Chapter 2
Technology and the Challenge of Aging

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2.1 Introduction

The aging of populations is a global phenomenon. At the present time, approximately 10 % of the world's population are aged 60 years and over, but the proportion is projected to increase to about 20 % by 2050. While the population worldwide is growing at around 1 % per annum, the number of people aged over 80 is growing at 4 % per annum. Moreover, the phenomenon of population aging is not limited to the developed countries. Currently 64 % of older people live in less developed regions, but this figure will rise to 80 % by 2050 (HelpAge International, 2012).

The aging of the population presents many challenges, not least how services can be improved in order to enhance the health and quality of life of older people in an era of strained financial resources. In this context, information and communication technologies (ICTs) are viewed as having a huge potential. ICTs for older people have emerged as a major component of research and development (R&D) programs worldwide (Sixsmith, 2012). For example, the European Union's Ambient Assisted Living Joint Program has invested significantly as part of a social inclusion agenda to improve access and uptake of ICT-based products and services by disadvantaged groups, such as older people, and to exploit the opportunities this brings for European industry (EU, 2007). There is growing evidence from evaluation research that technological supports can bring about significant benefits for older people, while at the same time improving the cost-effectiveness of health and social services (Bowles & Baugh, 2007; DH, 2011; Pare, Jaana, & Sicotte, 2007). However, the research has so far been limited in terms of real-world products and services (Meyer, Muller, & Kubitschke, 2012). This chapter is an attempt to provide an agenda of research on technology and aging by firstly identifying

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opportunities for technologies for seniors and secondly by articulating some of the key challenges that will need to be addressed if the full potential of ICTs is to be exploited.

2.2 Heterogeneity and Old Age

One of the limitations of much of the research and technological development in recent years has been the way old age has been perceived and how ageist assumptions appear to have been translated into the agendas for ICTs. Old age is often seen in negative terms, equated with ill-health and disability. However, this stereotype of old age contrasts with the high degree of heterogeneity within the older population. If the potential of ICTs is to be fully exploited in terms of developing new products and services, the opportunities afforded by a growing and diverse marketplace need to be taken seriously. This section explores these opportunities in terms of four key population groups: healthy and active seniors, people with chronic diseases, people with dementia, and people with mild cognitive impairment. The focus is very much on how ICTs can be used to enhance independence and active aging and identifies some of the interesting lines of research and technological development that is beginning to emerge.

2.3 Healthy and Active Seniors

To start the discussion on the opportunities afforded by population aging for developing new technology-based products and services, it is useful to start by saying that most seniors are relatively healthy and disability-free, leading rewarding and active lives. Of course, there is a strong association between aging and health outcomes, but the majority of seniors are likely to report that they are in good health. For example, surveys in British Columbia examined functional health status in respect to vision, hearing, speech, mobility, dexterity, feelings, cognition, and pain. The majority of seniors reported *very good* or *excellent* health (Wister, Sixsmith, Adams, & Sinden, 2009), although this does vary with age, with two-thirds (66 %) of those 65–74 years reporting very good or excellent health compared with 40 % of those aged 75 years and over. Significantly, Canadian data suggest that the proportion of older people who are disabled appears to have diminished over the last few decades (Federal Interagency Forum on Aging, 2004). Data from the USA show the age-adjusted rate of disability (limitations on activities of daily living) declined from about 25 % in 1984 to 20 % in 1999; these improvements can be seen in both men and women.

Despite the relatively good health and functional status of seniors, the key focus of research and development of technologies for seniors has been on the sick and disabled. This focus appears to be limited in its vision, and there is a need to move

from a technological agenda that addresses ill-health and dependency to one that promotes active aging in settings where older people want to live:

> Until recently, many traditional assumptions associated with aging and elder care often cast seniors in a more passive role, not a proactive one. For a variety of economic, sociological, and technological reasons, this paradigm is now shifting. Broadband-enabled technologies are providing seniors with an interactive lifeline to the world, empowering them to live more robust, healthful, and independent lives….With the senior population set to double in the coming decades, broadband and broadband-enabled technologies are poised to play an invaluable role in transforming senior life and the senior care paradigm. Continued competition, innovation, and investment in the broadband market will allow current and future generations of seniors to age in place, stay relevant and connected to their communities, and take advantage of lifesaving applications (Davidson & Santorelli, 2008, pp. 1–2).

The actual and potential growth of ICTs is seen by Davidson and Santorelli (2008, p. 14) to confer a number of social, economic, and health-related benefits on seniors:

- Increased connection to family and friends
- "Feelings of relevance and…an interactive outlet to the world"
- Access to e-services, such as commerce, personal finances, medication, and employment
- Improved health, wellness, and preventative care
- Enhanced health, safety, and security through telecare services
- Benefits to society at large through healthcare savings, workforce participation by seniors, and senior-related content and services

Helping older people to remain independent and *age in place* is widely recognized as important to the quality of life for individuals (Sixsmith & Sixsmith, 2008). Solutions that help older people to remain at home are of interest to health policymakers due to potential cost savings over more expensive care in institutional settings such as nursing homes (Müller & Sixsmith, 2008). In some ways, the challenge presented by healthy seniors in respect to ICTs is a social one. The agenda of dependence is strongly reflected in the research and development agendas. This has begun to shift in recent years; for example, the EU-funded Ambient Assisted Living Joint Programs (see Chap. 12) has addressed some of the more positive avenues of research and development mentioned above. A further social challenge is how the benefits of access to ICTs can be made available to all seniors. Currently, a *digital divide* in socioeconomic terms persists, where those who are mostly likely to benefit from digital products and services are the least likely to be able to access them.

2.4 People Living with Chronic Disease

Chronic diseases are physical or mental conditions that have a long-standing duration, require ongoing medical care, and usually have significant impact on the person's functional capacity and quality of life. Chronic conditions include life-threatening diseases such as heart disease, cancer, and respiratory disease.

Indeed, these have emerged as the major causes of death in the modern era as opposed to the contagious diseases of earlier periods of history. Other conditions such as arthritis and osteoporosis may not be as deadly as the major killers but are nonetheless very serious in their impact on the health and well-being of millions of seniors. For many older people, living with one or more chronic diseases is a fact of life. As the population ages, the prevalence of chronic disease also increases, presenting challenges in terms of how chronic disease is managed. Key questions to be addressed in this area are as follows: how can we help people to remain living independently at home rather than being admitted to acute care or long-term care? How can we help people to maintain their health and avoid decline into dependency? How can we help people to manage their own health conditions more effectively? How can technology help healthcare professionals monitor and communicate with patients living at home? The benefits of helping people to remain living at home are particularly apparent for this group; even when faced with declining health, older people prefer to remain living at home, while supporting people at home is a more cost-effective solution than institutional care (Wiles, Leibing, Guberman, Reeve, & Allen, 2011). Given this clear win-win scenario, then it is unsurprising that this area has received considerable attention by both academic researchers and commercial organization and a range of telehealth and telecare systems and applications have emerged that may have a very positive impact on the health and independence of this group.

One major component of emerging ICT systems is activity monitoring, which collects data from sensors in the home (e.g., infrared movement sensors) and body-worn biomedical sensors to create a profile of a person's typical pattern of living and health status, such as when they get up in the morning or how they move around the home. Research in this area has been carried out for many years, including early work by Celler, Earnshaw, Ilsar, et al. (1995), Sixsmith and Johnson (2004) and more recently Floeck, Litz, and Spellerberg (2012), and this work is now emerging as telehealth and telecare systems, although these are still a long way from being mainstream services. Activity monitoring data may be very helpful in identifying incipient health problems, facilitating early interventions and helping people to self-manage their conditions. Variations from the typical activity pattern, for example, reduced levels of activity during the day, may be indicative of a decline in health status. These systems may generate some kind of alert, for example, to a monitoring centre, which would then organize a response by healthcare professionals or informal caregivers. This approach is useful for monitoring a range of situations, for example, critical events requiring immediate response (e.g., heart attack) and non-critical situations that require longer-term preventative interventions (e.g., exacerbations of a chronic illness). Work reported by Bhachu, Hine, and Woolrych (2012) illustrates the potential of this kind of technology to help chronically ill people remain living at home. A field trial of a system using activity monitoring and biomedical sensors was set up to provide information to help community nurses to better manage patients with chronic obstructive pulmonary disease (COPD) and particularly to avoid expensive and unnecessary hospital admissions. The trial provided good evidence for the effectiveness of activity monitoring, for example, by providing easily understandable health data to the patients themselves and by

prompting nurses to engage early with patients once changes in patterns of activity were detected. Early results of a large-scale trial in the UK, known as the Whole System Demonstrator, indicates that low-cost ICT-based services may have a significant benefit in terms of avoiding hospitalization reducing mortality and improving quality of life of people with long-term illnesses (DH, 2011).

Activity monitoring may also be useful in managing chronic mental health problems. For example, GPS technologies are being used to track older people with bipolar disorder in order to see whether changes in micro-geographical patterns of activity are associated with mental status (Namazi, Sixsmith, Glaesser, & O'Rourke, 2012). Bipolar disorder is characterized by rapid and extreme changes in mood, and it is hypothesized that manic and depressive periods will be reflected in the range and type of geographical activity. The system also includes the capture of *real-time in-the-moment* subjective data, where a mobile device will prompt individuals to complete a questionnaire about their mood state. Again, the use of ICT-based technologies will help care professionals to better understand the needs of patients and to provide more sensitive and timely interventions.

Despite the potential of these systems, certain concerns remain, especially in respect to the loss of privacy and the intrusiveness of being monitored at home. However, users are often willing to trade-off privacy for the additional feelings of safety and security these systems afford (Beringer, Sixsmith, Campo, Brown, & McCloskey, 2011). Older people are also often concerned that the introduction of technology will reduce the level of human interaction. It should be emphasized that these technologies cannot work in isolation and should be seen as part of an integrated care solution that enhances the formal and informal networks of care that already exist.

2.5 People with Dementia

Dementia is an age-related condition with as many as 35.6 million persons worldwide living with the condition with numbers expected to increase to 65.7 million by 2030 (Wimo & Prince, 2010). Amongst 65–70 year-olds, about 2 in every 100 will be affected, but this rises to 20 % amongst the over 80s age group. It should be emphasized that dementia is not part of the normal aging process, affecting only a fraction of the older population. However, it is a very debilitating condition for many older people leading to a severe decline in cognitive status, such as severe memory impairments, confusion, and disorientation in time and place and inability to communicate. Cognitive decline means that they can no longer do everyday activities like dressing or washing. The changes to the brain associated with conditions such as Alzheimer's disease are permanent and currently untreatable. Drugs are not yet effective in curing or significantly affecting the progress of dementia, and care interventions need to focus on managing the symptoms and providing help and support to informal carers. Typically, the application of technology for people with dementia has addressed issues of safety and security (Sixsmith, 2006).

For example, wandering is seen as a major problem for both people living in the community and in nursing homes, and there are commercially available systems to trigger an alert if a person leaves their dwelling place. Another common problem is to do with household safety, and technologies have been developed to detect and control a range of potentially dangerous situations, such as flooding, extreme temperatures, fire, and gas leaks. These are clearly important areas, but emerging AAL technologies also have the potential to develop interventions that can positively enhance independence and well-being. A major strand of research has focused on how technology can help people to perform everyday tasks of living that are important to continued independence. For example, Mihailidis, Boger, Czarnuch, Jiancaro, and Hoey (2012) have developed the COACH system using computer vision and artificial intelligence to support the user's performance of the various components of hand washing. An audiovisual interface prompts the person if help is required. Work by Kearns, Nams, and Fozard (2010) focuses on the potential of sensor technology in the assessment of cognitive status. This examines the relationship between the person's ambulatory movement and the level of cognitive function by measuring path tortuosity or the extent to which a person's movement path deviates from a straight line. Their research with residents in an assistive living facility found a significant negative association between path tortuosity and measures of cognitive status; simply put, the more erratic the pattern of movement, the lower the cognitive function of the person. This system has the potential to identify early changes in cognitive status allowing more targeted care interventions to support the person as their dementia progresses.

Other research has focused on how technology can positively enhance quality of life. For example, Sixsmith, Orpwood, and Torrington (2010) developed a music-playing device specifically for people with dementia. Music can evoke powerful memories, and people with dementia may recognize enjoy, and sing along with a song even when they may be experiencing severe problems with their memory and ability to communicate. However, access to music by people with dementia may be very limited. For example, they may not be able to operate music devices such as CD players or MP3 players. The music player was designed to be simple to use and also provided prompts to encourage people to use the device. In another project, Schmid et al. (2012) report on project MUSE, which developed a music-playing chair for use in long-term care facilities. The chair was a *smart* device that uses Radio-Frequency Identification (RFID) technology to recognize a person and play personally relevant music from a preloaded playlist. MUSE and other music-playing devices help people with dementia get access to music, and trials of the devices have been shown to have a positive impact on mood and social engagement.

2.6 People with Mild Cognitive Impairment

Declining cognitive ability has a major effect on the health and well-being of older people. As already discussed, there has been considerable attention given to the growing numbers of people with dementia. However, many older adults may be

living with mild cognitive impairment (MCI), which is defined as cognitive impairment in at least one aspect of cognitive functioning, with no sign of dementia and no significant decline in functional activities of daily life (Luis, Loewenstein, Acevedo, Barker, & Duara, 2003). It has been estimated that perhaps as many as 20 % of people aged 65 and over may be experiencing MCI (Petersen, 2011). Piau, Nourhashémi, Hein, Caillaud, and Vellas (2011) point to the lack of effective pharmacological interventions for cognitively impaired people. Currently, there are no effective disease-modifying drugs, and there appear to be none in the pipeline, under trial, or near to market. This situation highlights the importance of non-pharmacological interventions to enhance the cognitive health of older people and provides a real opportunity for developing ICT-based solutions that help with planning and managing everyday activities and ensuring a safe and comfortable living environment.

ICT-related research has not yet specifically addressed the needs of people with MCI, and there has been a much greater focus on people with dementia and more severe levels of cognitive impairment. Older people with MCI have a stronger potential to learn to use new technologies than those with dementia, and introducing devices and systems for people with MCI when they are more able to adapt and interact with the technology may have more potential. Moreover, while many people with MCI will progress to dementia, this is not inevitable, and a crucial need is to develop innovative approaches that will help maintain or even improve cognitive status, extend independent living and enhance quality of life. Providing ICT *supports to enable self-care and self-management* and facilitating *cognitive stimulation* may allow those living with MCI to draw upon varying levels of support tailored to their specific needs and situations and provide stimulation and engagement to maintain or improve cognitive function. Many of the ICT solutions already described have considerable potential for people with MCI, and research funded by programs such as *Everyday Technologies for Alzheimer's Care* (see Chap. 12) has included the development of prompting technologies to remind and assist older adults in performing essential activities of daily living (ADLs). EU projects such as SOPRANO (see Chap. 8) have been developing systems to assist with tasks such as personal medication, exercise, nutrition, and home security.

One line of research which has recently emerged that may have special relevance for people with MCI is brain training, where a person engages in serious gaming, such as Nintendo's *Brain Age* to promote cognitive function. Digital games offer many potential benefits for people generally and people with MCI specifically for improving cognitive and social function in a way that is motivating and enjoyable. While the evidence base for these cognitive benefits and the understanding of the possible underlying processes remains weak, electronic games represent a huge opportunity for involving people with MCI in activities that may help them to reengage constructively with the challenges of everyday life. Astell (Chap. 10) argues that digital games can contribute to seniors' well-being through social interaction, cognitive stimulation, and physical activity that may motivate them to positively manage their lives. Games can promote highly engaged and enjoyable experiences (Csíkszentmihályi, 1996; Hwang, Hong, Hao, & Jong, 2011), offer opportunities for social interaction, and also support learning through progressive levels of practice (Sauvé & Kaufman, 2010).

2.7 The Challenge of Turning Research into Reality

Despite the considerable potential benefits of new technology outlined above, research and development in the area has had surprisingly little impact. In this section, a number of challenges to the research and development process are highlighted. While technical issues remain important, future efforts must primarily respond to a number of nontechnical challenges to service and product innovation. There is a need for a more collaborative *transdisciplinary* approach to the research and development process, while at the same time facilitating better end-user and stakeholder engagement in the research and subsequent knowledge translation. More fundamentally, there is a need for better theoretical and conceptual approaches if research is to be effective in driving technology innovation.

2.8 The Research and Development Process

It is becoming increasingly common for projects to have teams with numerous partners, involving several countries and languages, commercial, government and academic organizations and multiple disciplines. Indeed, it is difficult to envisage research in the area of technology and aging without this kind of collaboration. However, it is important to consider the many practical and operational challenges involved in the R&D process. Woolrych and Sixsmith (2012) document the problems encountered within the EU-funded SOPRANO project that aimed to develop an Ambient Assisted Living (AAL) system to help older people live independently (see Chap. 12). Multinational projects, such as SOPRANO, encounter communication barriers in terms of language, sharing information, and everyday interaction. Also, different organizations and countries present local challenges that require a level of flexibility and local autonomy that is difficult to achieve within a rigid research framework. Moreover, the different expectations of the various collaborators (including funding bodies) need to be carefully reconciled and managed throughout the R&D process. For example, how do technical problems or unexpected delays in one part of a project impact on the project as a whole, and how are they dealt with?

However, the issues of collaboration and teamwork go beyond practical and technical concerns; there is a need to look critically at the culture of research and development and the language, concepts and mindsets that frame and determine the development and implementation of new technology for older people. Research has often been driven by technological agendas and a *silo* mentality towards the development of ICT-based solutions (Müller & Sixsmith, 2008). This has been a major factor in limiting the practical outcomes, as systems and devices are often poorly aligned with the needs, preferences and wishes of end users. Inter- and multidisciplinary approaches tend to bring different disciplines together in ways which complement each other but do not generally achieve holistic understandings, focus on

problem solving or explore methodological integration (Ramadier, 2004). In the area of technology and aging, where complex, multidimensional problem-based phenomena demand innovative approaches, a transdisciplinary approach is appropriate. Transdisciplinarity is characterized by a problem focus, evolving methodology and intense collaboration (Wickson, Carew, & Russell, 2006), whereby partnership working allows expertise, knowledge, and joint working practices to transcend disciplinary boundaries. Approaches such as *Action Learning* (McGill & Beaty, 2001) and *Appreciative Inquiry* (Cooperrider & Whitney, 2005) have been designed to bring together all the relevant disciplines on equal basis to engage in methodological development and interpretation of findings. Transdisciplinarity highlights the implications of research findings for technological design, conceptual development, creative processes, and professional practice much more rapidly than individual isolated efforts.

A further requirement is to educate and train a new generation of researchers and break down the traditional disciplinary boundaries (e.g., technical versus domain knowledge) and promote transdisciplinary teamworking as the basis for effective R&D. A number of these initiatives have emerged over the years. For example, the European Union funded intensive courses on gerontechnology under their Erasmus and Socrates programs. The International Society for Gerontechnology has for many years run master classes where leading researchers in the field mentor graduate students to develop their ideas, skills, and career pathways. While these initiatives are valuable, they are somewhat disparate and peripheral within the overall educational landscape, and there remains a need for a more programmatic approach, where the necessary concepts, approaches, and skills are embedded in the mainstream education of gerontologists, engineers, and computer scientists. There are signs that this is beginning to happen with various credit-bearing degree courses emerging, for example, Pace University's intergenerational service-learning computing course (http://csis.pace.edu/gerontechnology/).

2.9 User-Driven Approaches

One issue that has often been raised is that much of the research within the area of technology and aging has been technology driven, without assessing how they impact on the everyday lives of older people, often resulting in low take-up and usage of the technology by potential end users. Without a more user-focused approach, there is a danger that technologies will be ill-conceived and fail to match the needs and situations of older adults. Commentators have been largely critical of the attempts to involve users in the design and development of technology. They are rarely involved at every stage of the process, highlighting a tokenistic approach to user involvement with little representation in the development of the technology at later stages (Fudge, Wolfe, & McKevitt, 2007). Indeed, within most technology projects, the resources for user research are significantly less than those devoted to the technical aspects of the research and development. While there is still a long

way to go, there has been a recent shift towards user-centered research in response to the above critique (Rubin, 1994; Steen, Kuijt-Evers, & Klok, 2007). Grounding the whole R&D process in the real experiences of users can create technologies that are usable, useful, acceptable, ethical, and supportive (Eisma, Dickinson, Goodman, Syme, Tiwari, & Newell, 2004). Rather than constraining users within rigid technological frameworks, it is important that devices are context aware and able to respond unobtrusively to the routines and activities of older people (Guo, Zhang, & Imai, 2010). The emphasis needs to be placed on putting users in control of the technology and using it to take control of their own lives and enhance choice and independence (Davidoff, Lee, Yiu, Dey, & Zimmerman, 2006).

Adopting a user-centered research approach requires a level of flexibility in the approach that can be difficult to achieve in practice. Woolrych and Sixsmith (2012), in a reflection on involving users in the development of an AAL system, highlight some of the difficulties that were encountered. In this case, the research was guided by an Experience and Application Research (E&AR) approach to involve end users (older people, carers, and service providers) in the entire R&D process (Sixsmith, 2011): requirements specification, development of use cases, prototyping, implementation, and evaluation. For example, early-stage prototypes (mock-ups) were presented by actors in a scripted drama workshop to allow an audience of older people to visulaize how the system might work and contribute their ideas to further refinement and development. Working closely with users in this way requires relationship building with local providers and older people (van den Hove, 2006), with a considerable commitment of time, effort, and resources. But beyond this, there has to be genuine participation by users and stakeholders though appropriate communication and dialogue between all the parties involved. The benefit to the research process is that users and service providers have local knowledge that is in turn helpful in recruitment and maintaining participation, for example, in field trials. Users on the other hand need to be appropriately remunerated for their involvement, as this can be a highly demanding role. There is an expectation that older users have the time and desire to participate in research, when they often lead busy lives, for example, with work, volunteering, family commitments, as well as their own personal activities. The research process can also lead to consultation fatigue that may result in them dropping out.

One of the potential benefits of a user-centered approach is that it will result in products and services that are more marketable because they accurately reflect the needs of older people. However, while technologies may be more usable and acceptable, this does not necessarily lead to innovation. A user-centered approach also involves the identification of routes to market and knowledge translation. Older users are likely to be consumers of multiple services and systems, and the development of new technologies needs to take this into account, emphasizing their complementarity and added value to existing services. It is essential to be aware of all the various stakeholders involved, such as older end users, their families, community organizations, service providers, and policymakers. These actors will often have competing agendas and needs that have to be carefully explored and accommodated within the development of technology-based solutions. For

example, service-provider organizations are likely to have strongly defined cultures and processes that in themselves create challenges to the adoption of innovatory technologies. In this context, the process of technology development has to be predicated on a good understanding of the business models and processes of service providers. At this point, it is difficult to envisage that new technologies will simply replace the face-to-face care that is typical of most personal services for older people and ICTs should be seen as part of an integrated spectrum of care (Miskelly, 2001).

2.10 Knowledge Translation and Technology Exploitation

It is both interesting and ironic that despite the considerable research and development into new systems and devices to help older people, the uptake remains low despite the benefits that they can potentially provide. The *technology-push* approach has typically failed to appreciate the significant challenges to creating viable service processes and business models that include technological innovation. Making technology solutions a reality in terms of real-world products and services requires addressing these challenges in a way that creates positive outcomes for all the stakeholders involved. Indeed, our ideas of knowledge translation must go beyond the typical end-of-project dissemination approach to one that includes stakeholder participation and business modelling as fundamental to the whole R&D cycle so that technologies are congruent with the real-world opportunities and constraints. Research by Meyer and colleagues (2012) explores the international markets for the different generations of telecare systems and highlighted international differences in penetration. They argue that barriers to the creation of effective markets remain considerable worldwide, with factors such as funding and reimbursement systems and organizational issues within care services constraining service innovation. Despite this, the case for ICTs being part of the spectrum of care is increasingly compelling, but there is a need for a more holistic approach to technology development and deployment that includes key activities: user requirement analysis, care process design, and business case modelling. The aim here is to ensure that systems and devices are aligned with all the key stakeholders involved in the consumption and delivery of technology-based services.

Health and social care provision exists within a context of complex economic, social and political factors while user and financial considerations are pushing the delivery of services away from traditional settings such as long-term care facilities and hospitals into the homes and communities in which older people live. While ICTs have the potential to play an important role in the delivery of home-based services, the realization of this potential is also dependent on government policy to facilitate and encourage the uptake of new technologies within the caring services. Marin and Mulvenna (2012) examined technology policy initiatives in the UK. A key component in the effective implementation of technological solutions is a research and development cycle that is evidence-based and closely aligned to

national policy objectives. In the UK, a range of initiatives have been demonstrated to have significant cost savings and improved delivery of services. The development of strong evidence-based policy has been a major driver of the introduction of new technologies in local health and social services.

The discussion in this and the previous section has focused on how to transform research and prototypes into useful real-world products and services. The key challenge is how to achieve user-centered product development alongside greater penetration of the market. This route to market is not straightforward, and indeed, some of the considerations outlined above suggest that there are contradictory factors at play. As Woolrych and Sixsmith (2012) note, providers are often highly conservative institutions that are resistive to innovation, and the ongoing failure to translate research into viable products and services points to structural weaknesses within service delivery systems as much as weaknesses in the viability of new systems and devices. ICTs offer avenues for developing innovative solutions for older people that go well beyond existing concepts of elder care, and it is beholden on those working within the field of technology and aging to adopt a critical perspective that will itself challenge the status quo rather than simply reflect the business-as-usual approach that is implicit in current lines of research.

2.11 The Need for Theory in Gerontechnology

A final issue is the way we think about technology both within the research process and in respect to how our ideas and concepts about technology and aging are reflected in the ways we support older people. In the 1980s, James Birren referred to gerontology as being data rich yet theory poor (Birren & Bengtson, 1988). While theoretical perspectives appear to have become more significant within recent gerontological literature generally, if one scans the rapidly growing literature on aging and technology, it would be fair to say that it is almost devoid of theory. There have been some attempts in the nascent field of gerontechnology to map out its disciplinary boundaries and dimensions, but even cursory comments on theoretical ideas and issues pertaining to research in the area are noticeably lacking.

Theory is important for a number of reasons. Firstly, it allows us to develop, define and articulate our basic ideas about a problem domain. Describing technology and aging research as *atheoretical* does not necessarily mean it is non-theoretical but that its theoretical ideas and principles remain largely tacit and unsystematic. Without a well-worked-out theoretical basis, there is a danger that our understanding of an area will at best remain limited and at worst embody some of the ageist attitudes that exist within society. Secondly, theories are, or should be, important drivers of empirical research, for example, in helping to develop research questions and hypotheses and to determine methods and research instruments. Theories can be used to create conceptual frameworks and models of the domain being investigated, and the development of these models is an important step to ensure that the basic approach is sound. These conceptual models are especially

important when the problem is inherently complex. Thirdly, theories are useful in interpreting the results of research and are important for the advancement of knowledge in an area. Without the development of theoretical narratives (theories are essentially high-level descriptions of the how and why of a phenomena), then it is difficult to arrange our ideas and build on previous knowledge.

Without these theoretical structures, research efforts in the area of technology and aging will remain impoverished with a consequent impact in terms of technology-based products and services for older people. Potential directions for theory development include theories of innovation to explain the way new systems and devices emerge from concept to realization. A more theoretical exploration of the ideas of *needs* within the older population is also a useful avenue. For example, theoretical ideas of person–environment fit (Lawton & Nahemow, 1973) may help to align the design of technological aids to the personal and situational factors of the older user. However, the emerging field of gerontechnology remains at the very earliest stage of theoretical development. A potential starting point in the development of theoretical ideas within gerontechnology is a fourth role of theory as a means to reflect and critique on our knowledge of a problem area. The process of reflection and critique is fundamental to scientific enquiry and the advancement of knowledge and is dependent on theoretical reasoning.

This critical perspective has developed since the 1970s within gerontology (Biggs, Hendricks, & Lowenstein, 2003) with a focus on how everyday life is often structured by social processes. Within the perspective, the attitudes, roles and rules that govern everyday life are mediated language, knowledge, practices and institutions and even the physical environment in which we live—all of which are socially constructed rather than given within an immutable world. For example, the idea of *ageism* has been used to describe the way society tends to marginalize and disempower older people (e.g., through mandatory retirement), while at the same time representing this as the natural order of things. It is possible to reconceptualize technology in exactly the same way, where we can see technology not in terms of attributes such as usability or function but in social and behavioral terms, structured by socially constructed processes of development, commercialization, and patterns of usage.

At the societal level, recent years have seen significant technological change within ICT in areas such as digital media, mobile telecommunications and Internet access to information/communication, where ICTs occupy an increasingly important place in society. These technologies have significant potential benefits for socially excluded groups. Older people, for example, could benefit from access to lower-cost goods and services available online (McLean & Blackie, 2004). However, access to and engagement with ICTs is unequally distributed across society leading to a digital divide (Korupp & Szydlik, 2005). This inequality has been further analysed as digital exclusion (Cushman & Klecun, 2006), with a much larger proportion of seniors not using ICTs compared to the general population, due to factors such as lack of skills in using new technologies. Skills are acquired through both formal and informal routes to equip the older person with functional abilities in using technologies, and without them, participation in many domains of everyday life can be

compromised excluding older people from wealth of potential benefits that emerge through continuing technological change.

Secondly at the behavioral level, it is important to consider the ways technologies, even those that are designed to aid old people, can in themselves contribute to social processes or marginalization. The prominent British social gerontologist, Peter Townsend, developed the concepts of structured or induced dependency to explain the way society and its institutions (e.g., retirement, poverty, institutionalization, and the restriction of social roles) contribute to the creation and maintenance of dependency within the older population (Townsend, 1986). Townsend also suggested that the dominant conceptual framework for understanding policy and practice was what he characterized as *acquiescent functionalism*:

> … a body of thought that attributed the causes of the problems of old age to the natural consequences of physical decrescence and mental inflexibility, or to individual failures of adjustment to aging and retirement, instead of the exertions of state economic and social policy partly to serve and partly to moderate market forces. Social inequality was thereby "re-configured" in the language which is now being applied to universal social services (Townsend, 2006).

The critique was particularly aimed at a dominant social policy agenda that had emerged in the early and mid-twentieth century that had in many ways marginalized the position of older people within Western societies. A family of theoretical ideas, neoliberal economics, democratic pluralism, sociological functionalism, and ideas within social psychology implicitly saw the stages of industrial development and modernization as progressive, benign, and beneficial for society. The acceptance of these ideas reinforced a concept of old age that accepted the structural inequalities within society and the dependency of older people as an inevitable consequence of this process and the combined ideas within acquiescent functionalism served to validate a policy of dependency. While a very strong critique of this perspective emerged in the later decades of the twentieth century, there remain features of institutionalized agism that persist in shaping the lives of older people in contemporary society.

As mentioned, the underlying idea from critical gerontology is to try and reconceptualize technology as something that is fundamentally social in nature. For example, much of the technology development effort has been focused on enhancing the care and support provided to older people. Sixsmith (2012) suggests that the increasing use of surveillance technologies to monitor the activities and health status of older people is justified on the grounds of providing help and support to those in need. However, little attention has been given to how these technologies might impact on users' everyday lives beyond technical issues of confidentiality and data protection. While these systems ostensibly aim to help older adults live more safely, their development and deployment has generally adopted an *agenda of dependence*, focusing on issues of clinical needs, impairment, and incapacity. This is particularly important given that monitoring technologies have extended surveillance into the fabric of everyday life. Even though users are generally accepting of these technologies, the intrusion of the *clinical gaze* into everyday life changes the power

relationships between the carer and the client and observer and observed. The exposure of hidden, intimate spaces to external observation has a regulatory effect (Foucault, 1995) both on the everyday behavior of the person being observed and the actions by the observer/carer necessitated by the new categories of knowledge afforded by surveillance.

Technology-based solutions tend to be constrained within an existing provider-led agenda of care that has typically focused on reactive services rather than preventative interventions, and an uncritical adoption of technology may actually contribute to a process of induced dependency. Moreover, the technology/care agenda also fails to recognize the way technologies can transform everyday life and social relationships. Personal and social constructs and characteristics such as gender, education, ethnicity, and disability play key roles in older adults' relationship with technology, impacting on their social inclusion and quality of life. A vital element in understanding this is the older person's own views and experiences of technology, which can often be at odds with mainstream conceptualizations (Freeman & Lessiter, 2001; Sixsmith & Sixsmith, 2000). In particular, technology is often framed in terms of *supporting* frail and disabled older people. While this ostensibly aims to help older adults live independently and enhance their quality of life, the approach has generally focused on issues of *impairment*, *age-related decline*, and the *problems* associated with later life rather than positive aging. Such research largely fails to address the very diverse experiences of older people and their meaningmaking around technology in everyday life, although exceptions to this model of technology and decline do exist, for example, McCreadie and Tinker (2005) identify older adults' own meanings of the consequences of *assistive* technologies for their identity. This work suggests that people's life experiences and *technological biographies* within the context of the lifecourse may also impact on their engagement with a changing technological landscape (Avgerou & McGrath, 2007). Further, much of the everyday experience of interacting with technologies happens at the level of practical activity embedded amongst all other everyday experience. The key issue here is identifying *how* people engage with an everyday world that is profoundly familiar and largely taken for granted, so that the findings can become the basis for developing suitable technological interventions that can be embraced by older adults because they can readily recognize their potential for maintaining a good quality of life and also feel well equipped to utilize them in the ways, and for the purposes, that suit the individual within the context within which they live.

2.12 Conclusion

The fact that most people in the developed world (and increasingly in the developing world) can now expect to live into old age is one of the great success stories of recent history. In many ways, modern society and its political and economic institutions are still coming to terms with the very dramatic progress that has been made

in the last 100 years or so in terms of reduced mortality and fertility rates, better standards of living, health, and hygiene, and rapid advances in medical treatment. However, the discourse on aging and old age within society is often highly negative. While older people often experience a range of problems associated with the aging process, their depiction is typically stereotyped and overgeneralized and fails to recognize the positive experiences of older individuals and their contributions to society.

The technological solutions outlined in the first part of this chapter highlight the many potential ways information and communication technologies can be harnessed to enhance the well-being of older adults. However, the research agendas that have emerged may in turn be constrained by a number of practical, methodological, and conceptual weaknesses. Perhaps the most significant is that technology research has often used the same language of problematization and desperation that has been described as an *apocalyptic gerontology* that is informed by a discourse of dependency and the overwhelming impact of aging on modern societies (Gee & Gutman, 2000). The idea of *dependency* characterizes old age in terms of illness, frailty, impairment, and incapacity, implying a simple relationship between population aging and the demands placed on health and welfare services. However, as Lloyd-Sherlock, McKee, Ebrahim, Gorman, Greengross, Prince, et al. (2012) highlight, simple measures of health (e.g., morbidity) are not always good indicators of functional status. The relationship between health, functional status (the ability to perform tasks of daily living), and the demands placed on healthcare systems is far from straightforward. For instance, there are considerable variations within and between countries in the health and functional status of older populations. Lloyd-Sherlock and colleagues also point to the mounting evidence that relatively cheap and simple interventions can have a very significant impact on the person's ability to live independently and manage their health conditions at home and better information and advice about health issues, preventative measures, and support for carers can all have a major impact. However, most countries have failed to make these kinds of interventions generally available, representing almost a negligent attitude within the policy and practice arenas to make an impact on the health and well-being of many millions of people, while at the same time creating much of the service demand for which the rising population of older people is blamed (Lloyd-Sherlock et al., 2012):

> …instead of being portrayed as a problem, increased human longevity should be a cause for celebration. Moreover, population aging provides opportunities to rethink health policy for the benefit of all (Lloyd-Sherlock et al., 2012).

Much of the discussion in this chapter has aimed to defuse the so-called demographic timebomb and to emphasize how we can potentially utilize technology for the betterment of society by enhancing the independence, health and quality of life of older people. Yet it is important not to underestimate the huge shift this will require in the mindset about old age and the reorienting of the research and development agenda. While technical challenges still exist, the most significant and intransigent challenges are likely to be more social and attitudinal in nature.

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