products that can appeal to older people and their families as shoppers for new types of consumer goods (Higgs *et al*. 2009). This means centring the discussion on something that does not yet exist: an *affordable* care robot. Why this does not exist, and what the implications would be of its arrival in the market place, form the main contribution of the paper. The sections that follow are based on a rigorous search of published academic literature, newsletters and professional magazines, web sites and patents, synthesising material not normally brought together in one study - in robot technology, care and marketing. This reveals a lacuna around the possible commercialisation of a low cost care robot that nevertheless appears already to be in the realm of the 'adjacent possible' (Johnson 2010). Its uptake on a commercial scale depends on learning from the marketing of other 'really new products' (Lehmann 1997).

Care robots: a gap in the market?

Assistive technology suppliers are very dependent on procurement by care provider organisations rather than a consumer market, which remains very small. As a result, suppliers emphasise cost savings for public services or care insurance budgets, and this is where much of the research effort has been concentrated. For example, the York Health Economics Consortium has estimated that a Scottish Government investment of £6.8m in developing telecare delivered £11.2m million of savings in one year due to quicker hospital discharge, less unplanned admissions, reduced sleepover care and less home check visits (Beale, Sanderson and Kruger 2009). Evidence of benefit extends across falls prevention, less pressure on carers, better compliance with medication, and avoidance of dangerously low indoor temperatures (Yeandle 2009).

In the UK there is now a focus on large-scale adoption following major demonstration initiatives such as England's Whole System Demonstrator (WSD) programme, running since 2008 and involving more than 6,000 participants, and Scotland's telehealthcare demonstration programme, starting in April 2012 and involving at least 10,000 older and disabled people (Sweet and Down 2011). Other research initiatives concerned with mass uptake include a recent UK Technology Strategy Board call for research proposals, this time focusing on developing economic and business models to grow the telecare and telehealth markets, and understanding better the social and behavioural issues involved. The Board described a paradox of rapid technical development contrasting with slow market pull (Technology Strategy Board 2010).

While market pull has been slow, product push is very much in evidence but to public sector procurers rather than individual consumers. The availability of product information for organisational purchasers is growing, with the UK's 'Buying Solutions' web portal listing over 900 telecare, telehealth and telecoaching products (www.buyingsolutions.gov.uk) and a dedicated web site now supporting telecare and telehealth product comparison (www.alvolution.co.uk/compare/product_comparison_website). These sites do not list any care robots, and although care robots exist they are far outside the mainstream of telecare and telehealth products because they are costly and still largely experimental. This means that a product push for care robots based on saving money is not evident, contrasting with other spheres. Industrial robots, for example, now have a fifty year history, and there has been substantial growth over the last decade in robotically assisted surgery and physical and occupational therapy (Okamura, Matarić and Christensen 2010). In addition to these medical robots, the robotics market includes robots for manufacturing, service robots such as for cleaning or security, and entertainment robots. Over the past twenty years prices have fallen sharply while quality has continued to improve, along with new capabilities such as human-robot cooperation (Kumar, Bekey and Zheng 2004).

The research and development effort in care robots is pursuing the same course as for telecare and telehealth, based on the promise of reducing labour costs and delaying admission to residential care. Funding from the European Commission is currently supporting major research and develoment projects such as LIREC (LIving with Robots and intErative Companions: http://www.lirec.eu) and SERA (Social Engagement with Robots and Agents: http://project-sera.eu). As with telecare equipment, these robots are often promoted as ways of managing age-related 'decline' rather than as labour-saving devices or lifestyle enhancements, terms more typically associated with domestic appliances and personal technology such as vacuum cleaners and smart phones. Yet it is these comparisons with 'ordinary' – albeit innovatory - consumer products that suggest a different course for assistive technology that could be pioneered by care robots.

Not only are telecare and telehealth products not marketed on any significant scale directly to the public because suppliers see their prime markets to be care organisations aiming to save money, but public attitudes also tend to be that supplying such equipment is a matter for public services and insurers rather than their own disposable income and ordinary shopping (Ipsos MORI Social Research Institute, 2011; PricewaterhouseCoopers 2009; Yeandle 2009). This is increasingly likely to be a problem when governments around the world are attempting to encourage their citizens to invest in their own care so that public funding can be concentrated where it is most needed as their populations age. For the majority of older people and their families there is no reason why buying something that helps with care should not be a normal consumer purchase. While it has not yet been possible for telecare equipment to break into a mass consumer market, similar functionality but packaged in a small robot may have the potential to make it to supermarket shelves. This would not be as a special need aid - as telecare, designed for and predominantly purchased by public services and professional care organisations, is usually thought of - but as a desirable and useful consumer product. Affordability is a challenge, but if development is refocused on certain specific functions that do not involve the costs involved with capabilities such as fetching and carrying or mimicing a human being or pet, and if the robot is embedded in social media, then both affordability and marketability are more likely to be achievable.

Commercialisation risk has been a barrier to innovation in assistive technologies generally. In 2007 the Foundation for Assistive Technology studied 362 assistive technology projects in small and medium-sized enterprises (where most innovation sits) and found that only twelve had delivered a commercial product (ATcare 2009). Issues included lack of research time, funding gaps, lack of commercial expertise and the market being underdeveloped. A key problem was the challenge of marketing a 'really new product'. Really new products present consumers with products that are like nothing they have seen or experienced before (Lehmann 1997). So, if care robots were to appear on the market, what would they actually be able to do?

Robot capabilities

Robotic platforms are now generally available at relatively low cost. A small robot with on-board processing, radio communication and a mobile base platform can be built from commercial off-the-shelf components for around £100. The Roomba robot vacuum cleaner is essentially a low cost platform, retailing at £200-300, and is able to support much more than just vacuuming tasks (Tribelhorn and Dodds 2007). Localisation, mapping and navigation capabilities are improving all the time, and are essential if a robot is to be able to move about a user's home effectively on the basis of a routine or in response to user commands. Robotic manipulators are available and continue to increase in sophistication, from robotic arms to assist people with dexterity impairments to complex manipulation devices able to fetch and carry, but this functionality escalates costs considerably (e.g. Abudulrazak, Mokhtari and Grandjean 2004; Graf, Parlitz and Hägele 2009).

Much technical effort is currently focused on robots able to track and recognise people, interpret gestures and identify from a person's posture whether they are anxious or not feeling themselves (Cesta and Pecora 2005; Hacque and Prassle 2010; Perrin *et al*. 2010). Several research groups are working on mobile service robots able to communicate verbally, undertake video monitoring, sense vital signs and deliver medicines, with examples including Kompaï, CareBot, CompanionAble, Florence Nightingale and Pearl (Badii, et al. 2009; Besio, Caprino and Laudanna 2008; Pollack *et al.* 2002; Dautenhahn *et al.* 2005). Work on human-robot interactions has identified the information needed by both humans and robots for different levels of interaction, and human-robot interaction standards have been derived and evaluated in tests (Goodrich and Schultz 2007; Hearst 1999; Scholtz 2003; Tsui *et al.* 2008). As well as multimodal dialogue systems that can perceive people in their environment and both recognise and synthesise speech, three-dimensional gesture recognition has been developed from virtual reality games (e.g. Nickel and Stiefelhagen 2007; Nieuwenhuisen, Stueckler and Behnke 2010).

Automated understanding of the emotional or physiological state of a person is a current research frontier in robotics (Okamura, Matarić and Christensen 2010). The use of wearable devices to track vital signs such as heart rate is well-established in telehealth, but there is a range of situations when signs of something being wrong can be observed visually. Robots can undertake visual monitoring such as of facial expressions and some are already able to recognise signs of pain (Littlewort, Bartlett and Lee 2009). A robot's analysis of natural language and non-verbal expressions can recognise different emotional states as a basis for interaction (e.g. Saint-Aimé *et al*. 2010). Other advances, in the field of robot intelligence, include learning and predicting human behavior. A robot can learn what to expect and respond with a verbal warning or an alarm to a third party if what it encounters is not what it anticipates, such as distress or risky behaviour. This can extend to monitoring the environment, detecting hazards such as dangerous obstacles, smoke or a gas escape. Further advances in evolutionary robotics are enabling robots to cope with situations without being programmed with prior knowledge of them, creating intelligent and autonomous robot controllers (Lee, Kim and Bien 2010; Nelson, Barlow and Doitsidis 2009; Nolfi and Floreano 2004).

The RoboCare project has investigated the acceptability and usefulness of a socially interactive robot in the home, with positive findings especially for increasing personal safety (Cesta and Pecora 2005). The CompanionAble robot is being developed for people with chronic cognitive impairment, embedding the robot in a smart home as part of a total assistive environment (www.companionable.net). The University of Hertfordshire's Robot House is experimenting with a robot in an ordinary home environment, exploring human-robot interactions regarding routine home tasks such as carrying food from a fridge, as well as investigating aspects of user acceptability (Koay *et al.* 2009). User acceptance by older people in home settings has been a focus of several studies with generally positive findings, especially if the robot can communicate, but with concerns about capability limitations, reliability and the price of both the robot and its maintenance (Broadbent *et al.* 2009; Cesta *et al*. 2000; Heerink *et al*. 2009).

Paro, a fur-covered robot baby seal, is one of the best know robot pets already on the market, specifically developed for older people to stroke and interact with, and costing around £4,000. These have been evaluated for their therapeutic benefits for people with dementia, with positive results for emotional state, reducing loneliness and increasing communication and interaction (Banks, Willoughby and Banks 2008; Kanamori, Suziki and Tanaka 2002; Song 2009; Tamura *et al*. 2004). However, these devices when used by people with dementia or very young children raise particular ethical issues concerning the illusion of sentience, which is considered in the next section.

In summary there is much useful technical development and evidence about acceptability, but this has so far not resulted in significant adoption of a product, even though robot technology can clearly deliver the benefits identified by evaluations of telecare and telehealth from vital signs monitoring, safety and security monitoring to information, advice and support. Crucially, an affordable product has yet to be developed based on market research. This consumer-focused approach implies giving as much - if not more - attention to attractive design, engaging functionality and intuitive usability as to technology development. In addition, although research in this field is increasingly multidisciplinary, the contribution of the social sciences is under-developed. An important example of where this is needed is seeing both the person with assistive needs and their carer/s in the context of their social networks. Any intervention needs to work with and strengthen these networks, which are essential to the psychological wellbeing of older people, and a robot needs to be seen as part of a human-machine network rather than a standalone device (Blackman, Brodhurst and

Convery 2001; Burnett *et al*. 2006; Coughlin, Pope and Leedle 2006; Duner and Nordstrom 2007; Eloranta, Routasalo and Arve 2008; Golden *et al.* 2009; Walker and Hiller 2007).

A care robot may have its own effect on loneliness given some existing evidence on companionship, but it also has a key role in creating supportive networks around the user (Banks, Willoughby and Banks 2008; Kanamori, Suziki and Tanaka 2002; Wada, Shibata and Kawaguchi 2009). Robots can be linked to a mobile phone and web applications that provide a means for carers to keep in touch, receive and respond to messages, and programme the robot remotely. The robot is an actor in this networking, such as alerting a carer or circle of carers to an emergency or possible risk, or enabling a group of carers to purchase a robot jointly which is then used to share periods of respite and, via a related web application, network and share news and advice. This concept draws upon the idea behind www.justvisiting.com, a recent start-up social enterprise in North East England that facilitates a circle of friends and relatives keeping in touch with a hospital patient.

Ethical issues

There are several ethical concerns about assistive robots, mainly concerning the possibility of inappropriate attachment to them by users, privacy, the robot not distinguishing between lower and higher level risks, and the confidentiality of information collected by the robot, such as visual images. These have been most exhaustively explored in relation to childcare robots that are already on the market (Sharkey and Sharkey 2010). These both monitor the child by transmitting images to a mobile phone or computer and occupy the child with activities. Concerns have been raised about addiction and emotional and psychological damage if children are exposed for large amounts of time to the robots at the cost of human interaction, especially with parents and carers. However, it is also argued that the risks are over-stated, with other authors drawing parallels with the pretend play typical of childhood, emphasising educational and therapeutic benefits, and citing evidence of how children can be very aware of the limitations of robots (Belpaeme and Morse 2010; Feil-Seifer and Matarić 2010; Movellan 2010).

There is an argument to be made that design and functionality should not suggest a real animal, possibly implying having its own mental state and emotions, since this might be regarded as deception and engender inappropriate bonding, especially for people with cognitive impairments. It may also invite others to believe that their own time caring for someone or just keeping them company can be adequately substituted with a robot. A further risk from creating the illusion of sentience and emotions is that the user may dangerously exaggerate what the robot can do for them. Nevertheless, the Paro robotic baby seal is already being purchased by health and social care services as a social companion for people with dementia, and as already noted has been shown to encourage nursing home residents to interact with each other (Belpaeme and Morse 2010; Feil-Seifer and Matarić 2010). It is also important to recognise evidence that how people perceive and respond to robots, and the relationships they form with them, will not be the same for everyone. These have been found to vary according to pre-existing attitudes and prior exposure to robots in literature or entertainment media, although not by age or sex (Broadbent *et al.* 2009).

For older people, the main issues are raising awareness about risks, hazards and appropriate use among both users and carers, which apply to any new technology including telecare. Suggestions that telecare is intrusive, reduces personal contact or causes isolation have not been supported by evaluations. Robots raise additional issues but the potential for harm can be minimised by describing as far as possible their capabilities and limitations to users and carers as guidelines, possibly underpinned by regulation (Whitby 2010). Ganyo, Dunn and Hope (2011) suggest that manufacturers should be under a duty to inform potential buyers and users of the ethical issues raised by telecare products and the unwanted effects that may arise, making a parallel with how the pharmaceutical industry is required to alert patients to the possible side-effects of its products. However, this may continue to frame and indeed stigmatise telecare as special needs devices rather than consumer products. Marketed robots are already covered by the same consumer protection legislation as any product regarding instructions, warnings and a duty of care to the customer (Lichocki, Kahn and Billard 2011). If these responsibilities are appropriately enacted there does not seem to be a good argument for regarding care robots or other assistive technology as a special case for ethical protection.

The zoomorphism and anthropomorphism characterising much care robot development is probably unstoppable given that products are already on the market and views are divided about the ethical issues, reflecting both personal and cultural differences of opinion. However, aside from the ethical concerns, these features are not necessarily helpful in marketing care robots as really new products beyond the niche market of therapeutic pets that do not need to be fed or toilet trained. This is because a more obvious and less problematic source of comparison for consumers is not animals and humans but products that enable prior knowledge to be used to build representations of the really new product and what it can do as something that is both useful and desirable. These are other well-designed domestic appliances and personal technologies: assistive robots are a hybrid of a domestic appliance such as a vacuum cleaner and a personal technology such as a smart phone, and there is potentially a mass consumer market for them.

Care robots are telecare's 'adjacent possible'

In 2010, the telecare device industry turnover in the UK was estimated at only about £100m and fairly stable (Technology Strategy Board 2010). The market is still undeveloped and, as already noted, there is currently no significant consumer market. In the UK, uptake even by public services has been slower than expected, although is certain to be boosted by the WSD results and the Department of Health's commitment in England to extend telecare and telehealth to at least three million people with long term conditions and/or social care needs (Department of Health 2011). It has been argued that to date this slower than expected pace of adoption is not so much due to limitations of the technology as to poorly joined up service models, resistance to change by frontline staff, a lack of commissioning knowledge and a culture of thinking in terms of hours of care (Moore 2011; Yeandle 2009).

While it might be possible to improve uptake by public services using policy drivers, the potentially very large latent consumer market needs a different approach, with products that are not perceived as disability aids but are stylish and engaging as well as useful, integrate with the existing lifestyles of users and family carers, and are intuitive to use. This is also likely to mean that such products when procured by the public sector are more appealing to users, less stigmatising and cheaper because of the larger market.

The assistive robot concept offers a solution that is not aimed at people needing complex assistance but at the much larger numbers needing inclusive technologies with helpful features. In addition, while the product would be aimed at private purchasers, these will increasingly include people referred to public health and social care services in countries such as England where much direct provision by these services is being replaced with personal budgets enabling users to making individual purchasing decisions (Bönker, Hill and Marzanati 2010).

The US is likely to take a lead in marketing high cost assistive robots starting at around $12-15,000, with the price justified by a comparison with residential home costs (Owusu 2010). However, an alternative concept is to focus on meeting low to moderate level needs that may then help prevent escalation to higher level needs, with entry-level pricing of a few hundred pounds and the option to spend more on specialist modules, either for purchase or hire. The product would be likely to substitute for many telecare packages as a more flexible and customer-friendly alternative, but more importantly also expand the market significantly. This in turn would have the potential of supporting the growth of a low cost care robots sector.

Rather than a technological leap, such a development is a move into what Johnson (2010) calls the 'adjacent possible' in innovation. Figuratively, this is the empty room next door to already occupied rooms where new innovations arise from novel combinations of existing technologies and/or the adaptation of an existing technology to a new use. From this perspective, affordable assistive robots are a special case of, on the one hand, the now common use of telecare and, on the other, small robots such as robotic vacuum cleaners. From a user viewpoint, a small robot that can perform functions similar to existing telecare equipment installed into a person's home promises a more flexible and portable option, as well as physical embodiment in one personal device, which some studies suggest older people prefer to mediation through a telephone or computer screen (Heerink *et al.* 2009; Tapus 2009).

If such a product can be developed, it also promises to reframe the arguments often made for telecare that we face unsustainable costs from an ageing population. Rather than this ‘ageing burden’ narrative, assistive robots can appeal to lifestyle needs and successful ageing (Neven 2010). Their negative association with dependency could also be addressed by having a wider market than just personal care, such as remote surveillance of an unoccupied home, and the portability of the robot means that it can be taken on holiday, used for only temporary spells or shared among a group of users and carers as respite. It is a product that should be wanted as well as needed.

More research and development is needed to keep the potential selling price low while incorporating important functionality but this is incremental rather than transformational R&D. Software architectures with search algorithms for finding objects and selected localisation are feasible, as are mapping and obstacle avoidance algorithms to provide navigation capability in cluttered and changing indoor environments. Development challenges and costs begin to escalate with providing mechanical and physical assistance, even though this offers potential for aiding manipulation, fetching and carrying, or opening doors. It is not a direction for a relatively low cost device but could be available as add-on modules at extra cost depending on market demand.

More promising for a mass home market is that functionality embraces personalised communication, monitoring of the older person’s state and their environment, and a range of response protocols from interaction with the individual user to communication across their social or family network. This last requirement is about future-proofing. Although the vast majority of telecare monitors are connected via a regular telephone line, increasing numbers of users and many carers (including family members and neighbours) have a mobile phone.

An affordable care robot therefore needs to provide mobile phone connection and be ready for mobile phone video conferencing services. Broadband internet connectivity needs to be built in, allowing remote communication and programming, as well as linkage with a website that also encourages and supports social networking. The use of social media platforms such as Facebook is set to spread even further with the growth of digital TV ownership and online access using familiar devices, as well as easy-to-use tablet computers, which are also likely to see improvements for users with impairments.

Rolling these functions into a single attractive design creates a really new product, although based on incremental technology development. The marketing literature, however, suggests great caution about bringing ‘really new products’ to the market, since they have a much higher failure rate than products that are ‘incrementally new’ mainly due to a lack of understanding of the product’s features and benefits by consumers (Feiereisen, Wong and Broderick 2008). Steps to address this have focused on using marketing communication strategies that draw on analogies and simulation of the potential purchaser in a consumption situation. Examples for a care robot include the robot vacuum cleaner, a conventional telecare alarm, smart phones and social networking sites such as Facebook. A simulation might be envisaged of an older person in their home being prompted by the robot about a meal time or querying why they are making for the front door in the middle of the night. Family members are as much, if not more, the target for these messages as the older person needing support.

As discussed above, the potential of robots to have ‘pet appeal’ has been demonstrated and, beyond a therapeutic value, helps to maintain the user’s interest in the device and what it can do. At one level it is unavoidable that this type of attachment will occur with a small, attractively designed machine. Feil-Seifer and Matarić (2010) report how users of a robot vacuum cleaner become attached to it, including getting the device repaired when broken rather than replacing it. Although designing a care robot deliberately to create the illusion of sentience and emotions is questionable, there is every reason to design an affordable assistive robot in a way that is aesthetically pleasing as well as functional, not least to position it as a consumer product rather than an aid for special needs.

In reviewing the literature on assistive robot development for this article, there was a marked absence of commercialisation considerations, revealing a lack of marketing research input to the projects. Interestingly, a bibliographic search in Web of Knowledge combining "really new product*" with "robot*" produced no results, with the literature on robotics dominated by technological papers. Yet the research about really new products is extremely relevant and important insights are available, not least learning from product failures in technology markets due to poor customer acceptance. Important considerations in addition to price are targeting, positioning and inter-firm partnerships and alliances critical to fostering adoption of the product. The last is especially important in technology markets because really new products are usually systemic innovations that are part of a wider system of interrelated components that need to respond with complementary actions, such as battery and software suppliers and retailers (Chakravorti 2003; 2004). Indeed, fruitful strategic partnerships between a robot developer and a business with large reach such as the 'over 50s' company Saga or a trusted brand such as Dyson could be envisaged.

Another important consideration regarding the mass market necessary to bring down costs for the consumer is diffusion. This can be significantly affected by post-purchase attitudes among early adopters, who can exercise considerable influence on the growth of the market for a really new product. Later adopters inevitably tend to be more risk averse, and relatively often early adopters develop a negative attitude towards the product because it fails to meet expectations (Chiesa and Frattini 2011). The lessons point to new innovations needing to arrive on the market completely developed and functioning perfectly. Configuration of the product on launch is therefore best confined to a limited number of functions that appeal strongly to early adopters, with this reflected in the product's advertising.

Conclusions

An affordable and portable care robot for older people exists as yet hypothetically in the category of really new products, but as an adjacent possible to telecare, domestic appliances and personal technology. This article argues that much of the current development effort in this area is too focused on expensive machines, often aiming to mimic humans or pets, with little marketing research behind the work. An affordable care robot that essentially recombines the functionality of existing telecare technology into a really new consumer product is a much more promising possibility. It is currently technically possible for the functionality to include a useful degree of wellbeing monitoring and preventative care, with a capability to identify deteriorating health and prevent some critical situations. Because its functionality is deliberately limited, there a much higher prospect of it working perfectly and being widely bought and used. As a really new product it is early adopters who are the crucial initial market, for whom the novelty of an assistive device marketed as a lifestyle accessory rather than a special needs aid could provide the compelling purchasing message.

Older people are a growing market rather than a growing burden, especially for affordable and useful products. There is also evidence that far from being resistant to innovation, older consumers do look for new and interesting products and services to suit them (Carrigan and

Szmigin 2000; Szmigin and Carrigan 2001). Even with the effects of the global financial crisis set to last in many countries for several years, new cohorts of older people are likely to spend more on novel consumer goods because their ‘generational habitus’ has been that of a technological consumer society, including in the emerging economies (Higgs *et al.* 2009). An affordable care robot is a really new product but the benefits are recognisable: an ability to act on signs of something being wrong, mobility around the home and portability beyond the home, a hub in a wider social network of family and friends, possibly assistance with cleaning and basic manipulation tasks, and company – not so much in the sense of a pretend pet, although some attachment might be expected just as with a favourite car, but more in the sense of the company offered by a radio or TV.

An exclusive emphasis on usability neglects the appeal of aesthetic design, too often considered the prerogative of younger consumers, as well as older people wanting fun and enjoyment from what they purchase or what is purchased on their behalf (Piqueras-Fiszman *et al*. 2011; Sudbury and Simcock 2009). Having a limiting condition does not mean that these values change, just as ageing in general does not mean that products and brands should ‘get customers to “act their age” ... using labels and positioning that call attention to their senior status’ (Zaltman and Zaltman 2008: 29). Although it is unlikely, therefore, that we will see a proliferation of assistive technology shops full of older customers in prime high street and mall space, a scenario of existing well-known retailers stocking affordable care robots on their home electrical shelves and for purchase from their web sites may soon be with us.

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