

## **Aging-in-Place: Present Realities and Future Directions**

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### **Abstract**

Elderly populations are growing globally, due in large part to increasing longevity (United Nations 2002). With the number of moderately or severely disabled older persons in the United States predicted to increase by as much as 350% in the next 40 years (Administration on Aging n.d.), the increased need for assistance will be dramatic. A number of technologies available to the general public are not available to the elderly because of non-intuitive interfaces. Because living arrangements of the elderly are linked to income, health status, and availability of caregivers (Federal Interagency Forum on Aging-Related Statistics 2004), the need for assistive technologies to facilitate aging-in-place becomes more prominent for researchers and legislators.

This paper will establish the need for assistance to the elderly in aging-in-place and describe available technology for assisting elderly persons' functioning in their own homes. The paper will go on to discuss identified gaps in areas of need for the elderly which new research may help to fill. Finally, implications of aging-in-place for policy makers will be discussed.

### **Introduction**

The proportion of the elderly population is growing globally, due in large part to increasing longevity and decreasing birth rates (United Nations [UN] 2002). The United Nations estimates that in 20 years more than one billion people will be over the age of 60 world-wide and by 2050 that number will reach 2 billion (United Nations [UN] 2003a; World Health Organization [WHO] 2004). The over 80 group is the fastest growing age group, a trend that is expected to continue for at least the next 50 years (UN 2002). Further, the majority of older people will live in developing nations who are, often, the least prepared to meet changing societal needs (UN 2002). This shift in age structure will have a profound effect on social, economic and political conditions (UN 2002).

With an elderly population of 36 million people in the United States, persons over the age of 65 currently make up 12% of the population (Federal Interagency Forum 2004). The future growth of this population is staggering. The Census Bureau projects that by 2030, there will be more than 71 million persons over the age of 65, representing nearly 20% of the population (Administration on Aging [AOA] n.d.a). The United States had 16.1 persons age 60 and older

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per 100 persons in the population in 2000. By 2025 that figure is expected to rise to 24.8 and, by 2050, 26.9 (UN 2002). Other countries expect staggering growth as well. For example, Japan's population of persons 60 and over per 100 persons in the population is expected to rise from 23.2 in 2000 to 35.1 in 2025 and 42.3 in 2050 (UN).

In addition, the dependency ratios show the number of older persons in relation to younger persons. The old age dependency ratio is the number of persons 65 years and over per 100 persons 15 to 64 years old (UN 2002). In the United States, the old age dependency ratios for the years 2000, 2025, and 2050 are 18.6, 29.3, and 34.9 respectively (UN). Japan has a grim future if the old age dependency ratios are even close to correct. In 2000, their ratio was 25.2; predictions are the ratios will climb to 49 by 2025 and 71.3 by 2050 (UN). The demographics clearly demonstrate that increasing numbers of persons will need care and decreasing numbers of caregivers will be available, resulting in a societal chasm.

Lengthening the time the elderly can safely age-in-place will positively affect the elderly, their families, and society (Tinker et al. 2004). The critical gap, represented by the numbers above, requires action. This action must encompass quality of life; that is, meeting both the physical and psychological needs of the elderly. Quality of life, according to the elderly, is linked to their health, family and social networks, home and independence (Tinker et al. 2004). The elderly are not one homogeneous population. In addition to having greatly varying abilities and disabilities, their cultural, ethnic, class, and gender differences mean that 'one-size-fits-all' solutions will not work. A wide range of practical and policy solutions, with many different nuances, will be necessary in order to meet functional needs and enhance the quality of life for all elders.

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### **Need for Assistance: Aging-in-Place**

With increasing age comes a decrease in physical functioning and the possible loss of independent living status (Brach and VanSwearingen 2002; Foresight Joint Taskforce on Older People 1999). Physical functioning, defined as one's ability to perform activities of daily living (ADLs), instrumental activities of daily living (IADLs), and mobility tasks necessary for independent living (Guralnik and Simonsick 1993; Kaplan et al. 2001), impacts aging in place. ADLs (bathing, dressing, toileting, eating, moving around the house) and IADLs (preparing meals, shopping, managing money, using the telephone, doing housework, getting around outside, taking medications) (AOA 2002; National Aging Information Center 1996) are reference points for ascertaining an elderly person's physical functioning. The inability to perform an ADL or an IADL alone or without assistance is the definition of a disability (National Aging Information Center 1996).

The United States Administration on Aging (1997), documents that persons reporting problems with two or more activities of daily living (ADLs) included 6% of those 65 years and older, and 18.1% of those 85 years and older. In addition, 49.8% of those 85 years and older have a self-care and/or mobility limitation (AOA 1996). Aging into the 21<sup>st</sup> Century (AOA, 1996) concludes that the number of moderately or severely disabled older persons will increase sharply over the next 40 years, perhaps as much as 350%. Of course, specific populations are

affected in different ways. For example, elderly persons with higher levels of disabilities are Black, non-Hispanic, women, and persons below the poverty level (AOA 1997).

Living arrangements are a further confounding factor (AOA 2002). With 40% of US women and 19% of men over 65 living alone (Federal Interagency Forum 2004), with 27% of those living alone having no living children (AOA n.d.b), and with 16% of older men and 21% of women who live alone being in poverty, there are certainly ramifications.

While the figures quoted represent the picture in the United States, societies world wide must prepare for meeting the varying needs of huge numbers of elderly people. Despite the problems, most elderly persons desire to stay independent, living in their own homes (Kharif 2004; Soderlund 2004) as long as their health and financial situations permit. Forlizzi, DiSalvo and Gemperle (2004) found independence and dignity were unanimously important to elders. Helping the elderly to maintain their independence is paramount. Thus, the need to develop assistive technologies (AT) to facilitate aging-in-place becomes essential for researchers and policy makers.

### **Gaps in Available Technology**

With current AT, a number of gaps exist. If the elderly are to age-in-place, a shift in emphasis from institutional care to home-based AT augmented care must occur. Kent Larson, of the MIT Home of the Future research project, suggests that “the existing way of delivering health care is unsustainable...The gravity of health care will shift from the hospital and clinic to the home” (Kharif 2004, 2). While high technology smart homes (Miskelly 2001; Ross 2004) are receiving media attention, a balanced solution needs to embrace a full range of approaches. Bathroom grab bars, ramps, and contrasting color schemes to highlight changes in walking

surfaces (Lansley 2001) provide one end of the AT spectrum while wireless sensor networks (Stanford 2002) and robotics may represent the other end.

Researchers can easily get carried away with many innovative technologies; unfortunately, there is the potential that AT may provide a mechanistic aid that does not meet the essential needs of the elderly person. Providing for physical needs and not also considering psychological needs of elderly persons will not help them enjoy a high quality of life. Thus, AT systems that empower the elderly to live independently should increase their feelings of self-efficacy, that is, the sense that they can manage their own lives, supporting their needs for dignity, independence and personal identity (Forlizzi, DiSalvo and Gemperle 2004).

Identity and self-concept are related to the way elders accept a disability. Heinemann and Pape (2001) suggest that the use of AT devices may threaten the user's identity because one's identity is shaped by how people see themselves and their relationships with others. Stigmas, feelings of dishonor, disgrace and embarrassment may restrain elders from using some AT devices.

Some AT devices, such as sensor networks that monitor the elderly, provide a detailed description of the person in the environment so that interventions can take place in a timely manner. However, these networks do not empower the elderly person. If the elderly are not empowered, they may, in fact, become dis-empowered (Dewsbury et al. 2003). Preserving elder's identity and self-concept is a critical gap just as essential for independent living as meeting functional needs.

Many systems are available that could assist the elderly but their interfaces prevent adoption by those who could significantly benefit from them (Edwards 1997). For example, elderly drivers may become disoriented and could be assisted by global positioning systems

(GPS). However, programming the GPS receiver may be beyond their level of cognitive skills and/or patience; if they try to program the GPS and fail, negative repercussions could occur. Natural and intuitive interfaces are essential if the elderly are to use them to age-in-place (Edwards 1997). The need for natural and intuitive interfaces represents a critical gap.

For the elderly, current robotics mainly encompass mobility aids (eg. walkers, rollators, and wheelchairs) (Forlizzi, DiSalvo, and Gemperle 2004). Industry and society at large do not even consider wheelchairs and similar devices to be robotics. There are a few ‘real’ robots, such as Care-O-Bot (Fraunhofer IPA 2002), but, as a visit to ‘Abledata’ ([www.abledata.com](http://www.abledata.com)), a web resource site funded by the National Institute on Disability and Rehabilitation Research of the U.S. Dept. of Education clearly shows, there are very few other service robots generally available.

The lack of service robots is going to become ever more critical as the disparity between the number of caregivers and the number of elderly becomes greater. Thus the wide ranging field of robotics, from mobility aids to service robots represents a critical gap. Once more, functionality is not the only issue. A review of the literature by Forlizzi, DiSalvo, and Gemperle (2004) found that one third of elders abandon mobility aid devices within the first three months, while as many as 54% limit the use in normal social situations because of their appearance. A wheelchair that looks more like a tank is not likely to be greeted with alacrity even though it can work autonomously (FAW 2003).

This aesthetic gap is not limited to robotic devices (Galvin and Donnell 2001). Grab bars and wearable monitors are also noted as having been rejected because of their aesthetics (Forlizzi, DiSalvo, and Gemperle 2004). Forlizzi, DiSalvo, and Gemperle (2004) concluded that elderly people want devices that they find aesthetically pleasing and support their functional

needs. Aesthetics represents a critical gap. AT may well be spurned if functionality without aesthetics is the norm.

Does AT make the elderly happier? Technology does not always make people happy (Surowiecki 2005) and improve their quality of life. When AT research does not include multiple perspectives, the results may not improve the quality of life for the recipients. User centered, rather than technology centered (Scherer 2001), AT devices represent a critical gap.

### **New Research to Begin to Fill the Gaps**

With the phenomenal increase in numbers of older persons, researchers must lead the way in addressing the needs of the elderly so that evidence based policy making can occur (Bartlett 2004b). Researchers need to be certain that the right questions are asked, the right research teams are employed to answer the questions, and findings are disseminated so that policy and practice can benefit (Bartlett 2004a). Multiple research methodologies, including qualitative studies, need to address elders' physiological and psychological needs. Listening to the needs of the elderly is vital (Department of the Environment 2001; Foresight 2000; Seal et al. 2002; Tinker, et al. 2004), even though the elderly are sometimes thought of as objects rather than key stakeholders. (Dewsbury et al., 2003; Stanford 2002; Seal et al., 2002). In addition, considering the needs of the whole person (Tinker et al. 2004), including their identity (Department of the Environment 2001; Heinemann and Pape 2001) is essential. Pilot studies need to test AT to discern if the device is making life better for recipients. For example, testing levels of happiness before and after introduction of AT will help determine whether quality of life enhancement has been achieved (Surowiecki 2005).

One approach to enhance quality of life could be artificial intelligence. In 1966 Weizenbaum developed Eliza, a computer program that mimicked a therapist following the

Rogerian approach (Kendall 2001). This was one of the early systems to pass the Turing test, that is, users could not tell whether they were interacting with a machine or person. This type of approach could be used with the elderly to give them “someone” with whom to talk when they feel lonely and no caregiver is available, thus helping to meet psychological needs. To further enhance the experience, the interaction could be provided through a robot such as the Sony QRIO (Sony 2005). QRIO is an autonomous wireless robot. Designed to live with people in their homes, QRIO recognizes individuals by their faces and speech and talks with them, remembering specific individuals and previous conversations. Its seven microphones allow it to determine sources of sounds and its mobility allows it to turn toward the sound. QRIO also walks around and picks itself up if it tumbles. QRIO sees and adapts to changes in the environment such as when a person or object moves. Colored lights around QRIO’s eyes express emotion. QRIO could actually provide for a number of psychological and functional needs. The elderly need companionship, and, according to the BBC News (2002), when teddy bears were introduced to the bedrooms of a retirement community to monitor the residents, most formed a bond with their bear. Animals often are companions; in much the same way QRIO could be a companion of infinite patience with whom the elderly could have an ‘intelligent’ conversation. In the future QRIO could be programmed to fetch things and assist in other ways. Elders’ quality of life could be enhanced by QRIO.

Elderly people often find computer interfaces confusing. In Bristol, England, many housebound elderly shoppers found it difficult to use internet shopping. A Brunel University professor designed an easy to use barcode scanner that connects via email to a local supermarket. Shoppers scan bar codes from a catalogue or actual merchandise, receive verbal confirmation of the item, and then place their orders. The merchandise is delivered to the home (Brunel

University 2005). Home scanning for groceries is one example; standardized guidelines for the design of interfaces that meet the physiological and psychological needs of the elderly are required.

Infra-red remote controls with large buttons are used for some devices, predominately the telephone, TV, and VCR, but many other devices are amenable to remote control (Cowan and Turner-Smith 1999). However, remote control units use infra-red communications which require line of sight which can be a problem to an elderly person with limited flexibility. Using a remote, for example, to close draperies located behind the elderly person may be difficult. With the recent introduction of the IEEE 802.15.4 standard, known as ZigBee, there is now an international standard for the wireless control of in-home devices, obviating the line of sight problems associated with remote controls (ZigBee Alliance 2005). ZigBee represents an enabling technology that, with appropriate interface, could help elderly people with mobility problems maintain control of their environment.

In addition to the robotic application mentioned above, robots are available to help with instrumental activities of daily living (IADL). The Care-O-Bot (Fraunhofer 2002) fetches things and interacts with people through multimedia communication. Many opportunities exist to expand robotic technology through more sophisticated service robots.

Mobility enhancing robots range from canes to wheelchairs (Forlizzi, DiSalvo and Gemperle 2004). Modern wheelchairs are designed for those who cannot walk but who have strong arms; powered wheelchairs are little different than their non-powered counterparts. Today a user has to perform many small control adjustments to keep their powered wheelchair on track, this is tiring and totally unnecessary. The technology already exists for wheelchairs to

automatically avoid obstructions and be somewhat self navigating (Jones 2001). Further research, re-thinking elderly mobility, is needed.

An alternative for elderly mobility is the Toyota concept vehicle (Toyota 2005). The 'i-unit' may give the elderly a fresh experience of mobility. The i-unit features an ultra compact size; at low speed it is just larger than a wheelchair but incorporates an intelligent transport system technology designed to avoid accidents. It also has a safe autopilot mode when used with specially equipped lanes (Toyota 2005). If an intelligent navigation system, that included GPS, was incorporated, the i-unit could have the potential to take its driver to any destination on a voice command. The aesthetics of the i-unit would have the elderly the envy of all their grandchildren!

The elderly are very conscious of aesthetics. As mentioned, some wearable monitors are rejected because of their aesthetics despite the designers doing all they could to make them attractive. Monitors do not need to be conspicuous. Sensatex corporation has a t-shirt in which the wires and sensors are woven into the fabric (Marculescu et al. 2003). The t-shirt has a network which includes microphones, sensors and controllers. Wearable networks will include many, perhaps hundreds, of elements so that if some are damaged in the wash enough will remain for the system to continue functioning. Sensors woven into the fabric of daily life have the potential to be 'cool' while providing a new level of safety.

Much of the basic technology exists to provide for the diverse needs of the elderly. However, more research is needed to adapt and expand current technology to meet those needs. Goals of research efforts need to include functionality and aesthetics as well as personal empowerment and enhancement of elder persons' quality of life. Funding for significant research efforts that expand current technology is essential.

## **Policy**

There is no question of global aging; most countries are projecting large numbers of elderly people within the next 20 years. A great opportunity exists to develop effective public policies that meet the challenges associated with aging-in-place. The issues surrounding aging are complex and interrelated (Hoskins 2002); they require long-sighted decisions (Pyper 2003). Major public policy issues for the elderly related to aging-in-place are quality of life, accident prevention, and long term care (Tinker et al. 2004).

Aging-in-place involves individual, family and societal concerns. Governments are the mechanisms that link individual and family concerns with societal concerns. Family sensitive policies, as outputs of the political process, have the potential to construct policy solutions that address aging-in-place problems while enhancing elderly person's quality of life (Zimmerman, 2001).

Frankle and Owen's (1993) policy framework suggests that a sound knowledge base and supportive political climate weave together to form the political process in which issues compete for attention of policy makers. If policies are to meet the needs of the people, they must be informed by research (Bartlett 2004a). Australia addressed the need to identify models for effective interfaces between researchers and policy makers in their 'Evidence into Policy: What Works in Ageing' workshop sponsored by the Academy of the Social Sciences in Australia (Bartlett 2004b). Research is an important element in policy-making because through research we have a better understanding of the scope of a problem, factors that influence a problem, and strategies that do and do not ameliorate a problem.

In addition to a sound knowledge base, a supportive political climate is necessary for effective policies. The policy making process begins when issues become part of the political

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agenda (Frankle and Owen 1993). Key stakeholders, that is the elderly themselves (Department of Environment 2001; Foresight Joint Taskforce 1999), their caregivers, designers, builders (Foundation for Assistive Technology 2004), research scientists, legislators and other individuals, groups, and pertinent organizations must dialogue to express concerns, share scientific research, and propose solutions (Stanberry and Blackwell 2001). Mutually satisfactory goals evolve through compromise and consensus (Frankle and Owen 1993).

The burden of policy makers is to systematically examine, plan and then articulate to the public, ways to adjust and adapt policies that meet the needs of an aging society who wish to remain in their homes for as long as possible (Hoskins 2002). Policy makers, who often operate on short time lines, must be willing to make enduring rather than coping decisions (Pyper 2003).

The United Nations (2000) wants to ensure that priority attention is given to the elderly. Their Principles for Older Persons address issues of independence, participation, care, self-fulfillment, and dignity. The UN encourages governments to incorporate these principles into their national programs (UN 2000). For example, their principles related to independence suggest that “Older persons should be able to live in environments that are safe and adaptable to personal preferences and changing capacities” and “Older persons should be able to live at home for as long as possible” (UN 2000, 2). The principles related to dignity suggest that “Older persons should be able to live in dignity and security and be free of exploitation and physical or mental abuse” and “Older persons should be treated fairly regardless of age, gender, race, or ethnic background, disability, or other status, and be valued independently of their economic contributions” (UN 2000, 3). The United Nations Principles for Older Persons lie at the core of public policy related to the aging population.

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Many countries have the aging issue on their political agendas. The United Kingdom, the United States, Korea, Australia and world organizations such as the United Nations and the World Health Organization have engaged work groups to study the issue of aging populations and formulate recommendations and policy frameworks. For example, the Vienna International Plan of Action on Ageing, 1982 (UN 2003b), All Our Futures (Department of Environment 2001), Older Americans 2004: Key Indicators to Well-Being (Federal Interagency Forum 2004), the National Strategy for an Ageing Australia (Bartlett 2004b), Queensland Families: Future Directions (Bartlett 2004b), and Korea's Planning Committee for Developing a Public Long-term Care Security System for the Elderly (SunWoo 2004) are the result of the aging issue coming to the forefront. From these work groups, strategies and policies are being initiated.

In bringing together key stakeholders, persons with significant knowledge related to the issues of the aging population, the efficacy of public policy is enhanced (Bogenschneider et al. 2000). In fact, the public policy process *depends* on working relationships and explicit communication. Based on Kingdon's (1995) theory, through bringing problems to the forefront, having evidence-based solutions available, and building on a supportive political climate, a 'policy window' opens. All three conditions, problem recognition, available solutions and a supportive political climate, must coincide in order for the policy window to open. "When policy windows are open, the conditions are right for social change on an issue, and policymakers are willing to invest their time, energy, and political capital because their efforts may pay off" (Bogenschneider 2002, 201).

Social care as well as health care policies for the elderly are needed (SunWoo 2004) in order for the elderly to age-in-place. In some countries, such as the United Kingdom, social care and health policies have increasingly become more focused on promoting independence and

providing nearby care and support services rather than using institutional care because of the costs associated with institutional care (Department of the Environment 2001).

Because most elderly persons wish to remain in their own homes for as long as possible, policies need to support this wish through housing, primary care, community health services, and social services (Department of the Environment 2001). To promote aging-in-place, housing policies need to address such issues as helping elderly people to maintain their independence through AT and home adaptations (Foundation for Assistive Technology 2004). Housing designs that fail to adequately meet the needs of the elderly are a preventable problem (Foundation for Assistive Technology 2004). Thoughtful design and attention to the needs of all persons, including those of minority ethnic communities, can enhance the quality of life for elders (Foundation for Assistive Technology 2004; Department of the Environment 2001) as they age-in-place.

Elderly person's homes often offer challenges because of their physical characteristics and location (Department of the Environment 2001). With the demographics suggesting an increase in elderly persons living alone and/or having no children to help care for them, the importance of establishing elder care systems that provide assistance for these persons—and rural persons in particular—is imperative (SunWoo 2004).

### **Conclusions**

The aging of the population world-wide presents a systemic problem, a problem that will affect all aspects of life. Changes will reverberate through society, impacting families, customs, cultures and social policies (Yoon and Hendricks 2003). With the elderly to caregiver ratio declining drastically, AT can be a significant part of the solution as long as it is applied with due thought to the elderly and their needs as individuals, addressing quality of life as well as

functionality. The needs of the elderly are not homogenous. Public policies, coupled with evidence-based research, must reflect the divergent needs of the majority and minority populations (Department of the Environment 2001). With a sound knowledge base and a supportive political climate, current and projected challenges can lead to efficacious public policies that lengthen the time the elderly can age-in-place safely with an enhanced quality of life.

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