

**OLDER PEOPLE'S ATTITUDES TOWARD
RESIDENTIAL TECHNOLOGY:
THE ROLE OF TECHNOLOGY IN AGING IN PLACE**

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**Older People's Attitudes Toward Residential Technology:
The Role of Technology in Aging in Place**

by

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(Abstract)

Recently, technology and its impact on aging has become an expanding field of inquiry among marketers, designers, and housing professionals. A major reason for this interest is that the use of technology can help older people who experience deteriorating health to live independently. Another reason stems from an increase in the elderly population. According to the survey conducted by the American Association of Retired Persons (AARP) in 2000, about 90% of persons aged 55 and older would prefer to stay in their current residences as long as possible. However, there are many real factors that make it difficult to stay in their current homes as they age.

The purpose of this study was to investigate older people's attitudes toward adopting technology as it relates to homes that could improve the quality of life and assist in aging in place. Attitudes were examined in terms of perception and acceptance of residential technology.

Data for this study were gathered by an online survey. Online questionnaires were distributed to the potential sample of 9,789 e-mail addresses through the Virginia Tech alumni list serve on February 3, 2004. The response rate was 15.8% with 1,546 eligible responses returned by February 27. The majority of the sample for this study can be described as Caucasian, married men, age 55 to 64 with good or excellent health and a post graduate college education living in owned single-family detached homes.

Chi-square, ANOVA, Pearson's correlations, and path analysis were employed to test hypothesized relationships. Nine hypotheses were proposed to examine the relationships of variables based on the research framework. The ANOVA revealed that there were significant differences between the degree of desire to age in place by age, the

number of household members, employment status, income, tenure type, length of residence in current dwelling, and location. Other ANOVA tests showed that age, employment status, health, education, income, and length of residence in current dwelling influenced both the perceptions and acceptance of residential technology. Pearson's correlation implied that people having higher perception scores tended to have higher acceptance scores. As for the relationship between attributes of innovation and attitudes toward residential technology, the ANOVA tests showed that only two of the seven factors, ease of use and reasonable price, influenced both the perceptions and acceptance of residential technology. Pearson's correlation tests revealed that there were negative linear relationships between the desire to age in place and both perceptions and acceptance of technology. The results of path analysis presented that many hypothesized relationships between demographic, housing, and technology factors were significant. Although, many direct effects of hypothesized relationships were supported, the relationship between the desire to age in place and attitudes toward residential technology were not strong enough to support their definite relationship as a strong motivation to adopt technology. Results from testing the proposed hypotheses presented support for eight of the nine hypotheses.

Results from this study cannot be generalized to a national population because of the limitations of the sampling frame. Results, however, are significant in terms of the investigation of early computer adopters who are age 55 and older living independently. Their desire to age in place was not very different from the national population. Findings about the attitudes toward computer and Internet technology indicated that respondents had surprisingly similar attitudes. Age was revealed as an important factor for both the desire to age in place and attitudes toward residential technology as a direct effect.

As the early adopters, the sample for this study has some uniqueness. Although this fact has important implications, it limits the generalizations of the results. Results revealed that age was a significant factor in understanding attitudes toward residential technology and the desire to age in place. However, future research should include people with various demographic backgrounds. In addition, the results of this study imply that differentiated marketing strategies should be recommended to reach older consumers.

To My Parents

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CHAPTER 1. INTRODUCTION

Technology has had a tremendous impact on our daily lives. However, this impact has not affected everyone equally. These influences are different according to various characteristics of technology adopters. Recently, technology and its impact on aging has become an expanding field of inquiry (Wylde, 1995). A major reason for this interest is that the use of technology can help older people who experience deteriorating health to live independently (Chappell, 1988). Another reason stems from an increase in the elderly population. As the number of older persons increases, businesses are beginning to view them as an attractive market for their products, especially those who live independently (Chappell, 1988). Not only is the number of elderly consumers increasing, but this age group also has more money available to spend than has traditionally been thought.

The most recent survey by the American Association of Retired Persons (AARP), conducted in 2000, indicates that 89% of Americans age 55 and older prefer to live in their current homes as long as possible (Bayer & Harper, 2000). This report cites various adaptive behaviors of older people that allow them to cope with their environment as they age in place. Some use personal help, some use technical aids, and others modify their homes. Although research has been limited in this area (most involves research about why people prefer various types of aids), the results from that research do consistently indicate that elderly people have many unmet needs. Additional research is needed to take into account the broader issues of older people including how physical, psychological, and environmental factors influence their decisions. This will help us to understand their adaptive behaviors.

Statement of the Problem

The growing number of older people, together with the increasing social costs of public healthcare and assistance, may lead to the need for housing that is accessible and

equipped with technology and specific kinds of support for helping elderly people live in their homes while maintaining a high quality of life (Morini & Biocca, 2001). In fact, there have been many attempts to implement this technology into homes for older people, especially in Europe and Canada. However, little empirical research is available about how older people perceive, use, or reject this technology, and why they might reject it.

The assumption of this study was that housing design and supportive technology, called residential technology in this research, could play a significant role in supporting the independent living of older people, especially those who want to stay in their homes as they age. Working under this assumption, research is needed to analyze and evaluate the interactions between technology, the environment, and users in order to facilitate successful implementation of residential technology in homes. Until now there have been no empirical studies about the relationship between technology and its use in housing occupied by older people in the United States. Theoretical explanations for this interaction do not exist either.

Purpose of the Study

The purpose of this study was to investigate older people's attitudes toward adopting technology, as it relates to homes that could improve the quality of life and assist in aging in place. Attitudes were examined in terms of perception and acceptance of residential technology.

This study had a two-stage approach. First, the desire to aging in place was assumed to be a main factor in motivating older people to adopt residential technologies. In order to investigate the behaviors of older people who want to age in place, barriers and constraints to aging in place were investigated. The relationships between housing preference and selected demographic, housing, and neighborhood/community characteristics were examined. Second, the perceptions and acceptance of residential technologies by older people were examined. The influence that selected characteristics (including the technology adopters' characteristics, attributes of the innovations, and housing preference) have on

older people's perceptions and acceptance of residential technologies was examined. The direct impact that the desire to age in place has on attitudes toward technology was also examined.

Objectives of the Study

The research objectives of this investigation, for a sample age 55 and over, included the following:

1. To investigate the factors that hinder older people from aging in place:
 - 1) Who wants to age in place?
 - Demographic characteristics
 - 2) What are the barriers to aging in place?
 - Housing characteristics (housing type / tenure type / age of building / length of residency / location)
 - Health conditions
 - Neighborhood and community factors (availability of medical services / availability of housekeeping related services / availability of emergency services)
 - 3) What current behaviors have been implemented to overcome the difficulties of aging in place?
 - Housing repairs and modification or remodeling
 - Housing adjustment behaviors
 - Personal resources from family
 - Community and home-based resources
2. To investigate the perceptions and acceptance that older adults have concerning residential technologies:
 - 1) How familiar are older adults with the technology?
 - 2) How do they learn about the technology?

- 3) How much do they use the technology?
 - 4) What factors are most important in adopting the technology?
3. To make recommendations for older adults who want to age in their homes regarding modifications and adaptation of dwelling spaces to include residential technologies:
- 1) What should the characteristics of residential technology for older adults be?
 - 2) How can marketers and the industry meet older adults' needs?

Theoretical Framework

To investigate older people's attitudes toward residential technology, two theoretical frameworks were employed in this research: the person-environment interaction model (Lawton & Nahemow, 1973) and the diffusion of innovations theory (Rogers, 1995; Rogers & Shoemaker, 1971).

The first part of the conceptual model was built based on Lawton's revised person-environment interaction model (1989a, 1989b). Person-environment interaction (P-E) models have been used extensively in solving community service delivery and housing problems by creating environments that fit objective levels of competence (Pollack & Newcomer, 1986, cited in Wister, 1989). One of the consequences of this approach has been the adoption of an implicit assumption that there is an ideal environment for any given set of individual competencies. This has led to the omission of other factors, especially those that capture the active role that the individual assumes such as attitudes, knowledge, preferences, and perceptions. In response to this critique, Lawton (1989a, 1989b) suggested the "environmental proactivity hypothesis." This model emphasizes the person's competence as a determinant in the environment as opposed to the environmental docility hypothesis, which suggests that, as competence declines, the environment will account for an increased proportion of the variance in outcome. In other words, "environmental

proactivity hypothesis” suggests that, as the person becomes more competent, the environment affords increasing resources relevant to the person’s needs. In terms of proactivity, Lawton states that “proactivity in seeking such resources thus represents the behavioral magnification of achieved autonomy” (Lawton, 1989b, p.140). Wister (1989) states, “personal resources are regarded as means by which one can engage in proactive behavior, whereas reactive behavior is simply a response to environmental press” (p. 271).

The aging-in-place strategy (e.g., home modifications) can be considered one of the proactive behaviors resulting from older people’s attempts to mitigate reduced levels of well-being. In this theoretical framework, older people’s strong desire to age in place is identified as their proactive intention of maintaining a moderately challenging environment in order to avoid premature dependence. Within this conceptual framework, this research seeks to investigate and interpret older people’s perception and acceptance of technology as one of the ways to balance the demands imposed by the environment (press) and the individual’s ability to cope with those demands (competence) to avoid the occurrence of maladaptive behavior. According to this theoretical framework, regardless of the individual’s level of competence, environments can be manipulated to become moderately challenging and thus assist the resident in maintaining independence. The degree of perceptions and acceptance of technology can be interpreted as one of the choices that elderly persons make in order to maintain independent living.

To investigate older people’s attitudes toward technology, the diffusion of innovations theory (Rogers, 1995; Rogers & Shoemaker, 1971) and related diffusion research were used. Technology is often regarded as an innovation. The diffusion of innovations theory has been widely used as a theoretical base for understanding the process in which an innovation is communicated among the members of a social system through certain channels over time.

Until now there have not been many attempts to determine how older people adopt innovations. Moreover, age has been considered one of the adopters’ characteristics, but the older population has been considered a homogeneous group in diffusion research.

In this research, older people's perceptions and acceptance of technology were analyzed in terms of the attributes of the innovations, the characteristics of adopters including demographic characteristics, housing factors, and the desire to age in place. It was assumed that the desire to age in place would have a direct impact on attitudes toward technology based on the theoretical framework. Inconsistencies between elderly persons' perceptions and actual adoption behaviors were predicted.

Research Framework

Based on these theoretical backgrounds and the related literature review, a research framework was developed as shown in Figures 1 and 2.

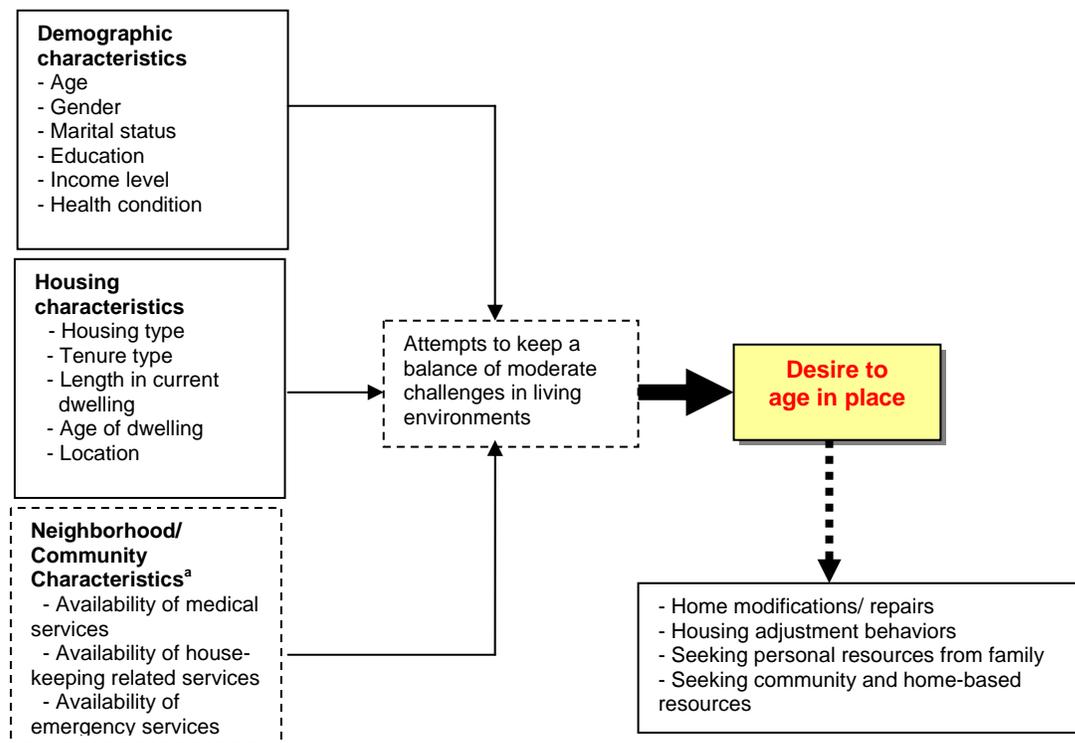


Figure 1. Research framework: Phase I.

^a Neighborhood/ community characteristics were included in the research framework. However, the research hypotheses did not include this variable, because this research mainly focused on housing and demographic characteristics.

This framework is composed of two phases: the first phase was designed to investigate the influence of demographic, housing, and neighborhood / community factors on the desire to age in place. The desire to age in place was the dependent variable.

Independent variables were:

a) Demographic characteristics

Age

Sex

Marital status

Education level

Income level

Health conditions

b) Housing characteristics

Housing type

Tenure type

Age of dwelling

Length of residence in current dwelling

Location

c) Neighborhood / Community characteristics

Availability of medical services

Availability of housekeeping related services

Availability of emergency services

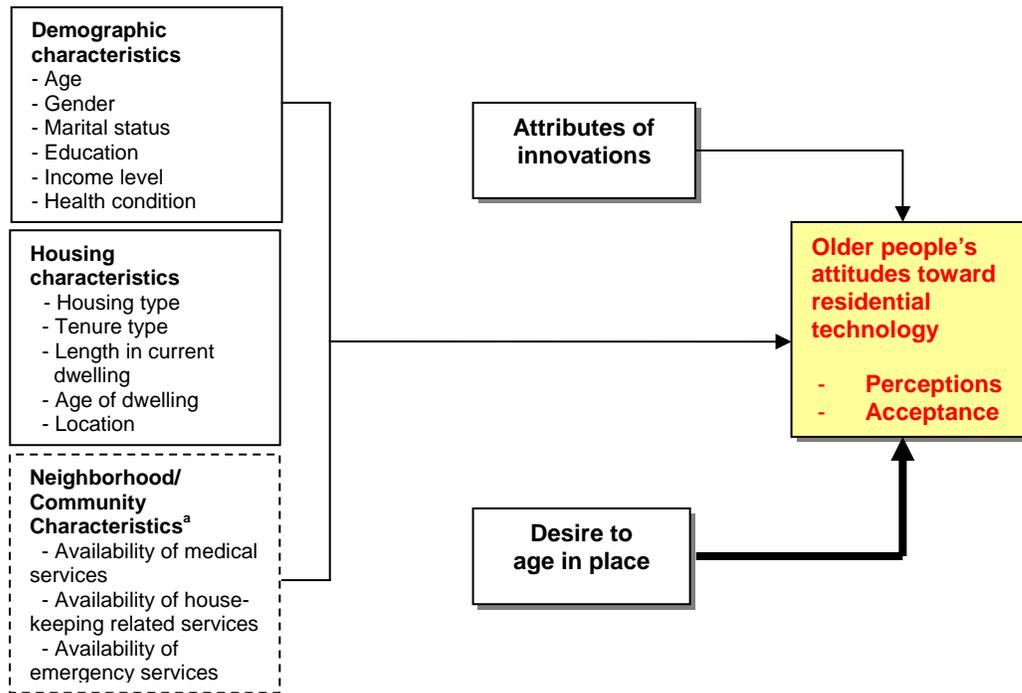


Figure 2. Research Framework: Phase II.

^a Neighborhood/ community characteristics were included in the research framework. However, the research hypotheses did not include this variable, because this research mainly focused on housing and demographic characteristics.

The second phase was designed to determine the factors that affect the perceptions and acceptance of residential technologies. It was assumed that the adoption of residential technologies by older people would be greatly motivated by the desire to age in place. Independent variables were examined in relation to two dependent variables, perceptions and acceptance of residential technologies. The independent variables were:

a) Demographic characteristics

- Age
- Sex
- Marital status
- Education level
- Income level

- Health conditions
- b) Housing characteristics
 - Housing type
 - Tenure type
 - Age of dwelling
 - Length of residence in current dwelling
 - Location
- c) Neighborhood / Community characteristics
 - Availability of medical services
 - Availability of housekeeping related services
 - Availability of emergency services
- c) Attributes of innovations
 - Relative advantage
 - Compatibility
 - Complexity
 - Trialability
 - Observability
 - Perceived risk

The practical research frame for this study is shown in Figure 3.

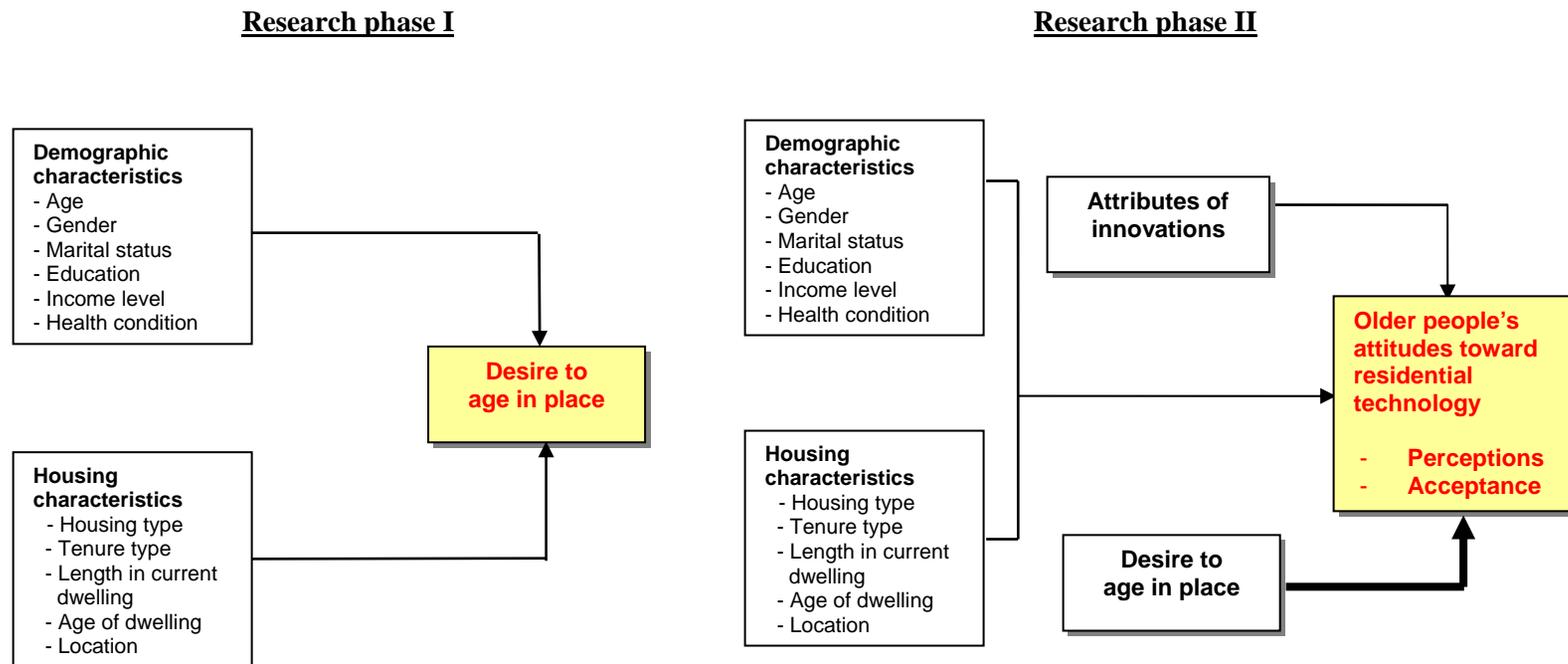


Figure 3. Research Framework.

Hypotheses of the Study

Nine research hypotheses were proposed based on the theoretical background.

- H1: Demographic and housing characteristics will significantly influence the desire to age in place.
- H2: Demographic and housing characteristics will significantly influence older people's perception of residential technology.
- H3: Demographic and housing characteristics will significantly influence older people's acceptance of residential technology.
- H4: There will be a significant relationship between older people's perception and their acceptance of residential technology.
- H5: There will be significant relationships between the attributes of innovations and older people's perception of residential technology.
- H6: There will be significant relationships between the attributes of innovations and older people's acceptance of residential technology.
- H7: There will be a significant relationship between the desire to age in place and older people's perceptions of residential technology.
- H8: There will be a significant relationship between the desire to age in place and older people's acceptance of residential technology.
- H9: The desire to age in place will be more directly related to older people's perceptions and their acceptance of residential technology than other variables such as demographic characteristics or housing characteristics.

Justification of the Study

The purpose of this study was to investigate older people's attitudes toward adopting residential technologies that could improve the quality of life and assist in aging in place. There have not been many empirical studies about the relationship between older people and their adoption of residential technology. Therefore, the results from this study can be expected to provide marketers, policy makers, and designers with valuable information concerning developing, distributing, and marketing new technologies in the future.

Many innovation studies indicate that socio-economic characteristics such as gender, education, and income are closely related to innovation decisions (Ha & Weber, 1991; Rogers & Shoemaker, 1971; Rogers, 1995). These characteristics differ by adopter categories such as earlier adopters or later adopters. Although there is inconsistent evidence about the relationship between age and innovativeness, earlier adopters have more formal education, are more likely to be literate, and have a higher social status than later adopters (Rogers, 1995).

An online survey was conducted as the data collection method. Because of this data collection method, the population for this study was limited to people having e-mail addresses and Internet access. The Virginia Tech Alumni Association was selected as a convenience sample. Although the sample for this study represents higher-educated and wealthier people than the general older population, it was believed that employing online survey techniques for this sample would present useful information about the attitudes that early adopters have toward residential technology as well as lend insight into the use of online surveys as a means of data collection with older adults.

Delimitations of the Study

Only those living in independent housing were considered for the sample. Because of the data collection method (online survey) the population of this study was limited to householders, age 55 and over, who had e-mail addresses and Internet access.

Limitations of the Study

1. All respondents were people who had at least some college education, because the sample was drawn from the Virginia Tech Alumni Association. Therefore, the results of this study might not be applicable to the general population.
2. All respondents were people who had e-mail addresses and Internet access, because the survey was only conducted with people who had e-mail addresses and Internet access. According to a national survey conducted in October 2000, 33% of U. S. householders age 55 and over reported having a computer and 26% had Internet access (U.S. Department of Commerce, 2000). According to the diffusion of innovations theory (Rogers, 1995), these people can be categorized as innovators, early adopters, or early majority in using computers¹. Therefore, the results of this study can not be extended to the general population.

Significance of the Study

The purpose of this study was to investigate older people's attitudes toward adopting technology, as it relates to homes that could improve the quality of life and assist in aging in place, using an online survey technique. This study has significance for several reasons.

¹ According to the diffusion of innovations theory (Rogers, 1995), the 2.5% of the individuals in a system to adopt innovations are categorized as innovators. The next 13.5% are labeled early adopters and the next 34% of the adopters are called early majority.

1. There have not been many empirical studies about the relationship between older people and their adoption of residential technology. The majority of innovation research has considered the older population as a homogenous group. However, in this study, older people (those age 55 and over) were not regarded as a homogenous group. The influence of age differences was carefully noted in each proposed hypotheses.
2. This study employed two theories, the person-environment interaction model and the theory of diffusion of innovations, in order to investigate the relationship between older early adopters of technology and the adoption of residential technology under the assumption that an older person's adoption of residential technologies will be greatly motivated by the desire to age in place. The proposed research framework has significance in terms of an attempt to understand the degree of adoption of residential technology as one of the proactive strategies in support of aging in place. Supported research hypotheses based on the research framework can provide more possibilities for understanding the relationship between older people's adoption of residential technology and the desire to age in place.
3. This study used a convenience sample--Virginia Tech Alumni Association members who are age 55 and over who had e-mail addresses and Internet access. The sample for this study represents people that have more education and are wealthier than the general older population. Those in this sample, all of whom have e-mail addresses, are also regarded as innovators, early adopters, or the early majority of computer technology. Therefore, the results of this research are expected to present the attitudes that early adopters of computers have toward residential technologies and to provide marketers, policy makers, and designers with valuable information concerning developing, distributing, and marketing new technologies in future.
4. This study employed an online survey technique. In terms of an initial attempt to conduct an electronic survey with an older population, this study has significance.

Respondents' reactions to the electronic questionnaire will offer useful information in designing web-based surveys for older people in the future.

Assumptions of the Study

Various factors influence older people's attitudes toward residential technology. These factors include demographic characteristics, social factors, previous experiences, innovative attributes, and so forth. In this study, it was assumed that an older person's adoption of residential technologies would be greatly motivated by the desire to age in place.

Definition of Terms

Activities of daily living (ADLs): Daily personal care activities including ambulation, bathing, toileting, feeding and dressing. They may also include cooking, cleaning, laundry, banking, or shopping.

Aging in place: The effect of time on a non-mobile population; remaining in the same residence where one has spent his or her earlier years (Harris, 1988).

Adoption: A decision to make full use of a new idea as the best course of action (Rogers & Shoemaker, 1971).

Adopter categories: The classifications of members of a social system on the basis of innovativeness. The five-adopter categories are: (1) innovators; (2) early adopters; (3) early majority; (4) late majority; and (5) laggards (Rogers & Shoemaker, 1971).

Compatibility: The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 1995).

Complexity: The degree to which an innovation is perceived as being difficult to understand and use (Rogers, 1995).

Diffusion: The process by which an innovation is communicated among members of a social system through certain channels over time (Rogers, 1995).

Home modifications: Adaptations to living environments intended to increase ease of use, safety, security, and independence (Pynoos et al., 1998).

Innovation: An idea, practice, or object that is perceived as being new by an individual or other unit of adoption (Rogers, 1995).

Innovativeness: The degree to which an individual adopts new ideas relatively earlier than other members of his/her system (Rogers & Shoemaker, 1971).

Instrumental activities of daily living (IADLs): Instrumental activities of daily living are those activities that are needed to carry out activities of living. They include walking, getting outside, preparing meals, taking medications, shopping for groceries, using the telephone, managing money, and housework.

Observability: The degree to which the results of an innovation are visible to others (Rogers, 1995).

Rejection: A decision not to adopt an innovation (Rogers & Shoemaker, 1971).

Rate of adoption: The relative speed with which an innovation is adopted by members of a social system (Rogers & Shoemaker, 1971).

Perceived risk: The degree to which risks are perceived as associated with the innovation (Bauer, 1960).

Relative advantage: The degree to which an innovation is perceived as better than the idea it supersedes (Rogers, 1995).

Residential technology: A system of Information and Communication Technology (ICT) components in housing that enhance and promote convenience, safety, security, communication, and comfort.

Trialability: The degree to which an innovation may be experimented with on a limited basis (Rogers, 1995).

CHAPTER 2. LITERATURE REVIEW

This research investigates aging in place, technology, and the relationship between the two. This literature review chapter is largely composed of four parts: aging in place, technology, elderly people and technology, and theoretical background.

Aging in Place

Aging Population

The older population (65 and over) numbered 35 million in 2000, an increase of 3.7 million or 12% since 1990. The number of Americans age 45 to 64 who will reach 65 over the next two decades, has increased by 34% during this decade (U.S. Department of Health and Human Services, 2001). The proportion of elderly people who live alone has increased in relation to age as well. Of those age 65-74 in 1990, 63% were married and lived with his or her spouse, and 24% lived alone. Of those age 85 or older, 47% lived alone.

According to Wiseman (1986), older Americans constitute one of the largest and fastest growing minorities. However, this segment of the population is not homogeneous. The projected increase in the number of elderly after 2010 is largely due to the aging of the baby boom generation--those born between 1942 and 1964--with assistance from the revolution in nutrition and health care that has extended life expectancies (Schafer, 1999). Between 2000 and 2020, late baby boomers (those born between 1955 and 1964) will be moving through the ages when their incomes are peaking, when they begin to plan seriously for retirement, and when growing numbers of them will not be supporting children.

An increasing number of older single-person households is another specific demographic characteristic of the older population. Single-person households are expected to be 30% of the 2020 total for this late baby boom cohort. Although baby boomers (ages 38-57 in 2003) have already stopped contributing to total net growth of housing markets,

their influence on housing will remain for the next few decades. Their changing demography will prompt new patterns of housing consumption (Masnick, 2001).

The influence of these demographic changes on the housing behaviors of older people can not be ignored. The fact that elderly housing patterns are distinguishable from general housing patterns has made policy makers, researchers, and housing professionals pay attention to the issue of elderly housing (Folts & Muir, 2002; Golant, 1992; Lawton, 1975; Pynoos, Hamburger, & June, 1990).

The Meaning of Aging in Place

Aging in place is not a new or unusual phenomenon. However, what aging in place means has been interpreted differently by scholars, housing providers, administrators of elderly housing, policymakers, and residents. Today, the number of older adults who want to age in place is increasing, and this trend raises fundamental questions about what aging in place means.

Aging in place is defined in the *Dictionary of Gerontology* as “the effect of time on a non-mobile population; remaining in the same residence where one has spent his or her earlier years” (Harris, 1988, p.18). Frank (2001) argues that this strict definition of aging in place refers only to changes that occur to the occupants over time; it does not address the changing nature of the environment itself. Frank mentions that several definitions of aging in place offered by scholars in recent years focus almost exclusively on changes in the inhabitants, overlooking changes in the environment (Merrill & Hunt, 1990).

Lawton (1990) describes aging in place as a transaction between an aging individual and his or her residential environment that is characterized by changes in both persons and environment over time. Lawton also explains that three types of changes occur as aging in place happens. First, there are psychological changes in the individual over time. Next, the residential environment itself will change due to physical wear, the natural environment, and the way the behaviors of older people affect the environment. Third, changes occur in the process of aging in place based on alterations the residents may make to their housing in

order to create a more supportive, private, and stimulating milieu. Change is thus a critical notion when discussing aging in place (Frank, 2001).

Heumann and Boldy (1993) define aging in place as “a term that, when used in reference to frail and elderly people, means solving their needs for assistance with independent living in their current housing, or an appropriate level of housing, and preventing a costly, traumatic, and often inappropriate move to a more dependent care facility (xi).”

Rowles (1993) presents an insightful rationale in understanding the idea of aging in place with the concept of sense of place. He, however, indicates that there are critical implications from the linkage between aging in place and place or location where one ages:

First, for many elderly people, the benefits of aging in place are entirely pragmatic. They have little to do with any sense of physical, social, or autobiographical attachment to place. Rather, for those people, aging in place is a high priority for reasons of cost and convenience. Second, not all older people are attached to a single place or set of places. Third, the role of place in the experience of aging may be changing, indicating generational effects. Forth, it can be argued that our communications technology and progress toward an increasingly global society are such that we are moving toward new manifestations of relationship with place that are modifying the way in which we develop affinity with environments. In sum, it would appear that both personal and societal images of the relationship between aging and place are evolving and assuming new forms.

(Rowles, 1993, pp.68-69)

Housing Situation

A number of studies have shown that the majority of older people live in their own single-family detached unit in a community setting. Earhart (1999) states that aging in place is the preferred option and that while most independent type of living arrangements meet the needs of the elderly, these arrangements may not meet the changing needs of all elderly people. Many researchers argue about this situation as they try to evaluate the appropriateness of aging in place.

The quality of housing occupied by older people has become a complicated issue because housing conditions for the elderly seem to be a big impediment to aging in place. According to a HUD report in 1999, half of all elderly householders having physical problems live in units that do not accommodate these problems, and these householders may not have the financial resources to correct this situation. One-half million senior householders live in severely substandard dwellings that pose a threat to their safety and welfare. Half of all elderly householders live in a dwelling built before 1960, whereas the median construction date for the entire U.S. housing stock is 1967 (HUD, 1999). The findings of the American Housing Survey (1999) concluded that, by and large, the housing occupied by seniors is in good condition. However, these findings also show that more than 1.45 million elderly households still lack the most basic elements of housing security, such as complete plumbing or a reliable source of heat.

Much research has shown that older people make a more positive appraisal of their residential situation than experts do (Golant, 1984; 1992). Filion, Wister, and Coblenz (1992), however, disagree about the different assessment criteria between residents and experts in their research, and they explore subjective dimensions of environmental adaptation among the elderly. As a result, researchers have recently become increasingly aware of the importance of individual preferences and attitudes among elderly persons. Policy makers and researchers have, however, generally relied on models that overlook key aspects of the individual, such as differences in time orientation, value systems, expectations, and the ability to psychologically adapt to one's environment.

As Folts and Muir (2002) point out in their recent exploratory research, *Housing for older adults: New lessons from the past*, the naïve belief that an infinite number of housing options could be created for older adults was based on the dual assumption that older adults should live in environments that assist them in meeting the basic demands of life, and that they would choose to live in such environments. It mattered little that there was strong empirical evidence indicating that older people overwhelmingly preferred to live in single

family housing regardless of what the experts viewed as serious deficits in that arrangement.

The Aging in Place Phenomena

Numerous theoretical frameworks have been used to explain and understand the aging in place phenomenon with theoretical backgrounds. Wiseman (1986) analyzed the aging in place phenomenon as an active choice, like migration. His analysis regarding how strongly aging in place affects the social context of geographic locations now needs to be complemented by a similar analysis of older people who decide to remain in place. He also mentioned aging in place, or the effect of the passage of time on a given immobile demographic population structure, as being probably the single most important process in understanding and predicting elderly populations because of the relatively low elderly mobility rates. His earlier research with Graff (Graff & Wiseman, 1978) included an explanation of *substantial aging in place*, a process magnified by the migration of younger people. They said that this migration changed the structure of the rural population, a structure that had involved aging of the elderly in place, producing the disproportionately large concentrations of the elderly in many rural areas.

Lawton (1986) mentioned the importance of housing satisfaction as one of the most important personal determinants of housing choice in moving or remaining in place. It seems that a great amount of housing satisfaction expressed by the elderly is independent of what has been defined as physical quality. In fact, the evidence suggests that older persons prefer to remain in their own homes, apparently irrespective of physical conditions (Lawton, 1980). In an effort to understand the discrepancy between objective housing quality and housing satisfaction among the elderly, housing professionals have generated a variety of explanations for this lack of congruence (O'Bryant, 1983). One of the earliest explanations as to why incongruence occurs was presented by Carp (1975), who views this phenomenon in terms of the need to reduce "cognitive dissonance." This framework provides an explanation for situations when an elderly person's environment is inconsistent

with his/her self-concept, and he/she is unable to improve this situation; one way to reduce feelings of inadequacy is to deny that the living situation is all that bad. Thus, the denial functions as a defense mechanism and it is used to explain the difference between reality and one's assessment of reality. While Lawton (1978) explained this as a "positive adaptive mechanism" used to persuade oneself that the situation is not so bad after all, it can be interpreted as meaning that the elderly are "unrealistic" about their circumstances (cited in O'Bryant, 1983).

Wister (1989) defined psychological adaptation as an internal response to the interaction between individual competence and environmental demands. Based on his research, the following psychological adaptive processes have been identified: (1) gradual acceptance of a variety of health-related inconveniences; (2) developing innovative strategies to negotiate an increasingly demanding environment; (3) changing expectations as to what constitutes "adequate" living conditions; (4) denial of deteriorating competence; (5) constricting perceptions of time remaining in one's life; and (6) redefining maladaptive behavior as a challenge. He contends that psychological adjustment appears to play an important role in the environmental adaptation process.

The reasons why older adults prefer to grow old in their homes include: economics (Cutler & Gregg, 1991; Mutschler, 1992); familiarity, comfort, and meaning associated with their homes (Herzog & House, 1991; Rowles, 1987; Rubinstein, 1989); independence and control (Wagnild, 2001); and benefits associated with remaining in a familiar neighborhood and community (Antonucci & Akiyama, 1991).

According to the research of McFadden and Brandt (1993), the majority of the respondents to their survey preferred to stay in their current single-family housing in the first ten years of retirement, but demographic variables including health status, gender, marital status, age and educational level, were not found to be related to a proactive stance.

The most recent survey of members of the American Association of Retired Persons (AARP) conducted in 2000 indicates that 89% of Americans age 55 and over would prefer to grow old in their current homes. The percentage of respondents increased significantly

from 84% in 1992 to 89% in 2000, when the question was last asked in a survey. If they need help caring for themselves, most respondents would prefer not to move from their current home (82%). Only a few expressed a preference for moving to a facility where care is provided (9%) or for moving to a relative's home (Bayer & Harper, 2000).

In an AARP survey (1992), poor health and insufficient funds were reported as significant concerns jeopardizing aging in place. According to a report by the U.S. Department of Health and Human Services (2001) in 1997, more than half of the older population (54.5%) reported at least one disability of some type (physical or nonphysical). Over a third (37.7%) reported at least one severe disability. Over 4.5 million (14.2%) had difficulty in carrying out activities of daily living (ADLs), and 6.9 million (21.6%) reported difficulties with instrumental activities of daily living (IADLs). Almost three-fourths (73.6%) of those age 80 and over reported at least one disability. The conditions occurring most frequently per 100 elderly in 1996 were: arthritis (49); hypertension (36); hearing impairments (30); heart disease (27); cataracts (17); orthopedic impairments (18); sinusitis (12); and diabetes (10). Older Americans spent 11% of their total expenditures on health, more than twice the proportion spent by all consumers (5%). Other major barriers include the availability of both informal and formal services and support (Morris & Morris, 1992; Wagnild, 2001).

Golant and Lagreca (1994) investigated the quality of housing where older people have lived a long time in their dwellings. Their findings show a strong relationship between a building's age and housing quality. In support of aging in place, they suggest implementing home repair programs that can easily be delivered to older homeowners. Their findings suggest that certain groups of elderly households are more in need of these types of programs than other groups.

Home Modifications and Repairs

The Meaning of Home Modifications

The idea of housing modification is not new. In the early 1960s, Lindsley (1964) discussed how the continuous action of good design and assistive devices could, without affecting physical limitations, enable an individual to cope with the environment more effectively. Historically, rehabilitation specialists have opted for home modifications as a way to respond to the needs of severely disabled or handicapped persons (Trickey, Maltais, Gosslein, & Robitaille, 1993).

Home modifications are adaptations to living environments intended to increase ease of use, safety, security, and independence (Pynoos, Cohen, Davis, & Bernhardt, 1998). Modifications can include: (1) change or additions to the structure (e.g. widening doorways, adding a first floor bathroom or a ramp); (2) special equipment (e.g. grab bars and handrails); (3) changing the location of items (moving furniture); and (4) adjusting the way where activities are carried out (moving to a first floor, changing the use of room). Home modifications overlap considerably with assistive devices (e.g. bath benches), which tend to be more mobile in nature and not attached to the structure of the house. In addition, home modifications for low-income persons often need to be accompanied by structural repairs (e.g. fixing worn stairs) to insure the usefulness of the modifications (Pynoos et al., 1998).

Wylde (1998) described this perspective as corrective, and presented an alternative perspective, the preventive perspective. The view from this perspective is that home modifications are an important component of home improvement and that they should prevent injury and improve ease-of-use and efficiency. She argues that home modifications can be understood differently by consumers, providers, and policy makers according these different perspectives.

Classification of Home Modification Activities

It is useful to categorize a range of activities relating to housing modifications when examining the incidence and pattern of these activities. Reschovsky and Newman (1990) presented three categories of adaptation activities: (1) home operation activities; (2) housing consumption adjustments; and (3) health-related activities. Home operation activities are those normal activities that are required for the operation of the housing unit and functioning of the household. These can be divided into light chores, heavy chores, and home repairs. Housing consumption adjustments serve to adjust the size, layout, location, or features of the housing being occupied in order to bring the home more in line with current needs and preferences. These adjustments can be divided into room use alterations, special features, and residential moves. The third category, health related activities, includes those activities that deal with ADL limitations and medical needs in the home. These can be divided into ADL help and in-home nursing care (Reschovsky & Newman, 1990).

Pynoos, Cohen, Davis, and Bernhardt (1987) categorized home modifications into six groups according to the type of work required to adapt the household to the functional limitation: (1) accessibility to permanent home fixtures; (2) prosthetic devices; (3) accessibility to furniture and accessories; (4) household equipment; (5) repair; and (6) general accessibility. Trickey et al. adopted this categorization in their research in 1993. According to their findings, accessibility to permanent home fixtures is the category group found most frequently among elderly households (480 of 898 households).

Wylde (1998) presents different categories of home modifications. These categories include: (1) structure; (2) plumbing fixtures; (3) addition of assistive devices; (4) safety; and (5) security.

Promoting Independent and Safe Living

Home modifications and repairs have been emerging issues relating to aging in place (Pynoos, 1992). Research on person-environment interaction has led experts to conclude that home modification is an important factor related to quality of life and functional autonomy. Numerous researchers assert that elderly persons' activities and safety can be facilitated by educating them about environmental dangers and by encouraging them to make adjustments in their home environments (Cream & Teaford, 1999; Hazen & McCree, 2001; Struyk, 1987; Wylde, 1998). The successful implementation of home modifications also may delay the need for more costly services such as personal assistance or relocation (Gitlin, Miller, & Boyce, 1999).

This issue has been treated with different approaches in a variety of academic and practical fields. An increasing number of health care professionals now view residential modifications as supplements to community home support programs and as alternatives to calling others for help when difficulties with daily activities arise. The issues as to whether elderly people can continue to access the important parts of their homes and whether their homes allow them to function safely and completely should become increasingly salient for homebuilders, health care providers, and public policy-makers (Louie, 1999).

The findings from Louie's research (1999) show that the vast majority of disabled elderly households lack accessibility features that household members feel they need. She maintained that the preference of aging in place and the act of moving less often than younger individuals results in elderly people having difficulty in maintaining their homes. The results of the analysis show region, structure age, education, and race emerging as the variables that most commonly have a significant relationship with the incidence of necessary modifications. She concluded that lack of knowledge about home modifications, rather than lack of resources, is a bigger obstacle when serving the accessibility needs of disabled elderly households.

Researchers have emphasized the benefits that home accessibility features can bring both to those with disabilities and those without impairments (Center for Universal Design,

1997). They affirm that carefully designed environments can provide help to those with physical or mental deficits. Others have also argued that almost everyone is subject to a disabling condition as they age. Everyone is likely to benefit eventually from a home with accessible modifications (Center for Universal Design, 1997).

As occupational therapists, Hazen & McCree (2001) present practical design implications for seniors. These environmental supports for assisting older adults are specific design guidelines based on age-related changes such as neuromuscular function changes and cognitive changes. Organizations and research institutes studying universal design (accessible home design) recommend a variety of physical changes in the homes of individuals who cannot move around their living spaces easily or safely. These features include: adding a chair lift to stairs, replacing stairs with ramps, widening doorways or adding offset hinges, lowering cabinets, installing more raised toilets, adding grab bars to the bath tub or toilet, or installing alerting devices for the hearing or visually impaired (Center for Universal Design, 1997).

The most recent AARP survey (Bayer & Harper, 2000) conveys the concepts and behaviors that older adults age 45 and over have toward home modifications. According to an AARP survey (2002), most respondents (86%) have made at least one simple change to their home to make it easier for them to live there. Respondents most frequently report having installed nightlights (63%), non-skid strips in the bathtub or shower (50%), and higher wattage light bulbs (32%). Safety is most often cited as a reason for making home modifications. A large percentage of respondents also say the reasons for making these changes were to make the home easier to use by all members of the family, to increase the ability to live independently, to provide flexibility to adapt to the changing needs of family members, and to upgrade or modernize the home. A majority of respondents (67%) who have made home modification think that those changes will allow them to live in their home longer than they would have been able to otherwise. Only 28% of respondents indicated an interest in information about types of home modification (Bayer & Harper, 2000).

Although the sample size (N=280) is much smaller than that in the AARP survey, an earlier investigation by Wister (1989) indicated similar design alterations. In his research, the two most frequently cited design alterations are stair railings (46%) and grab bars in the bathtub (33%). The majority (85%) of respondents indicated that they had not made any design changes (interior or exterior). Another surprising result from his research is consideration of future design alterations. The majority (65%) of respondents reported that they spend “no time” or very “little time” (19%) thinking about future changes to their environment.

Environmental Hazards in Homes

Carter and his colleagues investigated the self-assessment of elderly persons and directly observed environmental hazards in homes (1997). In their cross-sectional survey of people age 70 and over in a defined geographical area of Australia, the findings showed that one in five homes is hazard-free. Many of the older people in this research did not think their homes were unsafe (97 %). However, 80 % of homes had one or more hazards, and multiple hazards were found in rooms and areas where older people performed complex daily routines. The bathroom was identified as the most hazardous room, followed by the bedroom. Flooring and lighting were identified as the hazard types perceived most often. Respondents were aware that falls are the most common accidents in old age. Researchers, however, found that although many older people knew what could be done to prevent falls in general terms, they had not made changes to make their home safer.

In surveys with a “Home Safety Checklist” (1986 and 1987), the AARP discovered the most frequent home safety problems. These are: a) inadequate railings on staircases and grab bars in bathrooms, b) the hazard of wires running under carpets, c) lack of a smoke detector and a nonslip-bathtub mat, and d) lack of emergency numbers posted near the telephone (Fise, 1988).

There have been numerous studies of falls among the elderly in their homes. Falls are recognized as a leading cause of injury and death, particularly in the elderly population.

Researchers indicate, in many cases, that falls can be prevented (Aminzadeh et al, 2000; Granek, Baker, Abbey, Robinson, Myers, Samkoff., & Klein, 1987; Orhon-Jech, 1992; Rawsky, 1998). The effects of falls extend beyond obvious physical injury and direct cost. The psychological effect can have lasting, damaging consequences. Fear of subsequent falls in elderly people may contribute to a restriction in activity and mobility as well as reduced independence (Nevitt et al., 1989; Trnetti et al., 1994, cited in Rawsky, 1998).

Gill et al. (1999) argued that, at the present time, there is no direct evidence, either from clinical trials or from observational studies, linking environmental hazards to adverse functional outcomes other than falls. They conducted a cross-sectional study with a large sample of 1,088 persons, age 72 and over, to investigate the relationship between the home environment and physical capabilities among community-living elders. Their findings show that environmental hazards are no less common in the homes of older persons with specific deficits in physical capabilities, such as transfer, balance, and gait, than they are in the homes of older persons without the same deficits. The lack of a causal relationship between environmental hazards and adverse functional outcomes is surprising.

Stairs are one of the most dangerous areas in house. According to Wylde's (1995) telephone survey of those 65 years old and over, 26% reported that none of the essential services (toileting, bathing, sleeping, and eating) were on the ground floor. Among the 256 respondents, 18.3 % had fallen on the stairs in their homes. Sixty-one percent of the stair-fallers had fallen once, 28% had fallen twice, and the remainder had fallen three or more times (cited in Wylde, 1998).

When older adults become aware of safety hazards, 82% plan to correct the safety problems. Of those who plan no remedial action, 52.5% feel no repairs are necessary and 32.6% say repairs are too costly (Hazen & McCree, 2001).

Indicators and Constraints of Successful Home Modifications

To date, there have been numerous studies to determine the indicators of successful home adaptation and the constraints of elderly persons' acceptance of home modifications. Much of the research points out that one of the biggest constraints to successful home modifications is that no single and systematic service for providing these modifications for the elderly exists (Mann, 1997; Pynoos, 1992; 1998).

Pynoos, Cohen, Davis, and Bernhardt (1987) reported that there is no systematic program to educate professionals in assessing the needs of the elderly or handymen about the changing physical needs of older residents. In a later paper (Pynoos, Tabbarah, Angelelli, & Demiere, 1998), the researchers presented barriers in improving the delivery of home modifications. These barriers can be summarized as follows: (1) a lack of systematic and uniform assessments; (2) underutilization of home modifications by social service/ home care providers; (3) low priority of home modifications in government funded housing programs; (4) the medical orientation of the health systems; (5) lack of funding and instability of publicly funded home modification programs; and (6) the limited role of the building industry in home modifications. These problems are not much different from the key barriers identified in the First National Conference on Home Modifications Policy (Wilmer, 1994, cited in Mann, 1997).

While adaptation solutions exist, few consumers are aware of them or of the potential value they may be in helping these consumers remain independent and safe at home. A lack of technical knowledge among agency staff, subcontractors, builders, and remodelers restricts access to appropriate services.

Wylde (1998) pointed out that part of the problem stems from the fact that the home modification and accessibility movement has been approached from the "disability" perspective. Additionally, home modifications are often relegated to the medical realm. This influence pushes the consumer/supplier to focus on medically necessary modifications as opposed to independence and quality-of-life changes.

Wylde (1998) states that perhaps the best indicator of the home modification knowledge is consumer adoption of modifications. Consumers generally learn about products and services through traditional methods such as advertising. Another source of information about home modifications could come from professional homebuilders.

Although physical changes, safety issues, and housing conditions create the need for modifications, behavior also plays a role (Cream & Teaford, 1999; Gosselin, Robitaille, Trickey, & Maltais, 1993; Pynoos, et al., 1987). According to Lawton (1982), when an older adult demonstrates adaptive behavior in the face of environmental press, he/she will continue to maintain an adequate level of competence; however, at some point, no further changes in behavior can be made or the behavior changes threaten the safety of the person. Based on Lawton's theory, it can be said that the major barrier to home modification is the fact that older people may modify their behavior rather than make physical changes to their homes. Another reason that modifications are not made is that older people grow accustomed to their living conditions and simply accept them (Cited in Wylde, 1998). Pynoos (1992) goes on to state that many older people do not alter their environment until an accident has occurred or until they can no longer perform tasks because of chronic health problems.

According to the data analysis from the Survey of Housing Adjustments (SHA) of 1979 by Reschovsky and Newman (1990), the households that are the most vulnerable and frail in adopting home modifications are those that have the following factors: low income; lack of informal support either within or outside the household; and, for housing-related activities other than moving, being a renter rather than a home owner. Gosselin and his colleagues (1993) explain how a minor home modification program, offered free of charge, was accepted by elderly people. According to their research, the strongest predictor of adaptation is a favorable attitude towards home modifications. Other predictors include low-income status, good housing conditions, no difficulty in managing a budget, use of homemaker services, and recognition that home modifications might assist daily activities. The findings show that barriers to home modifications persist even when there are no

constraints linked to a lack of information or expense. Nonetheless, the findings indicate that when barriers related to information, availability, expense, and/or installation are removed, the offer of modifications is well received. According to additional research using the same data (Trickey, Maltais, Gosselin., & Robitaille, 1993), almost half of the modifications are made to bathrooms. The most common modifications include installation of grab bars, shower seats, and hand-held showers. These results support other research, which indicates that grab bars and extra handrails are the most frequent modifications installed in seniors' homes (Louie, 1999; Struyk, 1987; Wister, 1989).

Louie (1999) used data from the 1995 American Housing Survey (AHS) to explore the types and prevalence of home modifications for U.S. households with disabled elderly people. The data show that the modifications appearing most frequently are extra handrails or grab bars, and almost 45% of households with disabled elderly people have at least specified home modifications. She states that a relationship can be drawn between income, education, race, and age and the incidence of home modifications. The data also show that the incidence of building-wide accessibility modifications for disabled elderly households living in multi-family structures is relatively high. Based on this data, she says it is not immediately clear why certain hardware modifications are more often present in households, while other hardware items are so often absent. She believes it could be that awareness of the utility is higher for some modifications than it is for others, and that the survey process itself may have suggested to households a need for certain modifications that they had not previously considered. Alternatively, many households may try to avoid either visible indication of disabilities within the households or structural additions that may evoke the feel of institutional settings. She also suggests that Medicare benefits may contribute to the greater prevalence of personal help and assistive devices over home modifications when these aids are needed.

According to an AARP survey conducted in 2000, when respondents were asked why they had not modified their home or had not modified it as much as they would have liked, most often they said it was from not being able to do it themselves and not being able

to afford it. Other frequently selected reasons included: not trusting home contractors, not knowing how to make changes, not having anyone to do it for them, and not knowing how to find a good home contractor or company that modifies homes (Bayer & Harper, 2000). Pynoos (1992) pointed out a prominent problem with home modification for elderly persons have been the lack of providers who have the trust of older clients and the skills to make home modifications and repairs. Remodelers have generally preferred larger jobs such as a complete kitchens or bathrooms, and medical supply companies have focused on installing the hardware items that they sell. Older people are often concerned about the reliability, skills, and honesty of such private sector providers (Bayer & Harper, 2000; Pynoos, 1992). Pynoos (1992) also found the costs for home modifications and repair to be barriers for successful home modifications. While many alterations are low cost, others are too expensive for persons with low incomes, which are often those who need them the most. In addition, there have not been many financial resources to pay for the modifications. Therefore, many older people have to use their own money to pay for alterations. Thus, if the changes are costly, income is low, and the functional condition is severe, the older person will have to move within a short period of time.

Several studies focusing on the use of devices and/or the implementation of modifications in the home, point out psychological factors as a barrier to successful home adaptation. Poor aesthetic quality, awkwardness, and embarrassment at having to use a device or to make modifications can negatively affect usage (Gage, Cook, & Friday-Field, 1997; Louie, 1999). Trickey et al. (1993) also mention that the stigma one may feel due to having a disability could discourage the use of devices.

Home Modification as Coordinative Services

A number of studies suggest that home modifications and service delivery should be considered in terms of public policies (Bayer & Harper, 2000; Golant, 1992; Hazen & McCree, 2001; Pynoos, 1992). Aging in place strategies such as home modifications require a wide array of human, financial, and home maintenance and modification services

to enable older residents to meet their needs and preferences (Fisher & Giloth, 1999, Golant, 1992; Pynoos, 1992). From a public policy perspective, the debate about national health care, long-term care, and wellness emphasizes the need to understand the real and potential impacts that aging in place can have on health-care costs and the quality of life for the elderly population. A major challenge for promoting and including home modifications as a component of aging in place is to ascertain how health, housing, financing, and social services can be packaged to meet the distinctive needs of specific individuals, many of whom differ in terms of resources, preferences, health-care needs, and neighbor characteristics (Golant, 1992; Newman 1993).

Pynoos (1992) maintained that an estimated 20% of dwelling units for the elderly are in need of modification or repair. He suggested strategies to increase the incidence of home modification and repair. These strategies include more widespread and systematic home assessments, increased public awareness about the role of the environment, and the creation of more programs that provide affordable home modification and repair services.

Moreover, Fisher and Giloth (1999) stated that the use of expensive medical procedures and the premature and unnecessary admission to nursing homes can be significantly altered by preventing falls, the fourth-leading cause of death for seniors. Modifications that are thought to be effective in reducing falls and other accidents include installing a bathroom on the first floor, removing scatter rugs, or utilizing grab bars. However, their research is inconclusive concerning the benefits/costs of aging in place and home modification compared to nursing home costs. In conducting their project, the South East Senior Housing Initiative (SESHI), Fisher and Giloth discovered that many older people, particularly those with moderate incomes who were working-class people in their 70s and 80s, did not want to make home modifications. The older people's perspective was that they would rather cope, save their money, and leave inheritances to their children. Fisher and Giloth presented four areas of concern that emerged as a result of the research: aging in place strategies; cost effectiveness; collaborations; and national networking. They also found that aging in place information, techniques, and resources are useful and

necessary but that they are not the whole story; elderly people need access to counseling and funding mechanisms (appropriate loans, subsidies, and tax credits). Home modification services need to be better linked to key actors in the lives of older people. These actors are: the health delivery system for older adults; corporations offering benefit packages for their children who frequently are involved in decision-making with their parents; civic and religious institutions; social welfare organizations, as well as private contractors and home repair centers (Fisher & Giloth, 1999).

A variety of programs and organizations may be willing to help elderly persons fund home modifications. Over the past decade, hundreds of nonprofit programs have been created to make home modifications and repairs. While the total number of agencies providing such services is unknown, a recent survey has categorized at least 300 programs (Pynoos, 1992). According to another recent survey of home modification and repair programs (Pynoos, Lee, & Lee, 2001), the two most frequently cited funding sources are Older Americans Act Title III and Title V funds (39 %) and block grants (38%).

Many researchers, however, argue that home modification services remain fragmented, unstandardized, and independently funded with no single source of funds (Gitlin, Miller, & Boyce, 1999; Mendelsohn, 1997; Pynoos, 1992; Pynoos, Tabbarah, Angelelli, & Demiere, 1998). Medicare reimburses expenses for durable medical equipment if the equipment meets the following criteria: (a) the equipment is prescribed by a physician to serve primarily a medical purpose; (b) the equipment is unlikely to be useful after the illness or injury resolves; and (c) the equipment is capable of withstanding repeated use in the patient's home (Youngers, 1988). Hazen & McCree (2001), however, raised questions about the criteria for the reimbursement. They pointed out that a hospital bed or a walker can be reimbursable, but that a raised toilet seat or a grab bar is considered to be a convenience for the user and thus currently is not reimbursable by Medicare. The tax deduction is limited to the excess cost over the increased value of the home if the cost is over a certain percentage of income for the year.

Technology

Definition of Technology

The word *technology* is formed by combining the Greek root word *techne* or *techno*, meaning something involving the technical aspects of the arts and crafts, with the suffix word *logia*, meaning theory, doctrine, science or the study thereof. Like all words in a dynamic language, it has evolved and will continue to evolve (Wiens & Wiens, 1996). There are several other definitions of technology that are drawn from writers with various backgrounds and perspectives.

- Technology is the system of tool-using behavior (Ayres, 1961).
- The original meaning of technology was applied practical knowledge. In casual conversation, the physical aspects of technology (tools and products) serve as the symbols of this knowledge (Holloway, 1984).
- Technology can be understood in four ways: as an object; a process; knowledge; and a volition (having purpose and direction toward a desired end) (Mitcham, 1980).
- Technology is not just a machine or a body of knowledge: it is a way of thinking, an approach to problem solving that presupposes both ends and means (Wiens & Wiens, 1996).

(Wiens & Wiens, 1996, pp.5-6)

Conceptual and Theoretical Issues in Technology Research

Traditionally, the interaction between technology and society has been studied within the context of a technological revolution in industry (Venkatesh & Vitalari, 1985). A technological revolution affects daily life within a household with regard to time allocation patterns, the choice of social functions, the transmittal of cultural values, and overall human behavior (Cowan, 1976; Vanek, 1978; Robinson, 1980, cited in Venkatesh & Vitalari, 1985). Recently, researchers have investigated issues relating to information technology or

computing such as the profiles of innovators (Vitalari, Venkatesh, & Gronhaug, 1985), the nature of computer diffusion, social/psychological factors affecting computer use (McQuarrie, 1989), telecommuting and work at home (Venkatech & Vitalari, 1992), and the growing use of the Internet.

When a given technology begins to affect life in a household, it is a safe conclusion that the technology is being integrated into the social system and that it has been accepted as a basis for future social behavior. For example, automobiles have totally transformed the American value system, creating what is known as the automobile culture (Venkatesh & Vitalari, 1985).

Despite the recent dramatic trends in the diffusion of information technology, the significance of these developments is still not clear. Also, there is a lack of critical understanding of these developments and a lack of a sound theoretical and empirical base from which to observe and analyze them. Many technology providers have a sound knowledge of the technology they produce but not within the social context of the technology's usage.

Households as a Main Adopter Category

There have been research themes that consider a household to be a main adopter category. These studies mainly focus on the original nature of a household in understanding the interactions between technology and adopters. Venkatesh and Vitalari (1985) mentioned that although technological consciousness may appear to be an individual construct, it can also be viewed as a household construct. Technological consciousness develops through a process of socialization and cognitive development. To the extent that the integration is conscious, households react differently to various technologies mainly because of differing household characteristics. Both degrees of socialization and levels of cognitive development account for how households respond to the technological environment (Venkatesh & Vitalari, 1985).

Households may be regarded as human systems that adopt rational, economic, and social strategies to achieve their goals and to respond to the external environment. As a rational system, the household accepts or rejects new technologies based on measurable benefits that the technologies can present in the household; for example, time and cost savings and improvement in material conditions. As an economic system, the household will be inclined to evaluate technologies in terms of their potential to produce goods and services that are appropriate to the functioning of the household. As a social system, households adopt technologies because they may add power and prestige and improve their social status. A household develops both defensive and adaptive mechanisms, because a household does not have control over the sources of technologies (Venkatesh & Vitalari, 1985; Venkatesh, Kruse, & Chuan-Fong Shih, 2001).

According to Venkatesh and Vitalari (1985), defensive mechanisms permit the household to carefully evaluate technologies and determine how they would affect the existing life patterns and what changes they would bring to the household's present approach to solving problems. New technologies mean new ambiguities, new complexities, new patterns of resource allocation, and new fears of the unknown. Paralleling defensive mechanisms are adaptive mechanisms, which facilitate change.

Motivation to Adopt Technology

Technology is a tool that meets the specific functional goals of the household. In order for a given technology to be employed successfully and thus realize instrumental goals, the user must have the necessary knowledge as to how the technology can be utilized, have the ability to cope with the technological demands, and actually use the technology to meet specific functional needs. Venkatesh and Vitalari (1985) discussed the motivation of a household to adopt a particular technology. These can be discussed in terms of three theoretical dimensions: 1) instrumental/expressive; 2) passive/active; and 3) task-oriented/pleasure-oriented. The instrumental/expressive dimension is adapted from Parson's classification of pattern variables. Instrumental goals include objectives such as

need satisfaction, task performance, cost savings, and efficient use of time. The expressive side of technology refers to the possibilities that a technology creates for communicating emotions and affections and expressing family-related values through opinions and behavior. Such activities have a high personal and psychological meaning in the context of the household. Typically, technologies that are rich in their ability to satisfy both expressive and instrumental needs are likely to be more important in a household. The passive/active dimension of technology refers to the effort required by the user to achieve the desired results from the technology. It can be hypothesized that the skill level required to adopt or use a particular technology increases on the continuum as it moves from passive to active. The task-oriented nature of technology refers to the specific acts that the user has to perform before the technology can be put to its intended use.

Household/Technology Model (Venkatesh & Mazumdar, 1999)

Venkatesh and Mazumdar (1999) developed the household/technology interaction model, which consists of three related constructs: 1) social space; 2) technological space; and 3) physical space. Social space may be identified in terms of the household as a social structure (parents, children), the household activities performed by household members, the time allocation for such activities, and the social dynamics that occur between and among family members while performing the activities. Physical space refers to the interior spatial organization of the home. Technological space refers to the configuration of technologies in the home, from kitchen appliances to the TV, the computer, and a variety of other domestic technologies. Technological space also includes the specific uses of these technologies for performing household activities as identified within the social space.

The Nature of the Technology Impact

The idea that technology can confer both benefits and losses to the user is not new. Some researchers argued that mass adoption of technology could lead to unanticipated

consequences for society. With specific reference to information technology, the adoption of information technology is more complex than the adoption of most of the other household technologies.

A considerable body of literature has developed in the last twenty years regarding the social effects of the computer in large organizations. Several empirical studies have suggested that, in certain circumstances, computer technology can alter task structures, roles, interpersonal relationships, and organizational structures. Broadly speaking, microcomputer technology can be evaluated in terms of its technological, economic, and social impacts (Venkatesh & Vitalari, 1985).

Venkatesh (1997) maintained that the discussion relating to new technologies must be examined in terms of two temporal realities: the existing or current reality and the futuristic vision attributed to these technologies. Currently, with few exceptions, few domestic technologies are discrete and not linked. This means that current domestic technologies are designed as uni-purpose in functionality and well defined. However, scenarios and prototypes are being developed that enable domestic technologies to communicate with each other and with technological systems outside the home. In addition, the technologies can be programmed; hence the label, smart appliances.

Previous Research Streams of Household Technology

Venkatech (1997) identified the research themes of household technology that were used up until now. First, the socio-technical systems theory of technology adoption and use views an organization (household) as a social system and technology as an autonomous environmental system that acts on the social system as an external agent (Hedberg & Mumford, 1975). This approach has been criticized mainly because the socio-technical systems approach fails to recognize that technology is integral to the household environment and not external to it, and that there is a dynamic relationship between the two. The second approach, which is more common among organizational theorists and social constructivists in Europe, views technologies as socially embedded processes (Kling,

1980). Unlike the socio-technical systems approach, the social-embeddedness theory examines technology as being integral to the social organization. The third approach is based on an extension of new-home economics, which considers technology in the context of household production and consumption (Berk, 1980). From this perspective, technologies are viewed as time (and/or cost) saving devices, and households as optimizers of time/cost allocations based on household preference functions. The fourth approach is reflected in time-budget studies and is closely related to the third stream. Robinson (1977, 1980, 1990) is credited with the main contributions to this area. The focus here is on developing a scheme of time allocation by households for various household activities. The approach is more descriptive, analytical, and data rich, but not very theoretical. A synthesis of the previous work in these areas of research (Berk, 1980; Hardyment, 1988; Morgan et al., 1966; Nicosia, 1975, 1983; Nickols & Fox, 1983; Oropesa, 1993; Vanek, 1978; Strober & Weinburg, 1980) suggests that the household may be viewed as a social system divided into task environment and non-task environment, and that technologies can be viewed as part of the social system (cited in Venkatech & Nicosia, 1997, pp. 4-5).

Categorization of Technology

Technology can be categorized into different ways. Wylde (1995) pointed out the need to define a market for a technology. According to Wylde, in order to understand the nature of the market, following factors should be understood: 1) the type of technology; 2) its context -- the practical application and where, when, and by whom it will be used; and 3) the orientation of presenting the product. He also mentioned that the market for a technology depends on its definition. There are five broad areas of technology within the context of our everyday lives: 1) telecommunication technologies; 2) medical technologies; 3) environmental interface technologies; 4) personal technologies; and 5) assistive technologies (Wylde, 1995).

Goss and Beamish (2001) conducted a study concerning technologies incorporated in and/or planned for multi-family housing. They used the term “residential technologies”

and categorized them as those related to 1) designed spaces (community theaters, community business centers, or computer nooks); 2) home lifestyle systems (security or home entertainment); and 3) home management systems (home communication infrastructure systems).

Mekibes and Mekibes (2001) objected to the use of the term “smart” or “intelligent” housing in this context. Instead, they use the concept of “domotics.” They define domotics as “a system of IT (Information Technology) components in housing applicable to safety and security, comfort and self-care, communication, and property management.” These items can be classified into the four categories: safety and security; comfort; communication; and property management. Specific examples are shown in Table 1.

Table 1
The Domotic Concept

Category	Examples
Safety and security	Involving security alarm, burglary alarm, locking device, entrance video, etc.
Comfort	Such as remote control of doors, windows, curtains, video, TV, stereo, heating, lighting, ventilation, elevators, etc.
Communication	Telephone, intercom, tele-working, house owner, education, formation, diagnosis, care, dispensary, shops, banks, etc.
Property management	Heating, lighting, ventilation, etc.

Molnar (2002) categorizes technologies into three areas: 1) basic tech innovations for the home such as fixtures, lighting, and furniture; 2) high tech options such as remotes for appliances/utilities; and 3) personal health care technologies in the home such as portable oxygen. Table 2 shows various categories of technology.

Table 2

Categorization of Technology

Wylde (1995)	Goss & Beamish (2001)	Mekibes & Mekibes (2001)	Molnar (2002)
Telecommunication technologies Medical technologies Environmental interface technologies Personal technologies Assistive technologies	Designed space Home lifestyle systems Home management systems	Safety & security Comfort Communication Property management	Basic tech innovations High tech options Personal health care technologies

Definition of Residential Technology

Based on existing research, residential technology is defined in this research as a system of ICT (Information and Communication Technology) components in housing that enhances and promotes convenience, safety, security, communication, and comfort. Residential technology can be divided into three categories according to the technology's main usage: (1) home management; (2) communication; and (3) entertainment. Under the home management category, two sub categories were defined: (1) safety and security and (2) comfort. Residential technology can also be put into the categories of survival technology, basic technology (low technology), and high technology, according to the degree of functions of the technology and the degree of the current adoption rate. The boundary between survival and basic technology is not clear and subject to interpretation from individual to individual, contrary to high technology. However, some home appliances can be identified as survival technology in terms of an adoption rate. For example, a color television is commonplace in the home regardless of income level. The percentage of households that have a color television is 98.9%. The percentage of households that have a refrigerator and cooking appliances is 99.9% and 99.7% respectively (Department of Energy, Energy Information Administration, 2002). Based on

these definitions, residential technology was categorized in a two-dimensional model in this research. Possible examples are shown in Table 3 under the different categories.

Table 3
Categorization of Residential Technology

		Survival Technology	Basic technology	High technology
Home management	Safety & Security		Fire & smoke alarm	Security system - Security alarm - Entrance video - Burglary alarm
	Comfort	Refrigerator Cooking appliances Thermostat	Dishwasher Clothes washer Clothes dryer Vacuum cleaner	Remote control of doors, windows and curtains Personal health care products & services Advanced HVAC system
Communication		Telephone	Answer machine Fax machine Cellular phone	Internet Video phone
Entertainment		Color television	Cable or satellite TV Stereo system VCR CD player	Home theater system

Elderly People and Technology Usage

Assistive Technology Use

Technology and aging is an expanding field of inquiry (Wylde, 1995). To date much research relating to the relationships between older people and their usage of technology has been conducted. Technology in the field of the health of the older population has been defined as devices or systems that assist in achieving and maintaining an independent lifestyle.

Haber (1988) categorizes this technology into three levels. High technology uses physical and chemical principles to report and define information on the state of health of the elderly. Middle technology uses advanced principles in every-day equipment around the

home like television and stereo. Low technology includes devices such as furniture, bathroom appliances, heating utensils, and clothing. Chappell (1988) mentions that much of the interest in aging revolves around the use and adoption of low technology to enhance safety and the quality of life. The current focus is mainly on research relating to elderly people's use of assistive equipment, devices, or home accessibility features. Most research reveals unique perceptions and usage patterns by older persons compared to younger people. Older people's decisions to accept or abandon technology are complicated by additional factors such as health or affordability.

Conceptually, the development of assistive technology can be divided into three major sequences, which are best described as the specialized device, the interactive device, and the integrated device phases (Mendelsohn, 1997). Mendelsohn consistently argued that assistive technology should be treated as a governmental policy and explained why assistive technology should be regarded in this manner. As an example of using public policy in regard to technology, he uses The Technology-Related Assistance for Individuals with Disability Act of 1988 (The Tech Act). He stated that neither the concept nor the importance of assistive technology was sufficiently crystallized to allow for the dissemination of a broad definition of the term until 1988. The Tech Act outlines the definitions of assistive technology devices and services. It also represents a crucial evolution of public policy regarding assistive technology. Not only does it offer a workable definition of assistive technology, but also it elevates the subject for the first time to a position of national legislative concern in its own right, and it authorizes the appropriation of funds to states to conduct "consumer responsive, statewide programs of technology assistance" (Mendelsohn, 1997).

An analysis of national level data shows that finance is a barrier to acquiring assistive technology, regardless of the age distribution among the disabled population. It

also indicates the existence of considerable unmet demands for assistive technology (Laplante, Hendershot, & Moss, 1997).

Luborsky (1993) stressed the importance of understanding social, cultural, and ethical differences, as well as age differences, in understanding technology usage. Furthermore, he pointed out that culture and personal biography shape the course of technology acceptance more so at the individual level than at the cultural- and social-system levels. In his two case studies, which illustrate the socio-cultural and individual factors in using assistive technology by older disabled persons, he observed the effects that socio-cultural meanings and their consequences, as well as cultural and biographic perspectives had on technology use. The results show how users appreciate and experience adaptive equipment.

More recently, the behavioral model has been adapted to understand the use of assistive devices in the older population (Zimmer & Chappell, 1994). This model proposes that three domains of variables contribute to the use of health services: predisposing, enabling, and need factors (Anderson & Newman, 1972). Predisposing variables describe individuals who tend to use health services and include demographic characteristics, social structure, and health beliefs. Enabling factors are the means available to the individual for making use of the services. Need factors pertain to the health status or illness characteristics that constitute a threat to be addressed by the use of health services (Hartke, Prohaska, & Furner, 1998). Several recent studies of the predictors of assistive devices usage among elders suggest that the acceptance of assistive devices is a function of predisposing characteristics (age, gender, education), enabling factors (informal supports, formal services, income), and need (health status, number of mobility restrictions, or number of functional limitations). Need variables are consistently the most consistent predictors of the

use of assistive devices (De Klerk, Huijsman, & McDonnell, 1997; Hartke, Prohaske, & Furner, 1998; Zimmer & Chappell, 1994).

Zimmer and Chappell (1994) adapted the behavioral model to examine the characteristics associated with the use of mobility devices in older people age 65 and over. They found that the number of difficulties is the most important predictor of device use. Except for place of residence and age, the preposition and networking variables³ did not emerge as significant determinants of device use.

Hartke et al. (1998) analyzed national data to determine if selected demographic and health variables are associated with the use of assistive devices and need, based on the behavioral model. They identified the use of an assistive device, multiple-device use, and expressed need for the device as dependent variables. Selected demographic and health status characteristics were used as independent variables. As a result, they found age, sex, and race to be significantly associated with both device use and multiple-device use. For non-device-users, sex and education are significantly associated with expressed need. For device-users, marital status as well as race and income are significantly associated with expressed need. This implies that some association with age besides health status and frailty must be related to device use, for example, age-related attitude or self-perception.

Many other studies have reported barriers to the effective use of equipment. The most commonly reported reasons for not having or trying a device include lack of information, high cost, and the belief that a disability is not serious (National Academy on an Aging Society, 1999, cited in Gottlieb & Caro, 2000). Reasons for non-use or abandonment of equipment reported among elders discharged from rehabilitation hospitals include a preference for personal assistance, a feeling of embarrassment or stigma associated with equipment, and the denial of a disability. Other reported barriers are a lack of knowledge in how to use the device, poor fit between the device and the elder's home

³ The social network may act either enabling or need factor. Specifically social network factors include marital status, living with children, size and proximity of relations, satisfaction with contacts, and receipt of personal assistance (Zimmer & Chappell, 1994, p.190).

environment, or the experience that the item is too cumbersome or painful (Gitlin, 1995; Luborsky, 1993).

Seale, McCreadie, Turner-Smith, and Tinker (2002) employed a focus group methodology for exploring the extent to which older people themselves can identify and describe the nature of the indoor mobility-related problems that they encounter and put forward ideas for their resolution. They report that this methodology can help older people to identify and describe the nature of their mobility problems and that the results can be used as a basis for suggesting ideas for their resolution. The researchers, however, did not fully present the differences between the results of other experts' research, which employed different research methods, and this research, which employed focus group methodology.

Theoretical Background

Two theoretical backgrounds were employed in this research to investigate older people's attitudes toward residential technology: the person-environment interaction model (Lawton, 1989a, 1989b) and the diffusion of innovations theory (Rogers, 1995; Rogers & Shoemaker, 1971).

Person-Environment Interaction Models

Ecological Model of Aging (Lawton & Nahemow, 1973).

The recent emphasis on aging in place and the associated support of deinstitutionalization in North America is currently exhibiting a significant impact on housing policy and community service development targeted toward the elderly (Wister, 1989). The theoretical rationale underlying the current housing policy can be identified in an extensive body of literature found in environmental psychology. A series of models have been constructed that address person-environment transactions and the importance of balancing environmental demands with age-related individual competencies (Kahana, 1975; Lawton & Nahemow, 1973; Carp & Carp, 1984; Lawton, 1989a, 1989b).

In general, person-environment interaction models are used in understanding elderly people's housing adaptation behaviors in the aging process. Several leading perspectives stand out in the housing policy and social gerontological literature.

Person-environment interaction theories can be traced to the work of Lewin (1935, 1951) who argued that behavior could be viewed generally as a function of the interaction between people and their environment. More recently, researchers adopted the formula: $B = f(P, E, P \times E)$, where behavior (B) is a function (f) of person (P), environment (E), and the interaction between the two (P x E). Since the introduction of this conceptualization, researchers have attempted to demonstrate the various ways in which person-environment interaction occurs (Wister, 1989). The most influential of these theories in social gerontology and adjacent fields is Lawton's ecological model of aging that explains the impact of the environment on the aging process developed by Lawton and Nahemow (1973). The model explains individual behavior and well-being in terms of the dynamic balance between the demands imposed by the environment (press) and the individual's ability to cope with those demands (competence) (Wister, 1989).

The principal components of this model are individual competence and environmental press. Individual competence refers to the ability to respond adaptively in the areas of functional health, social roles, sensory-motor and perceptual functions, and cognition. Individual competence ranges from weak to strong. Environmental press is defined as the extent to which an environment demands a behavior response. Press can be found in the physical or social surroundings (Wister, 1989). Press is neutral, in that its positive or negative quality is defined by the interacting individual, rather than residing intrinsically in the environment (Lawton & Nahemow, 1973).

Until recently, there have been continuous attempts to clarify the interactions between older people and their environments based on P-E interaction models. In their research, *A Comparison of Four Person-Environment Fit Models Applied to Older Adults*, Cvitkovich & Wister (2001) state that following the research of P-E models incorporated into Lewin's theory, there are two basic approaches for understanding the interaction

between individual aging and situational environment: the competence approach (Lawton & Nahemow, 1973), and the P-E congruence approach (Kahana, 1982, Carp & Carp, 1984). Simply stated, the competence approach postulates that behavior is the result of how the individual's level of competence matches the demands of the environment, whereas the congruence approach contends that behavior is the result of how the environment meets the needs of the individual (Cvitkovich & Wister, 2001). They emphasize the attempt to clarify how older people make judgments about their environment based on complex subjective evaluations of their life situation.

Environmental Docility Hypothesis

A central hypothesis drawn from the original ecological model of aging is the environmental docility hypothesis. Lawton and Simon (1968) suggested the “environmental docility hypothesis” as a way to conceptualize differential changes in vulnerability.

This hypothesis indicates that individuals with high levels of competence can withstand greater levels of press, while those exhibiting low competence levels are more vulnerable to the demands imposed by the environment. Faced with increasing levels of press, individuals must either alter their competence or change their physical or social environment in order to mitigate reduced levels of well-being. Although rehabilitation of the mind/body or other means of improving competence may be a viable option, it is argued that environmental adaptations are easier, especially since the elderly tend to suffer from chronic conditions. Therefore, an implicit hypothesis is that the health status will be negatively associated with adaptation to the physical environment, which entails modification of environmental press or relocation (Wister, 1989).

Deficiencies in the Person-Environment (P-E) Models

Deficiencies in the Person-Environment (P-E) models have been identified. As Lawton (1980) recognized, the first problem is that each of these dimensions is really a large number of factors thrown together. Therefore, it is difficult to lump all of these

together and come up with meaningful “personal competence” level. Second, the importance of the category or categories of person or environment is likely to vary from time to time and situation to situation. And lastly, although many or all of the various factors that make up competence or demands may have effects pointing in the same direction at a given time, others are likely to be contradictory forces. Carp and Carp (1984) also indicates that the press-competence model has not adequately dealt with *people’s needs and preferences*, and that the environment is characterized by resources as well as demands. Kahana’s (1982) congruence model, based on Lawton’s model, also emphasizes individual needs and preferences. Kahana (1982) discusses the P-E model as follows:

The assumption being made in this instance is that not all areas of need are equally important. Thus, even large amounts of mismatch may be tolerable in areas that are less salient for the individual. However, match or mismatch is exceedingly important in salient areas.

(Kahana, 1982, p.114).

P-E models have, to a large extent, been used to solve community service delivery and housing problems by trying to create environments that “fit” objective levels of competence (Pollack & Newcomer, 1986). One of the consequences of this approach has been the adoption of an implicit assumption that there is an ideal environment for any given set of individual competencies. This has led to the omission of other factors, especially those that capture the active role that the individual assumes such as *attitudes, knowledge, preferences, and perceptions* (Wister, 1989). In response to this critique, Lawton (1989a, 1989b) revised the model. The critical distinction between the original model and the revised one are that (a) the environment is differentiated into resources and demands and (b) the stance of the person may be either passive or active (Lawton, 1989a).

Environmental Proactivity Hypothesis

As a companion to the environmental docility hypothesis, the environmental proactivity hypothesis states that the greater the competence of the person, the greater the number of environment resources that may be used in the pursuit of personal needs and wishes. Thus, a response may be prevented or shaped by environment demand, and conversely the person may shape his or her own environment in such a way as to afford a desired response (Lawton, 1989a).

Lawton concludes (1989a) that both docility and proactivity may lead to psychological well-being and in turn enhance personal competence. Only proactivity shapes the environment, however; thus proactivity, when exercised in a range that maintains at least a minimal level of congruence between person and environment, represents a unique pathway toward growth and the experience of positive affect. Regardless of the level of competence of the person, appropriately expensing the opportunities for choice and other forms of environmental flexibility is likely to give the older persons an increased chance to be behaviorally proactive and affectively self regulating and, therefore, to be most successful in enhancing positive affect (Lawton, 1989b).

Application of Person-Environment (P-E) Models

Filion, Wister, and Coblenz (1992) argue that the traditional home-institutionalization model was criticized for contributing to premature institutionalization and, therefore, for causing unnecessary loss of independence and a high cost to society. They offer an alternative to the traditional public sector approach to the housing needs of the elderly, which is simply two options: remaining in the home or institutionalizing as environmental competence declines over time (Filion, Wister, & Coblenz, 1992). They also argue this has been replaced with a new objective to allow the elderly the greatest possible autonomous fit for the longest period of time. They introduce an intermediary adaptation stage between fully independent living in the home and institutionalization. The

intermediary stage is meant to prevent undue dependence on services and to maintain as much autonomy as possible (Malozenoff, Anderson, & Rosenbaum, 1978, cited in Filion, Wister & Coblenz, 1992). They present three planning perspectives: (1) the continuum adjustment perspective; (2) the choice maximization perspective; and (3) the aging in place perspective. The aging in place perspective involves a constellation of support services designed to counteract a decline in environmental competence. The services required fall into three categories. First, there are health care services usually provided by visiting nurses. The second type of service includes personal services such as homemaker assistance. The third type of support concerns upkeep, repair, and adaptation of the shelter itself. They stressed that these perspectives can be distinct solely at a conceptual level, and mention that the three planning perspectives are consistent with Lawton's P-E interaction theory. In terms of Lawton's theory, contemporary planning approaches purport to prevent the occurrence of maladaptive behavior through environmental adjustments, specifically by changing the residence and/or by providing support services. In this way, older persons seek to maintain a moderately challenging environment in to order to avoid premature dependence (Filion, Wister, and Coblenz, 1992).

Theories of Diffusion of Innovations

A History of Diffusion Research

The origin of research on the diffusion of innovations can be traced from (1) the French sociologist Gabriel Tarde (1962), who pioneered in proposing both the S-shaped diffusion curve and the role of opinion leaders in the process of "imitation" and (2) the German-Austrian and British schools of diffusionism in anthropology soon after the time of Tarde in France. However, the revolutionary paradigm for diffusion research occurred in the early 1940s when two sociologists, Ryan and Gross (1943), published their seminal study of the diffusion of hybrid seed corn among Iowa farmers (Rogers, 1995). Diffusion research is a particular type of communication research, but it began outside the academic

field of communication. The diffusion research approach has since been taken up in a variety of fields: education; anthropology; medical sociology; marketing; geography; and most of all rural sociology. An important boost to the internationalization of the diffusion field was the rise of KAP surveys in developing countries during the 1960s. KAP studies are sample surveys of the knowledge (K), attitude (A), and practice (P) of family planning innovations. While many of the field experimental designs in the diffusion field were conducted in developing nations and were concerned with family innovations, a number of other field experiments were carried out in the United States by marketing researchers in the early 1960s. Unfortunately, a large proportion of these research reports are located only in the secret files of the sponsoring companies because of the threat of competition. They are, therefore, unavailable for academic synthesis and the subsequent progress of the scientific understanding of the diffusion process (Rogers, 1976). The most practical diffusion research is that of Rogers (1995) and Rogers and Shoemaker (1971), who collated and synthesized a body of knowledge in the field of diffusion research and proposed a generally applicable theoretical framework.

Elements of Diffusion

According to Rogers' definition (1995) in his book, *Diffusion of Innovations*, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding. Diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system. Innovation is an idea, or object that is perceived as new by an individual or other units of adoption.

The four main elements are innovation, communication channels, time, and the social system. In terms of time, Rogers and Shoemaker (1971) mentioned that "time dimension is involved (1) in the innovation-decision process by which an individual passes

from first knowledge of the innovation through its adoption or rejection, (2) in the innovativeness of the individual, that is, the relative earliness-lateness with which an individual adopts an innovation when compared with other members of his social system, and (3) in the innovation's rate of adoption in a social system, usually measured as the numbers of the system that adopt the innovation in a given time period" (pp.24-25).

Rogers (1995) and Rogers and Shoemaker (1971) identified the attributes of innovations that help to explain individuals' different rates of adoption: 1) relative advantage; 2) compatibility; 3) complexity; 4) trialability; and 5) observability. A sixth attribute, perceived risk, was conceptualized by Bauer (cited in Ostlund, 1974). Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be. Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and the needs of potential adopters. Meaning that ideas that are incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. Complexity is the degree to which an innovation is perceived as being difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and increased levels of understanding. Trialability is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on the installment plan will generally be adopted more quickly than innovations that are not divisible. Observability is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it (Rogers, 1995).

The Diffusion Process

Rogers (1995) defined the innovation-decision process as the process through which an individual (or other decision-making unit) passes (1) from first obtaining knowledge of the innovation, (2) to forming an attitude toward the innovation, (3) to making a decision to

adopt or reject, (4) to implementing the new idea, and (5) to confirming this decision. This behavior essentially consists of dealing with uncertainty. Rogers (1995) emphasized that the diffusion of an innovation is an uncertainty-reduction process. Individual's decision about the innovation is not an instant act, rather it is a process that occurs over time. Rogers presents model of the innovation-decision process. This conceptualization consists of five stages:

1. *Knowledge* occurs when an individual is exposed to an innovation's existence and gains some understanding of how it functions.
2. *Persuasion* occurs when an individual forms a favorable or unfavorable attitude toward the innovation.
3. *Decision* occurs when an individual engages in activities that lead to a choice to adopt or reject the innovation.
4. *Implementation* occurs when an individual puts an innovation into use.
5. *Confirmation* occurs when an individual seeks reinforcement of an innovation-decision already made, or reverses a previous decision to adopt or reject the innovation if exposed to conflicting message about this innovation.

(Rogers, 1995, p.162)

Rogers (1995) states that each stage in innovation-decision process is a potential rejection point. He mentions rejection may occur in two forms. Two different types of rejection are: 1) active rejection, which consists of considering adoption of the innovation (including even its trial) but then deciding not to adopt it; 2) passive rejection (also called nonadoption), which consists of never really considering the use of the innovation.

Innovativeness and Measuring Innovativeness

The concept of innovativeness can be considered at several levels. Rogers and Shoemaker (1971) defined innovativeness as "the degree to which an individual is relatively earlier in adopting new ideas than other members of his system" with a footnote about "relatively early." The footnote states that "relatively early" means earlier in terms of actual time of adoption, rather than whether the individual *perceives* that he adopted the

innovation relatively earlier than others in his system did (p.27). Midgley and Dowling (1978) mentioned that this definition is essentially operational since it is directly implied in terms of the measurement of innovations. They expressed the notion that innovativeness is “the degree to which an individual is receptive to new ideas and makes innovation decisions independently of the communicated experiences of others (p.236)”. Labay and Kinnar (1981) also mentioned that Rogers and Showmaker’s definition is an operational and behaviorally observable measure of the hypothetical trait, innate innovativeness. Hirschman (1980) stated that the definition of Midgley and Dowling views innovativeness as a personality construct possessed to a greater or lesser degree by all individuals. It is believed to be a continuous variable, normally distributed within a population of consumers and generalizable across products. Hirschman pointed out they did not discuss why some individuals exhibited more innovativeness than others.

There are essentially four measures of innovativeness that have been developed for locating innovators and later adopters. These are: 1) ratings by judges or sociometric choices; 2) self-designated measures; 3) longitudinal measures; and 4) cross-sectional measures (Robertson, 1971). By and large, researchers in the marketing area have used two main techniques, either a variant of the time of adoption method or the cross-sectional method (Midgley & Dowling, 1978).

Leavitt and Walton (1974) reported the commonalties found in diffusion marketing research methodologies as the following: (1) the dependent variable, adoption, is operationalized by the researcher; (2) an expedient assortment of independent variables is specified; and (3) correlation or regression analysis is used to measure the degree or strength of the relationship between a variety of independent variables and the dependent variables.

They pointed out that the results from this paradigm have not been encouraging. Indeed, the typical finding has been that only a small amount of variance in the dependent variable is explained by a variety of demographic and personality variables used as predictors. According to their view, one of the determinants of time-of-adoption may be the

individual's standing on some broad personality trait. Leavitt and Walton utilized psychometric methodology to construct a scale to measure innovativeness, a trait postulated as underlying adoption behavior. The results of these tests show that this scale is reliable and valid for measuring an individual's level of innovativeness.

Price and Ridgway (1982) developed a scale to measure use innovativeness that incorporates one type of exploratory consumer behavior. Exploratory behavior in the consumer context can be divided into three main types: (1) exploratory purchase behavior; (2) vicarious exploratory behavior; and (3) use innovativeness. According to Price and Ridgway, use innovativeness is expected to be composed of at least five factors: (1) creativity and curiosity; (2) voluntary simplicity; (3) risk preferences; (4) creative re-use; and (5) multiple use potential. They used 44 items to develop a measure of use innovativeness. This scale was tested to measure use innovativeness behavior with regard to a hand calculator. The test results indicated that the group scoring highest in the use innovativeness scale engaged in significantly more innovative behavior with a hand calculator than the other groups did. They mentioned that the multiple use potential factors were not measured very well. In addition, they felt that it was possible that one general factor and several second-order factors exist. These second-order factors may be the two levels of use innovativeness: multiple use potential and creative re-use.

These scales to measure innovativeness have been modified to measure innovativeness in the housing field. Gruber, Beamish, Carter, Shelton, and Webber (1990) developed an innovativeness scale of housing innovations based on existing scales. Items were selected from two scales designed to measure different aspects of innovativeness: trait innovativeness (Leavitt & Walton, 1974) and use innovativeness (Price & Ridgway, 1982). Items were reworded to reflect a housing orientation.

Adopter Categories

Adopter categories are the classification of members of a social system on the basis of innovativeness. The traditionally accepted five-adopter categories are: (1) innovators, (2)

early adopters, (3) early majority, (4) late majority, and (5) laggards. Rogers and Shoemaker (1971) emphasized that the measure of innovativeness and the classification of the system's members into adopter categories are based upon the relative time at which an innovation is adopted. Rogers (1995) stated that past research shows many important differences between earlier and later adopters of innovations in (1) socioeconomic status, (2) personality variables, and (3) communication behavior. They said "the distinctive characteristics of the five-adopter categories mean these adopter categories can be used for segmentation of adopters (p.280)." However, one problem that continues to vex consumer researchers is their inability to characterize innovators by means of any sociological, psychological, or demographic variables (Taylor, 1977).

Communication behavior varies according to the diffusion process. Beal and Rogers (1957) found that formal mass media communications are of predominant importance during the awareness and interest stages, while informal word-of-mouth communication is more influential during the later evaluation and trial stages of the adoption process (cited in Berning & Jacoby, 1974). However, in terms of communication behaviors according to categories of adopters, the results of research are very contradictory. While some studies show that innovators engage in more word-of-mouth communication than non-innovators do, there is other evidence which shows that later adopters seek information from personal sources more than early adopters do. Yet other data indicate virtually no difference in the use of personal sources by early vs. later adopters (Berning & Jacoby, 1974).

Donnelly and Ivancevich (1974) conducted a longitudinal study to identify the innovator characteristics of those purchasing a brand new car. Researchers selected one behavioral characteristic and social character. These people can be grouped into three types: traditional-directed; inner-directed; or other-directed. Persons who are tradition-directed guide themselves by membership in a particular class; inner-directed persons rely on their own internal standards and values to guide their behavior; other-directed persons tend to rely on the values of their contemporaries. The results of their study show that the social character of initial purchasers of brand new models differed significantly (more inner-

directed) from the social character of initial purchasers of new models of similar established brands for the comparable time period. However, as the brand new model becomes more widely accepted there were no significant differences between the two groups. Researchers mentioned it should be shown that initial buyers differ from later buyers of new products and, in the case of new brands, with buyers of similar established brands.

Jacoby (1971) used the personality attribute dogmatism in predicting innovation proneness. As the researcher predicted, the results showed that individuals that were less dogmatic tended to make significantly more innovative selections than individuals that were highly dogmatic. However, the relationship did not appear to be exceptionally strong. Jacoby argued that the notion of practical significance is more important for participants than either the statistical significance or even the size of the relationship.

Types of Diffusion Research

Rogers (1995) identified eight different types of diffusion research in his book, *Diffusion of Innovations*. These are as follows: 1) the earliness of knowing about innovations; 2) the rate of adoption of different innovations in a social system; 3) innovativeness; 4) opinion leadership; 5) diffusion networks; 6) the rate of adoption in different social systems; 7) communication channel use; and 8) the consequences of innovation. According to Rogers, more than half of all the empirical generalizations reported in diffusion publications deal with innovativeness. The major concern of many studies has been the identification of correlations in observed innovativeness including demographic and psychographic factors, social interaction, and consumption patterns (Robertson, 1971).

According to Rogers and Shoemaker (1971), 3,974 of 6,811 studies collected by the Michigan State University Diffusion Documents Center have focused on the “innovativeness of members of a social system” as predicted by “characteristics of members, system norms and other system variables, plus communication channel usage.” In contrast, only 82 of the 6,811 studies related such perceived innovation attributes to the

rate of adoption for the innovations. Ostlund (1974) argued that diffusion researchers have devoted a disproportional amount of effort to only one type of research. Their knowledge of how perceived innovation attributes affect the rate of adoption is, by comparison, minimal. Ostlund (1974) also pointed out that apparently not one study has gone beyond using the rate of adoption as the dependent variable to predict *who* would or would not adopt the innovation, that is, the innovativeness of individuals. He mentioned that this kind of research is not included in the typology of diffusion research of Rogers (1995) and Rogers and Shoemaker (1971). In addition, Ostlund (1974) conducted two studies of new customer package goods. The evidence from these two studies suggests that the perception of innovation by potential adopters can be a very effective predictor of innovativeness – more so than personal characteristic variables can. The relationships between the attributes perceptions and innovative behavior were generally positive, with the exception of perceived risk and complexity. This research can be considered a new direction in identifying innovators (Taylor, 1977).

A study conducted by Labay and Kinnear (1981) of the consumer decision process in the adoption of solar energy systems among 631 respondents in Maine shows a similar result. Findings revealed that attribute perception data afford somewhat greater classification ability than demographic data. There are many similarities between adopters and knowledgeable non-adopters over many measures. Researchers concluded that when there are two groups of individuals with apparently similar perceptual beliefs regarding solar-energy systems, yet one group adopts and the other does not, the reason why may be partially explained by differences in the specific products and economic factor ratings.

Conceptual/Methodological Biases in Diffusion Research

Rogers (1976) mentioned three important conceptual/methodological biases in diffusion research: 1) lack of a process; 2) a pro-innovation bias; and 3) a psychological orientation, leading to shortcomings in the structure. First, Rogers pointed out that although the concept of communication is a process, very little communication research includes

data at more than one observation point. Therefore, almost all communication research is unable to trace the change in a variable over time; it deals only with the present tense of behavior. These designs consist mainly of correlation analyses of cross-sectional data gathered in one-shot surveys of respondents. Diffusion research has mainly relied on the respondents' ability to recall their date of awareness or adoption of a new idea. This retrospection ability is not very accurate and undoubtedly varies on the basis of: (1) the innovation's salience to the respondents; (2) the length of time over which the recall is requested; and 3) individual differences in education, mental ability, etc. The second bias found in most diffusion research is an inherent pro-change bias, which assumes that innovation "good" and should be adopted by everyone. Rogers indicated that the pro-innovation bias means that diffusion research has mostly studied "what is" instead of "what could be" about the diffusion processes. Therefore, the methods have followed the assumption that innovation is good and that the present process of diffusion is satisfactory and only needs a minor tune-up rather than a major overhaul. In the past, this bias has often led to avoiding or ignoring the issue of causality. In terms of psychological bias, Rogers mentioned that it stems from (1) its historical roots in academia and (2) the researcher's acceptance of how social problems are defined. The monadic view of human behavior is that "the kinds of substantive problems on which such research focused tended to be problems of 'aggregate psychology,' that is, *within* individual problems, and never problems concerned with relations between people" (Coleman, 1958-59, cited in Rogers, 1976, p.296). The main focus in diffusion research on the individual as the unit of analysis has only recently shifted to the dyad, clique, network, or system of individuals, centering on the communication relationships between individuals rather than on the individuals themselves. The second reason for the psychological bias in communication research is the acceptance of a *person-blame-causal-attribution* definition of the social problems that researchers study. Rogers mentioned that this tendency toward stressing individual blame rather than system-blame is very common in communication research.

Housing Research in the Field of Diffusion Research

Although the diffusion of innovations research framework has been applied in many other academic fields, there have not been many studies in the housing area. Diffusion research in the housing field seems to be largely divided into two areas: perceptions and acceptance of (1) energy efficient housing alternatives (Beamish, Sweaney, Tremblay, and Bugg, 1987; Beamish & Johnson, 1994; Dagwell, 1983; Hanzal-Kashi & Combs, 1987; Weber et al., 1985) and (2) housing options for the elderly (Beamish & Johnson, 1994; Gruber, et al., 1990; Johnson & Beamish, 1994; Kwon, 1991; Till, 1988). Research relating to energy efficient housing mainly emerged in 1980s as a result of the rapidly increasing energy prices and adverse economic conditions throughout the United States during the 1970s and early 1980s. In the 1990s, housing issues for an aging population fueled research relating to housing options for the elderly.

Energy Efficient Housing Alternatives as Innovations

In research relating to energy efficient housing, energy efficient housing alternatives are considered to be innovations. This research focused on investigating individuals' adoption of and the diffusion of energy efficient housing types. Dagwell (1983) conducted research to examine factors influencing the decision as to whether or not to adopt innovative housing types (passive solar, active solar, and earth sheltered/underground dwellings). The researcher examined three factors: demographics, energy, and local regulatory codes for buildings. The finding showed that there are some significant differences for items such as age and education between probable adopters and probable non-adopters. Probable adopters were usually younger, had more education, were in the earlier stages of the family life cycle, believed in the energy crisis, believed the energy situation had impacted housing decisions, had attempted to reduce utility costs, and lived in a house with more energy-conserving features than probable non-adopters.

Beamish et al. (1987) examined how the perceptions of passive solar, active solar, and earth-sheltered housing alternatives may influence actual adoption of these housing types using four of the six innovation attributes developed by Rogers and Shoemaker (1971). Observability and trialability were not used because none of the housing features could be categorized into these two dimensions. Researchers investigated and compared the positive and negative perceptions of these three housing alternatives as reported by southern householders *who would* and *would not consider living* in the three housing types. They found that passive solar and active solar housing were considered to be somewhat acceptable, but that earth-sheltered housing was considered to be unacceptable to a majority of respondents. An analysis of the results suggests that design/appearance is a major factor in consumer acceptability, and that the high number of “uncertain/don’t know” and “nothing” responses indicate a lack of understanding of the housing alternatives. They mentioned that the lack of knowledge regarding the benefits and problems of these housing alternatives might have been a negative impact on the acceptability of these housing types. This implication can be supported by research examining the importance of the knowledge stage in adopting new energy efficient housing alternatives (Weber et al., 1987).

Weber, McCray, and Claypool (1987) developed a knowledge index for four specific energy efficient housing options (passive solar, active solar, earth sheltered, and retrofitted) to validate that knowledge indices may be convincing indicators in predicting consumers’ adoption of energy efficient housing alternatives. The findings indicate that the knowledge indices are valid in predicting the acceptance of innovative housing alternatives.

Ha and Weber (1991) developed a model to study the acceptance of innovative housing (solar house and earth-sheltered house). They used innovativeness, knowledge, attitude, and willingness to adopt as dependent variables, and household socio-demographic characteristics and the community’s housing market conditions as independent variables for LISREL (LInear Structural RELations) analysis and factor analysis. The findings indicate that the respondent’s sex, age, and education are significant factors in the decision to

choose innovative housing. The findings also show that there are significant relationships among willingness and innovativeness, knowledge, and attitude.

Hanzal-Kashi and Combs (1987) investigated loan officers' perceptions of earth-sheltered housing. One finding was that perceptions of financial risk, complexity, and relative advantage differ between those loan officers who favored financing this type of housing and those who did not favor financing of this housing type. As a result of each simple regression analysis, 62% of the variation in the area of favorability toward financing can be explained by financial risk, 60% of the variation can be explained by complexity, and 57 % of the variation can be explained by relative advantage.

Housing Options for the Elderly as Innovations

Research considering housing options as innovations for elderly people has focused on developing housing innovativeness scales, applying these scales, and investigating innovativeness attributes such as perceptions, acceptance, or the prediction of actual adoptions. Gruber et al. (1990) developed an innovativeness scale of housing innovations based on existing scales measuring personal innovativeness. Items were selected from two scales designed to measure different aspects of innovativeness: use innovativeness (Price & Ridgway, 1982) and trait innovativeness (Leavitt & Walton, 1974) (Gruber et al., 1990). Twenty-six items were used. After a factor analysis, six factors emerged: 1) new housing types; 2) repairing and fixing things; 3) chance taking/experimentation; 4) housing design and ideas; 5) improvement and utility; and 6) appearance versus comfort. Researchers compared innovative measures with selective respondent characteristics. The results of the comparisons of both household and intermediary samples show that there are relationships between specific subscales and age, sex, education, and income for both samples.

Till (1988) used housing innovativeness scales in a thesis with households and intermediaries in Alabama, a sub-sample of the study by Gruber et al.(1990). Her sample was not limited to the elderly population. The result of a factor analysis with the same 26 items identified five factors for each data set: 1) traditional orientation; 2) craftsmanship; 3)

active innovativeness; 4) passive innovativeness; and 5) semi-active innovativeness. Till (1988) found that active innovativeness, traditional orientation, and craftsmanship were related to specific characteristics such as marital status, homeownership, housing types, age, education, and income.

Kwon (1991) used housing innovativeness scales with people age 55 and over, a sub-sample of the study by Gruber et al. (1990), in her dissertation as well. The researcher identified six innovativeness factors after conducting a factor analysis: 1) new housing types; 2) repairing and fixing things; 3) experimentation and new design/ideas; 4) improvement and utility; 5) appearance versus comfort; and 6) risk taking. Although her sample was limited to an older population, this research shows that four of the six factors she identified are the same as the factors identified by Gruber et al. (1990). She found that age was related to the following factors: experimentation and new design/ideas; new housing types; repairing and fixing things; and appearance versus comfort. The younger population scored higher on these factors than the older population did. This result is consistent with that of the Johnson and Beamish (1994) research.

Johnson and Beamish (1994) pointed out that some factors developed by Gruber et al. (1990), such as repairing and fixing things and improvement and utility, did not directly address innovativeness. Thus, in their follow up research (1994), they used modified scales developed by Gruber et al. containing 16 items to examine housing innovativeness among elderly females. After a factor analysis, three factors were identified: 1) acceptance of new housing types; 2) willingness to take a chance; and 3) acceptance of new ideas. Their study identified clear relationships between selected demographic characteristics of elderly women such as income, education, and marital status and their innovativeness—that is their acceptance or willingness to adopt specific housing options.

Beamish and Johnson (1994) investigated predictors of new housing adoption using the same sample as the previously mentioned study. The researchers categorized respondents as being in one of four stages in the adoption process (awareness, interest, evaluation, and adoption). Each level, assigned by scores, was used as a dependent variable.

Demographic characteristics (age, education, income, marital status, employment, sex, race, tenure, and housing types) and innovativeness factors (acceptance of new housing types, willingness of take a chance, and acceptance of new ideas) were used as independent variables. After a regression analysis, education, age, income, and willingness to take a chance emerged as significant predictors of housing adoption ($R^2 = 0.16$). However, although this result cannot be generalized, their research consistently showed selected demographic factors and innovativeness are important factors in predicting adoption of new housing styles.

Online Surveys

According to Dillman (2000), the most significant advances in survey methodology during the twentieth century were the introduction of random sampling in the 1940s and telephone interviewing in the 1970s. However, researchers today are experiencing similar important advances in the field of survey methodology, with the introduction of technology-based survey technique such as the Internet, voice recognition system, and fax surveys (Cobanoglu, Warde, & Moreo, 2001). Especially with the rapid growth of Internet and e-mail users, online surveys are more often used as a data collection method. Although researchers extensively use online surveys as a data collection method, there has been relatively limited published research on the specifics of this methodology (Cobanoglu & Cobanoglu, 2003).

The majority of survey methodology researchers focus on the differences between mail and e-mail surveys such as response rate, response speed, and response quality (Sheehan & McMillan, 1999). Response rate is defined as the number of usable questionnaires returned as a percentage of the total number of questionnaires sent, response speed is defined as the time lag between return time and the mailing or e-mailing time of a usable questionnaires, and response quality is defined as the mean number of questions unanswered (Tse, 1998).

With the growing popularity of the Internet, online surveys will become more commonplace, and there are various ways to conduct them. Dommeyer and Moriarty (2000) summarize various ways to conduct online surveys. The simplest method is that the researcher embeds the questionnaire in an e-mail. Another way of conducting an online survey is to send the questionnaire as an attachment in an e-mail. A third way to conduct an online survey is to send an e-mail with an attachment that contains a survey program. The fourth method is to use a web-based survey. With this method, e-mails are typically sent to potential respondents, inviting them to go to a web address and to complete the questionnaire there. Each method has its limitations and advantages. There has been little research about differences between these different methods. Dommeyer and Moriarty (2000) did experiment research that compares an embedded e-mail survey with an attached e-mail survey. Results show that there was significantly higher response rate of the embedded survey (38%) than the attached survey (8%), but there were no significant differences between the two forms of the e-mail surveys on response speed and number of item omissions. Researchers concluded the reasons the embedded survey yielded a higher response rate is simple: the attached e-mail presents many obstacles to the potential respondents such as ability to download and upload, equipment to run the program, the knowledge of how to execute the various response steps, and so on.

Advantages and Disadvantages of Online Surveys

Many survey researchers agreed that the biggest advantages of online surveys compared with traditional mail and fax surveys are low cost, speed, and efficiency (Cobanoglu & Cobanoglu, 2003; Cobanoglu, et al., 2001; Dillman, 1999; Ilieva, et al., 2002; Sheehan & McMillan, 1999; Tse, 1998). The online survey eliminates mailing costs for questionnaires, saves time to handle questionnaires in sending and receiving, and reduces the cost of coding data (Cobanoglu, et al., 2001).

The major problem with an online survey is external validity (Dillman, 2000). This is mainly because an online survey is not conducted based on probability sampling. Many survey researchers agreed that the credibility of the results towards a national population is low. Indeed, population and sampling frames for online surveys are confined to only those members of a national population who are connected to the Internet. Online surveys can be used for data collection and generate externally valid results for a specific population provided that (1) a central register of that research population exists and (2) that all members of this population can respond through the online method (Schillewaert, Langerak, & Duhamel, 1998).

The summary of the specifications based on existing research is shown in Table 4.

Table 4

Specifications of Online Surveys

Specifications of online surveys	
Advantages	<ul style="list-style-type: none"> • Low financial resources <ul style="list-style-type: none"> ○ No cost for each survey (no postage and printing costs) except Internet connection charge ○ No return cost to the respondents • Speed of data collection <ul style="list-style-type: none"> • Short time to send and receive • Low labor needed <ul style="list-style-type: none"> • Save time sending questionnaires • Save time coding survey data • Environmentally friendly • Irrespective of geographical location • Instant access to a wide audience
Disadvantages	<ul style="list-style-type: none"> • Low coverage • Higher fixed cost (computer, software, and Internet connection fee) • High chance of delivering wrong addresses • No anonymity • Sensitive timing of a survey • Vulnerability of computer-based problems (computer virus, out of date software, etc.)

Taylor (2000) declares an online survey is fundamentally different in several important ways. These are:

- It is not based on probability sampling but on volunteer sampling or convenience sampling.
- It is a visual medium.
- It captures the unedited voice of the respondent.
- It may be more effective in addressing sensitive issues.
- Scales may elicit different response patterns.
- It may generate more “don’t know or not sure” answers.
- Raw online data substantially under-represent some groups- hence the greater importance of weighting than with good in-person or telephone surveys.

(Taylor, 2000, pp.53-54)

He considers online as a more innovative method. He suggests that online surveys fundamentally change the way we design questionnaires and think about how to collect and analyze data. Ilieva and her colleagues (2002) also argue “online surveys are more a new mode of data collection than a new data collection method” (p.368).

Cobanoglu and Cobanoglu (2003) pointed out some potential problems with online surveys in their research as to the effect of incentives in web surveys, such as multiple responses from the same participant to increase their chances to win a prize. Ilieva and her colleague (2002) agree that incentives may have a negative impact on data quality as respondents can be tempted to distort data by entering the survey several times.

Cobanoglu and Cobanoglu’s (2003) findings recommend that researchers use incentives when conducting online surveys to achieve higher response rates. However, the results show that offering a prize has no significant effect on the respondents. Researchers recommend that researchers offer a small prize to all respondents but also entering them into a draw for a bigger prize in order to get higher response rates.

Comley’s (2000) findings, however, show that incentives have little impact on response rate in online surveys. It does not present what incentives were provided.

Comparisons of Online Surveys with Mail Surveys

The majority of research about online survey methodology focuses on the comparison of mail surveys with e-mail surveys. Most research considers response rate, response speed, and response quality as comparison factors between online and mail surveys.

Cobanoglu and Cobanoglu (2003), however, indicate that the analysis of past research on the use of the Internet as a survey tool has shown that there is a wide variation in consequence such as response rates, speed, and response quality. Since the number of studies using these methodologies is limited and the populations and research topics they use are different, they may not give researchers a clear idea on the effects of Internet-based surveys. However, it is true that many researchers attempt to use innovative data collection method in order to increase response rates, because high response rates in questionnaires generally increase the confidence that the sample actually reflects the true population. Unreturned questionnaires or incomplete data pose a threat to the validity of findings (Sheehan & McMillan, 1999).

Response Rate

Comely (2000) summarizes the response rates of all online surveys in 1999, and most were in the range 15% to 29% (real range is 9% to 48%), with the average 24%. On the other hand, a report on online surveys by Cobanoglu and his colleagues (2001) shows that the response rate to e-mail responses varies between 19% and 75%. One research study conducted outside United States (Tse, et al., 1998) shows the response rate is under 10%. A summary of survey research methods using mail and online surveys from the research that compared results from e-mail, mail, and fax (Cobanoglu, et al., 2001) shows that there is no consistent results as to response rates (see Table 5). Ilieva et al. (2002) reported the average response rate and response time of online surveys and mail surveys based on past

research on online surveys. The e-mail average response rate and time are 38.72% and 5.59 days, and mail average response rate and response time are 46.16% and 12.21 days.

Table 5

Response Time and Response Rate: E-mail versus Mail survey

Authors	Technique	Response time (days)	Response rate (%)
Parker (1992)	E-mail	N/A	68
	Mail		38
Schuldt & Totten (1994)	E-mail	N/A	19.3
	Mail		56.5
Bachman et al. (1996)	E-mail	4.68	52.5
	Mail	11.18	65.6
Weible & Wallace (1998)	E-mail	6.1	29.8
	Mail	12.9	35.7
Schaefer & Dillman (1998)	E-mail	9.16	58.0
	Mail	14.39	57.5
Wygant & Lindorf (1999)	E-mail	2	50
	Mail	9.16	32
Ranchhod & Zhou (2001)	E-mail	N/A	6
	Mail		20

Source: Modified from Ilieva et al. (2002, p.367).

Response Time

Thirty four percent of online surveys took under two weeks, 33% between two weeks and one month and 33% longer than one month. The response time for online surveys (average response time 5.59 days) is shorter than the time necessary for mail surveys (average response time 12.21 days) (Ilieva et al., 2002). Researchers mention that the possible reason for delayed responses may be the timing of a survey. The response time of online surveys can be controlled by researchers, that is it depends on the length of time the survey is posted on the web.

Quality of Data

Ilieva et al. (2002) mention that it is not clear whether people react differently to e-mail and mail surveys. However, according to Schaefer and Dillman's (1998) research, there is different reaction about the open-ended questions. E-mail participants provided answers to the open-ended questions with 40 words on average, whereas the mail respondents' answers were briefer, with ten words on average.

Future Challenge of Online Surveys

Dommeyer and Moriarty (2000) discuss many areas of online surveying remaining to be investigated. These issues are to determine how e-mail can be used in conjunction with other survey media to overcome the coverage problems of online sampling frames and whether online surveys can benefit from personalization techniques, postpaid incentives, or the offering of survey results to respondents. Fundamentally, future studies should be aimed at developing a comprehensive framework for describing when to use and when not to use the various sampling methods for online surveys (Schillewaert, et al., 1998).

Summary

Older Americans compose one of the largest and fastest growing population sectors. Most of them report that they want to stay in their current homes as long as possible. The reasons why older adults prefer to grow old in their current homes are various: health status; economics; familiarity; comfort; meaning associated with their homes; independence; control; and benefits associated with remaining in a familiar neighborhood and community. However, the quality of housing occupied by older people has become a complicated issue because housing conditions for the elderly seem to be a big impediment to aging in place. Besides housing conditions, there are various factors influencing older adults' decision to stay in their current residence, such as community/ neighborhood quality,

health status, marriage status, climate, distance from other family members, or economic conditions.

Home modifications and repairs have been emerging issues relating to aging in place. Many older people report their home modifications or repairs as one of the ways to get a safer place and live with more independence and convenience. Many studies suggest that aging in place strategies such as home modifications require a wide array of human, financial, and home maintenance and modification services to enable older residents to meet their needs.

As the impact of technology on daily life becomes huge, the relationship between users, especially households, and technology has been focused on as a research issue. There have been many new theories and modified theories to understand and explain this relationship. However, until now there has not been much research about technology and the older people as users. In this study, the diffusion of innovations theory and person-environment interaction theory were applied to investigate the older people's usage of technology as a theoretical background.

Although online surveys have disadvantages, with the rapid growth of Internet and e-mail users, online surveys have become more commonplace as a data collection method. The major problem with using an online survey is that of external validity. This is mainly because online surveys are not conducted based on probability sampling. Many survey researchers agree that online survey results are not generalizable to the national population. Challenging issues of online surveys are to determine how e-mail can be used in conjunction with other survey methods to overcome the coverage problems of the online sampling frame and whether online surveys can benefit from personalization techniques, postpaid incentives, or the offering of survey results to respondents.

CHAPTER 3. METHODOLOGY

The major purpose of this study was to investigate older people's attitudes toward adopting technology related to homes that could improve the resident's quality of life and assist in aging in place. This study was divided into two parts: 1) an investigation of perceptions and behaviors of older people who want to age in place, and 2) an examination of attitudes toward residential technology.

Description of the Sample

The population for this study was people age 55 years and older who have Internet access. The sample was a convenience sample selected from members of the Virginia Tech Alumni Association who have e-mail addresses listed. The number of living alumni is almost 160,000 (Virginia Tech Alumni Association, 2004). The number of the potential sample for this study, those 55 and older with an e-mail address listed with the Alumni Association, was 9,789.

Data Collection

A web-based survey, conducted over the Internet, was employed in this research. Data were collected through electronic questionnaires developed as a web-based questionnaire and delivered via e-mail addresses.

Electronic survey methods such as surveys through e-mails and the web have emerged as innovative survey techniques. These survey methods have both advantages and disadvantages as compared with existing survey techniques. One of the greatest advantages of this method is cost reduction, which includes elimination of paper, postage, mail-out, and data entry costs (Dillman, 2000). Although the number of computer users is rapidly increasing, e-mail and web surveying of the general public is currently inadequate as a

means of accessing random samples of defined populations of households and/ or individuals. An additional problem is the possible disparity between what the designer and respondent see because of different operating systems, browsers, and screen configurations (Dillman, 2000).

An online questionnaire was linked into an introductory e-mail that was directly delivered to respondents by the Virginia Tech Alumni Association. By clicking the website, respondents could access the survey website and by clicking a submit button, the questionnaire was submitted. Online questionnaires were distributed on February 3, 2004 and respondents were asked to submit their response by February 27, 2004.

Description of the Instrument

Based on existing research, an instrument was developed. After a pre-study and a pilot study, the survey instrument was revised in terms of grouping questions, adding answering options, re-categorizing answering options, and so forth. The most important feedback from these pilot studies was about the format of the introductory e-mail and the online questionnaire. As expected, there were disparities between what the author designed and what respondents saw on their monitors. This disparity was corrected by using different computer operating systems.

The survey instrument was composed of four major parts: (a) housing (questions 1 through 6); (b) aging in place and home modifications (questions 7 through 16); (c) attitudes toward residential technology (questions 17 through 28); and (d) demographic characteristics (questions 29-38). Finally one question about the online survey experience was included (question 39) (see Appendix C). The specific questions were:

Housing: This section of the questionnaire was developed to investigate general housing conditions. It includes housing type, tenure type, length of residence, age of building, and location.

Aging in place and home modifications: The questions about aging in place and home modifications were composed of perceptions and behaviors related to aging in place and behaviors related to home modifications. These questions were developed to determine attitudes toward aging in place, and barriers and constraints to aging in place.

Attitudes toward residential technology: To investigate older people's perceptions and acceptance of residential technologies, two additional categories of questions were developed. The first group of questions addressed attitudes toward residential technology. Acceptance was measured by respondents' indication of the innovation decision process: 1) not familiar with; 2) have heard/ seen/ read; 3) have been interested in/ tried to look for information; 4) have considered purchasing, and 5) have purchased. Additionally a sixth alternative, "purchased, but do not use or rarely use" was added to determine if all those who purchased new technology actually used it. The second group of questions was developed to investigate older people's computer usage. The questions related to familiarity with the computer, familiarity with the Internet, and the subject's main purpose for using computers and the Internet. Perception was measured from the combination of familiarity with residential technology, computers, and the Internet.

Demographic characteristics: The last part of this questionnaire was composed of general demographic questions. It included gender, age, number of household members, employment status, self-reported health conditions, marital status, educational level, race, and income.

Pilot Study

Before conducting a pilot study, a pre-test with two conveniently selected respondents was conducted in late September 2003. The survey instrument was revised based on the results of this pre-study in terms of grouping questions, adding answering options, and so forth.

A pilot study was conducted to verify the contents and design of the survey instrument in early October 2004. Eight questionnaires were delivered via e-mail addresses by the researcher. After one week, six surveys were returned. Respondents were asked about their experiences, such as difficulties in completing the survey. Specifically, they were asked about: 1) time to complete the survey; 2) understanding of terms used in the survey; 3) problems with opening files and accessing online surveys according to their computer type (e.g. PC, Macintosh, etc.); and 4) operating systems (e.g. Windows 95, Windows 98, Windows 2000, etc.).

Survey Procedure

Online questionnaires were distributed in February 2004 and respondents were asked to submit their responses by February 17, 2004, if they wanted to participate in a drawing for a gift. The final closing date for survey acceptance was February 27, 2004. Questionnaires were distributed to the potential sample of 9,789 e-mail addresses by the Virginia Tech Alumni Association. Questionnaires were not directly distributed by the researcher, but through the alumni list serve. This idea was suggested by the alumni association in order to protect e-mail addresses of the alumni and to encourage participation. However, the impact of this procedure cannot be measured.

Twenty-seven questionnaires were eliminated, because twenty respondents lived in assisted living facilities and seven were under 55 years of age. The response rate was 15.8% with 1,546 eligible returned responses. On the first and second days, 670 and 365 responses were returned, respectively. Responses during the first two days constituted almost 70% of the total responses. The response pattern by date is shown in Figure 3.

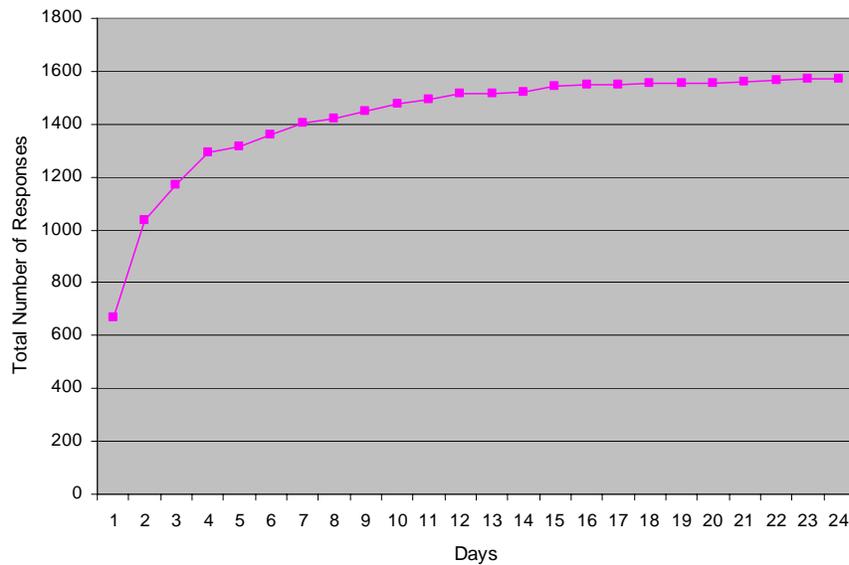


Figure 4. Response Rate.

The response rate was 15.8%. Although lower than some mail surveys, it is hard to say this response rate was due only to the online data collection method. Other factors might include the high education level of respondents, the predominance of male respondents, and the large number of e-mails that many of the sample receive on a daily basis. Additionally, there was no follow-up e-mail reminding them to complete the survey.

As an incentive, a drawing for a gift certificate for those who entered their e-mail addresses at the end of the survey was announced in the introduction letter. Eighty-four percent of the respondents (1,304) entered their e-mail addresses by the date required to be entered in the drawing. Four respondents were randomly selected under the supervision of the researcher’s advisor on February 24, 2004. They were notified through e-mail and asked to send their mail addresses to the researcher. All four winners responded and were sent gift certificates.

Data Analysis

The Statistical Package for the Social Sciences (SPSS) was used to describe and analyze data for this study. ANOVA was employed to test hypotheses 1, 2, 3, 5, and 6. Pearson's correlation was used to examine hypotheses 4, 7, and 8 and path analysis was employed to examine hypothesis 9. A confidence level of $p < .05$ was chosen as the criterion for accepting hypotheses. The nine hypotheses are as follows:

- H1: Demographic and housing characteristics will significantly influence the desire to age in place.
- H2: Demographic and housing characteristics will significantly influence older people's perception of residential technology.
- H3: Demographic and housing characteristics will significantly influence older people's acceptance of residential technology.
- H4: There will be a significant relationship between older people's perception and their acceptance of residential technology.
- H5: There will be significant relationships between the attributes of innovations and older people's perception of residential technology.
- H6: There will be significant relationships between the attributes of innovations and older people's acceptance of residential technology.
- H7: There will be a significant relationship between the desire to age in place and older people's perceptions of residential technology.
- H8: There will be a significant relationship between the desire to age in place and older people's acceptance of residential technology.
- H9: The desire to age in place will be more directly related to older people's perceptions and their acceptance of residential technology than other variables such as demographic characteristics or housing characteristics.

Validity and Reliability

The major problem with using online surveys is that of external validity (Dillman, 2000). This is mainly because online surveys are not conducted based on probability sampling. Many survey researchers agree that the results from online surveys lack generalizability for a national population. Indeed population and sampling frames for online surveys are confined only to those members of a national population who are connected to the Internet.

Online surveys can be used for data collection and generate externally valid results for a specific population provided that (1) a central register of that research population exists and (2) that all members of this population can respond online (Dillman, 2000; Schillewaert, et al., 1998).

CHAPTER 4. FINDINGS AND DATA ANALYSIS

The major purpose of this study was to investigate older people's attitudes toward adopting technology as related to homes that could improve the resident's quality of life and assist in aging in place. This study was largely divided into two parts: 1) an investigation of perceptions and behaviors of older people who want to age in place, and 2) an examination of attitudes toward residential technology. This chapter presents findings from the survey, analysis of the results, and tests of hypothesis. Finally, a summary of findings and data analysis are presented.

Description of Data

Demographic Profile of the Sample

Respondents who were age 55 to 64 years comprised 60% of the total respondents. Four hundred seventy respondents were 65 to 74 years of age (30%), followed by those who were 75 to 84 (10%). Only five respondents were 80 years of age or older. The majority of the respondents (76%) reported that there were two household members age 55 years and older. Approximately 22% of the respondents (341) were reported as single person households. Only eight percent of respondents (122) were female, reflecting the predominately male student population at Virginia Tech during the time these alumni were in college.

Forty percent of the respondents reported their employment status as employed or self-employed full-time, followed by retired and not working (38%), retired and employed part-time (20%), and employed or self employed part-time (3%). Ninety-five percent of the respondents reported their health status as excellent (51%) or good (44%). Consequently, 75% of respondents reported that they have no health related problems that cause them difficulty in getting around their homes. Among health related problems, arthritis (54) and

knee problems (51) were the most common, followed by back problems (40). Nine percent of the respondents reported they had more than one physical problem.

Approximately 90% of the respondents were married, while five percent were divorced. Almost 61% had completed at least some graduate study.

A large majority (98%) of the respondents were Caucasian. Thirteen respondents did not answer this question.

The sample was more affluent than the general population. Twenty-three percent of the respondents had household income between \$50,000 to \$75,000, 21% between \$75,000 and \$100,000, 16% between \$100,000 and \$125,000, and 16% over \$150,000. While almost 90% of the respondents had household incomes over \$50,000, 11% had household incomes under \$50,000. Ninety respondents did not answer this question.

The majority of the sample for this study could be described as Caucasian, married men, 55 to 64 years of age with excellent or good health and at least some graduate education. Table 6 shows the summary of the description of demographic characteristics of the sample used in the final data analysis.

Table 6

Demographic Profiles of the Respondents

Demographic Characteristics		Frequency (<i>n</i>)	Percent (%)
Gender			
	Male	1,418	91.7
	Female	122	7.9
Age			
	55-64 years	920	59.5
	65-74 years	470	30.4
	75-84 years	148	9.6
	85 years or older	5	0.3
Number of the household members			
	1	341	22.1
	2	1,178	76.2
	More than 2	24	1.6
Employment status			
	Employed or self employed full time	610	39.5
	Employed or self employed part-time	46	3.0
	Retired and employed part-time	297	19.2
	Retired and not working	579	37.5
	Unemployed	11	0.7
Health status			
	Excellent	783	50.6
	Good	685	44.3
	Fair	68	4.4
	Poor	6	0.4
Number of physical problems			
	None	1,170	75.7
	1	196	12.7
	2	96	6.2
	3	38	2.5
	4 or more	7	0.5
Marital status			
	Married	1,392	90.0
	Widowed	42	2.7
	Divorced	71	4.6
	Separated	11	0.7
	Never married	26	1.7
Education			
	Some college	18	1.2
	College graduate	584	37.8
	Post graduate study	937	60.6
Race			
	White or Caucasian	1,512	97.8
	Blacks or African	5	0.3
	American Indian	3	0.2
	Asian or Pacific islander	3	0.2
	Mixed race	1	0.1
	Other	9	.6
	No Answer	13	0.8
Income			
	Under \$50,000	161	10.4
	\$50,000 to less than \$75,000	344	22.3
	\$75,000 to less than \$100,000	321	20.8
	\$100,000 to less than \$125,000	248	16.0
	\$125,000 to less than \$150,000	136	8.8
	\$150,000 or above	246	15.9
	No answer	90	5.8

Housing Characteristics of the Sample

The majority of the respondents (92%) lived in a single-family detached home. Approximately 97% of the respondents owned their homes, while only 1.7% rented their homes. Six hundred seventy-one respondents (43%) lived in suburban areas, while 342 respondents (22%) lived in rural areas and 341 respondents (22%) lived in small towns. The length of time the respondent lived in his/her current home did not show a specific pattern, but was evenly distributed from 1 to 40 years. Twenty five percent of the respondents reported they had lived in their current homes for 11 to 20 years, 22% for 21 to 30 years, 21% less than 5 years, and 18% for 6 to 10 years. Only six respondents reported they had lived in their current residence for over 50 years. The age of respondents' homes varied. Just over 9% lived in a dwelling built before 1950 and 8% lived in dwellings built between 1951 and 1960. Other respondents lived in dwellings built between 1961 and 1970 (15.8%), 1971 to 1980 (22.8%), 1981 to 1990 (18.8%), and 1991 to 2000 (18.6%). Housing related characteristics are summarized in Table 7.

Table 7

Housing Characteristics of the Sample

Housing Characteristics	Frequency (<i>n</i>)	Percent (%)
Housing type		
A single-family detached home	1,416	91.6
A multi-unit building	31	2.0
A mobile home	2	0.1
A semi-detached home	67	4.3
Other	25	1.6
Tenure type		
Own	1,504	97.3
Rent	27	1.7
Other	5	0.3
Length in current dwelling		
Less than 5 years	317	20.5
6 to 10 years	263	17.0
11 to 20 years	387	25.0
21 to 30 years	336	21.7
31 to 40 years	203	13.1
41 to 50 years	34	2.2
Over 50 years	6	0.4
Age of dwelling		
Before 1950	141	9.1
1951 to 1960	124	8.0
1961 to 1970	245	15.8
1971 to 1980	352	22.8
1981 to 1990	290	18.8
1991 to 2000	287	18.6
After 2000	102	6.6
Don't know	5	0.3
Location		
Rural area	342	22.1
Small town	341	22.1
City suburb	671	43.4
City	184	11.9

Desire to Age in PlaceDesire to Age in Place

Approximately 56% of the respondents (863) thought that they would continue to live in their current residence for more than 10 years, while 23% (243) said they did not

think that they would continue to live in their current residence for more than 10 years. Twenty two percent (334) said they did not know (see Table 8). These answers were different between the age groups according to the chi-square test ($\chi^2 (4, N = 1,538) = 38.635, p < 0.05$) (see Table 9).

Thirty-four percent of the respondents (526) reported that they had not really thought about where they would live 10 years from now, while 33% (515) reported that they had begun to talk about where they would live in 10 years, 20% (308) had fairly definite plans, and approximately 13% had explored options for future living. The chi-square test shows that there is a significant difference by age groups ($\chi^2 (6, N = 1,538) = 14.575, p < 0.05$) (see Table 9).

Approximately 80% of the respondents strongly agreed (54%) or somewhat agreed (25%) with the statement : *I'd really like to live in my current residence for as long as possible*, while 19% somewhat disagreed (11%) or strongly disagreed (8%), and 2% said they did not know. The propensity for aging in place was significantly different by age groups ($\chi^2 (8, N = 1,546) = 69.939, p < 0.05$) (see Table 9). Results showed that older adults were more agreeable to aging in place statement. Table 8 shows the summary of housing preference.

Table 8

Desire to Age in Place

Desire to Age in Place	Frequency (n)	Percent (%)
Plan to live in the current residence more than 10 years		
Yes	863	55.9
No	243	22.2
Don't know	334	21.6
No answer	6	0.4
Have made plans for where to live 10 years from now		
Definite plans	308	19.9
Explored options	192	12.4
Have begun to talk about it	515	33.3
Haven't really thought about it	526	34.0
No answer	5	0.3
Degree of the agreement with statement about wanting to live in current residence as long as possible		
Strongly agree	836	54.1
Somewhat agree	384	24.8
Somewhat disagree	165	10.7
Strongly disagree	124	8.0
Don't know	31	2.0
No answer	6	0.4

Table 9

Future Plans and Degree of Aging in Place by Age

	Age						Total	
	55 to 64 years		65 to 74 years		75 years or older		(n)	(%)
	(n)	(%)	(n)	(%)	(n)	(%)		
Plans to live in the current residence more than 10 years*								
Yes	527	57.5	269	57.4	65	42.5	861	56.0
No	227	24.8	86	18.3	30	19.6	343	22.3
Don't know	162	17.7	114	24.3	58	37.9	334	21.7
Total	916	100.0	469	100.0	153	100.0	1538	100.0
Have made plans for where to live 10 years from now*								
Definite plans	188	20.5	89	18.9	31	20.3	308	20.0
Explored options	103	11.3	59	12.6	29	19.0	191	12.4
Have begun to talk about it	322	35.2	158	33.6	34	22.2	514	33.4
Haven't really thought about it	302	33.0	164	34.9	59	38.6	525	34.1
Total	915	100.0	470	100.0	153	100.0	1538	100.0
Degree of the agreement with statement about wanting to live in current residence as long as possible*								
Strongly agree	428	46.7	293	62.5	114	75.0	835	54.3
Somewhat agree	252	27.5	106	22.6	24	15.8	382	24.9
Somewhat disagree	116	12.7	42	9.0	7	4.6	165	10.7
Strongly disagree	99	10.8	22	4.7	3	2.0	124	8.1
Don't know	21	2.3	6	1.3	4	2.6	31	2.0
Total	916	100.0	469	100.0	152	100.0	1537	100.0

* $p < .05$

Among those who strongly agreed or somewhat agreed with the statement: *I'd really like to live in my current residence for as long as possible*, approximately 33% answered that community/ neighborhood quality influenced their responses, followed by housing quality (17%), and distance from other family members (8%). Health status (6%), economic conditions (4%), climate (3%), and marital status (2%) had little influence on their answers (see Table 10).

Approximately 24% of respondents answered that they would make plans to move to a different house if they found they were having difficulties in their current homes, where they wanted to live as long as possible. Twenty one percent reported they would make plans to move where they can receive assistance, such as in assisted living facilities, or in the home of a family member. Almost an equal number of respondents answered they would remain in their homes with help from family or friends (10%) and remain in their home with help from other people or agencies (9%). Five percent of the respondents answered that they would continue to live without any change, while 18% said they would consider repairs or renovations.

Forty-four percent of respondents (684) indicated that their housing would not present problems as they age in place. Of the 56% who thought there might be problems with their housing, 25% indicated the problems were design related. An additional 13.5% said their current home might present problems because of maintenance.

As for questions about problems related to the neighborhood, the majority of the respondents (73%) answered that the neighborhood and the community would not be a problem that they would most likely face. Around 10% reported unavailability of housekeeping related services would be a problem, followed by hard to get medical services (4%), safety (2%), and bad location (1%). Table 10 shows the summary of the opinions from respondents related to their housing.

Table 10

Opinions Related to Housing and Neighborhood/ Community

Opinions from respondents related to their housing and neighborhood/ community	Frequency (n)	Percent (%)
Factors influencing respondents' ability to remain in current residence		
Housing quality	263	17.0
Community/ neighborhood quality	505	32.7
Health status	90	5.8
Marriage status	34	2.2
Climate	38	2.5
Distance from other family members	118	7.6
Economic conditions	59	3.8
Other	128	8.3
No answer	311	20.1
Future plan that home might present problems in the future		
Make plans to move to a different house	375	24.3
Make plans to move to a place to be able to receive assistance	329	21.3
Consider repairs or renovations	280	19.1
Continue to live without any changes	58	3.8
Remain in the home with the help from family or friends	159	10.3
Remain in the home with the help from other people or agencies	148	9.6
Don't know	108	7.0
Other	77	5.0
No answer	11	0.7
Main reason that home might present problems in the future		
Hard to maintain current home	208	13.5
Inconvenient because of design	372	24.1
Too old to fix or remodel home	9	0.6
Too small for me	12	0.8
Too big for me	129	8.3
The house is not a problem	684	44.2
Other	122	7.9
No answer	10	0.6
Main reason that community/ neighborhood might present problems in the future		
Hard to get medical services	57	3.7
Hard to get house keeping related services	129	8.3
Hard to get emergency services	13	0.8
Safety	29	1.9
Bad location	18	1.2
The neighborhood and community are not problems	1,129	73.0
Other	153	9.9
No answer	18	1.2

Home Modifications

Over half of the respondents (64%) answered they had not made any home modifications within the last five years, while 35% said they had made home modifications. Approximately 40% of the respondents had not considered home modifications (see Table 11). This figure was lower than that of a national sample conducted by the AARP in 2000 (Bayer & Harper, 2000). According to the AARP survey, 90% of the respondents had made at least one simple change or major home modification to their home to make it easier for them to live there.

One hundred five of the respondents specified the home modifications they had completed. Home modifications were mainly made in the bathroom, bedroom, or kitchen. Twenty-two respondents upgraded the whole bathroom, ten added grab bars, six added walk-in showers, and three added higher toilets. Four of the respondents reported that they added bathrooms downstairs. Thirty-two respondents upgraded their kitchens including floor finishing, painting, and adding work areas. Twenty-four respondents had made general renovations including floor finishing, painting, and changing windows. Twenty five respondents reported they added rooms such as office areas, or exercise areas, while four converted existing rooms into other rooms. As for exterior modifications, ramps were added by eight respondents, and doors were modified to become wheelchair accessible doors by three respondents. As for other modifications, seven respondents changed door knobs into lever door handles, four respondents installed handrails, four respondents installed stair way elevators, and four respondents installed advanced HVAC systems. Only five respondents stated that they would consider home modifications in the future. Table 12 presents specifics about home modifications completed by respondents.

Table 11

Home Modifications

Home Modifications	Frequency (n)	Percent (%)
Home modifications made within the last 5 years		
Yes	544	35.2
No	990	64.0
No answer	12	0.8
Home modifications considered within the last 5 years		
Yes	310	20.1
No	640	41.4
No answer	426	27.6
Major reasons to have made or considered making home modifications		
For safety	71	4.6
For comfort and convenience	667	43.1
Other	119	7.7
No answer	689	44.6

Table 12

Specifics of Home Modifications

Location		Specifications	Frequency (n)	Percent (%)
Interior	Bathroom	Add grab bars	10	4.8
		Add walk-in showers (with seats)	6	2.9
		Add higher toilets	3	1.4
		Change wheelchair accessible showers and door	4	1.9
		Upgrade (floor finishing, and painting)	22	10.5
		Add bathroom downstairs	4	1.9
	Bedroom	Move or add downstairs	5	2.4
		Upgrade	3	1.4
	Kitchen	Renovate (floor finishing and painting)	32	15.3
	Other rooms	Add other rooms	25	12.0
		Convert existing rooms to other rooms	4	1.9
	Others	Change lever door handles	7	3.3
		Install handrails	4	1.9
		Install stair way elevators	4	1.9
Renovate whole interiors		24	11.5	
Install advanced HVAC systems		3	1.4	
Install ramps		8	3.8	
Exterior Main entrance	Add wheelchair accessible door	3	1.4	
	Other exterior spaces	Redo porch, parking areas, garage, and roof, windows, and land space	18	8.6
Others			9	4.3
Newly built		4	1.9	
Total			209	100

Note. Total was over 151, because responses that respondents reported more than one were included as well.

Respondents noted that reasons for home modifications were for comfort and convenience. As for other reasons for making home modifications, they responded that they made home modifications to improve home sale values, have a maintenance-free home environment, adjust for a spouse's health condition, prepare for children's visits, consider energy efficiency, and upgrade interiors and exteriors of their homes.

Attitudes Toward Residential Technology

This section presents perceptions and acceptance of residential technology. It also includes computer and Internet use by respondents. The results were examined by age groups.

Perceptions and Acceptance of Residential Technology

The majority of the respondents (67%) learned about newly introduced home technology products from traditional media such as magazines (24%), television (24%), and newspapers (19%), while 14% of the respondents got the information about these new products through the Internet. Seven percent of the respondents learned about these new home technology products from friends, 3% learned about them from family, and 2% learned about them from a salesman/ store (see Table 13).

The majority of the respondents (85%) reported they were very familiar or somewhat familiar with technology products, while 12% reported they were not (See Table 13). In order to investigate the influence of age on familiarity with residential technology, AVOVA tests were employed.

Table 13

Sources of Information about and Familiarity with Residential Technology

Sources of information about residential technology	Frequency (n)	Percent (%)
Sources of information		
Television	378	24.5
Magazines	371	24.0
Newspapers	296	19.1
Internet	214	13.8
Friends	104	6.7
Family	51	3.3
Salesman/ Store	31	2.0
Radio	4	0.3
Other	94	6.1
No answer	3	0.2
Familiarity with residential technology		
Very familiar	321	20.8
Somewhat familiar	1,010	65.3
Somewhat unfamiliar	174	11.3
Not familiar	36	2.3
No answer	5	0.3

ANOVA Test Assumptions

Prior to conducting the ANOVA, data were tested to determine if they met the underlying assumptions: independence of observation, homogeneity of variance, and normality. First, independence of observation was assumed. Levene's statistic was used to test the homogeneity of variances. The result of this test was not significant, $F(2, 1535) = 0.326$, $p < 0.05$. It means that there was no violation of homogeneity of variances. The result of the Shapiro-Wilks test ($p = 0.762$) reveals that the distribution does not significantly depart from a normal distribution. These statistics, however, do not mean the results from ANOVA were not valid because of the sample size ($N = 1,548$). When the sample size is small, such as 10 or less, these tests are unlikely to uncover departures from normality. In addition, when the sample size is large enough to uncover the departure from normality, such violations are unlikely to compromise the test or distort the p value. In other words, when the sample size is large, ANOVAs are usually accurate even when the distribution is not normal. The sample size for this research can be considered large enough to uncover the

departure from normality. Therefore, ANOVA tests were employed without violating the assumptions.

The result of ANOVA shows there is no significant difference by age group in terms of familiarity with technology, $F(2, 1435) = 0.442, p < 0.05$. Table 14 shows the means for age groups.

Table 14

Mean Comparisons: Familiarity with Residential Technology by Age

	<i>N</i>	<i>M</i>	<i>SD</i>
Age*			
55 to 64	918	3.04	0.640
65 to 74	467	3.07	0.643
75 years or older	153	3.03	0.653
Total	1,538	3.05	0.642

Note. Familiarity was coded as Not familiar=1, Somewhat unfamiliar=2, Somewhat familiar=3, and Very familiar=4

* $p < .05$.

Respondents were asked about their perceptions and acceptance of residential technologies such as home theater systems, microwaves, and so forth. Answering options were developed based on the innovation decision process: 1) not familiar with; 2) have heard/ seen/ read; 3) have been interested in/ tried to look for information; 4) have considered purchasing; and 5) have purchased. Additionally a sixth alternative, “purchased, but do not use or rarely use” was added to determine if all those who purchased new technology actually used it.

A majority of the respondents had purchased microwave ovens (98%), CD players (96%), VHS players (93%), cellular phones (88%), DVD players (74%), and remote garage door openers (70%). Many respondents showed an interest in high-technology products. They reported that they had heard, seen, or read about emergency alert products (83%), wireless health remote diagnostic products (65%), video-phones at entrance (63%), home theater systems (59%), remote controls for raising/ lowering shutters (54%), gas leak

detector alarms (52%), remote controls for home appliances (52%), satellite TVs (51%), PDAs (50%), and remote controls for turning on/ off lighting and dimming lamps (50%). However, over half of the respondents reported they were not familiar with voice-recognition door openers (56 %) and personal health remote diagnostic products (60%).

Respondents did not embrace all technology products. Approximately 9% of the respondents reported they purchased DVD players but did not use or rarely used them followed by VHS players (8.2%), CD players (6.7%), fax machines at home (6.4%), PDAs (6.1%), and electronic tooth brushes (5%). Although it is assumed that there are many factors influencing their decision not to use these products any more, for some products such as VHS players, CD players, and fax machines, they may have found more convenient alternative products. However, for more recently introduced products such as PDAs, DVD players, and electronic tooth brushes, they stopped using them because they were not as satisfied with these products as they had expected.

Table 15 presents a response pattern for each technology product or service.

Table 15

Responses about Technology Products or Services

Products or Services	Not familiar with this product or service (%)	Heard, Seen, or Read about (%)	Interested in/ tried looking for information (%)	Considered purchasing (%)	Purchased (%)	Purchased, but do not use or rarely use (%)	No answer (%)
DVD Player	1.1	10.0	1.0	13.7	64.4	9.4	0.3
CD Player	1.6	0.2	1.6	89.4	6.7	0.6	0.6
VHS player	2.3	2.9	0.4	0.8	84.7	8.2	0.6
PDA's (Personal Digital Assistants)	5.6	50.1	2.4	14.6	20.6	6.1	0.6
Laptop computer	0.4	26.9	2.3	21.7	46.2	1.7	0.7
Cellular phone	0.1	6.3	0.8	4.5	84.2	3.6	0.6
Fax machine at home	0.5	30.3	1.9	14.4	45.8	6.4	0.8
Satellite TV	1.3	50.6	3.0	17.1	26.2	0.7	1.1
Remote garage door opener	0.8	22.6	0.6	3.6	69.1	0.7	2.5
Microwave Oven	0.1	0.9	0.1	0.3	97.8	0.2	0.6
Electronic tooth brush	2.8	30.4	1.0	6.1	53.6	5.0	1.2
Video-phone at entrance	30.9	62.8	1.9	2.7	0.6	0.1	1.0
Voice-recognition door opener	56.3	40.7	1.1	1.0	0.1	0.1	0.8
Burglar alarm	1.4	49.4	1.9	14.3	29.7	2.4	1.0
Flood alarm	53.4	40.4	0.5	1.1	3.2	0.1	1.4
Gas leak detector alarm	19.9	51.6	1.6	4.4	20.8	0.2	1.4
Remote controls for temperature or humidity	27.2	49.9	2.2	2.8	16.8	0.1	1.0
Remote controls for turning on/off lighting & dimming lamps	9.0	66.4	2.5	5.6	15.2	0.4	0.9
Remote controls for rising/ lowering shutters	41.5	53.6	1.1	1.4	1.2	0.1	1.1
Remote control for home appliance	43.6	51.6	1.3	0.9	1.4	0.2	1.0
Home theater system	6.9	58.9	4.7	10.5	17.7	0.5	0.8
Personal health remote diagnostic product	60.0	34.0	0.7	0.5	3.9	0.1	1.0
Wireless health monitoring product	31.8	65.3	1.0	0.5	0.4	0.1	0.8
Emergency alert product	11.4	83.0	1.0	0.8	2.8	0.3	0.6
Video phone	10.0	84.2	1.5	2.7	0.9	0.2	0.5

Note. Highlighted figures indicate the majority of the responses in each technology category.

Specific patterns of responses regarding residential technology emerged (Figures 6 to 10). These are divided into five patterns based on the innovation-decision process.

Respondent options were created as indicators of each innovation-decision process as described by Rogers (1995) (see Figure 5). According to Rogers (1995), until the implementation stage, the innovation-decision process has been a mental exercise. However, implementation involves obvious behavior change, as the new idea is actually put into practice. The concept of adoption is the final stage of a multistage process. Rogers (1995) calls this the implementation or confirmation stage.

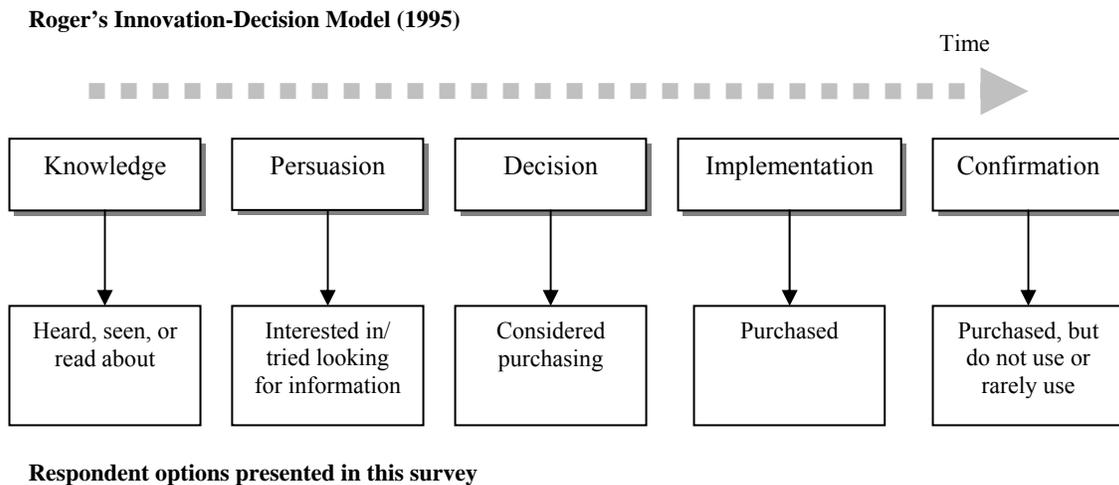


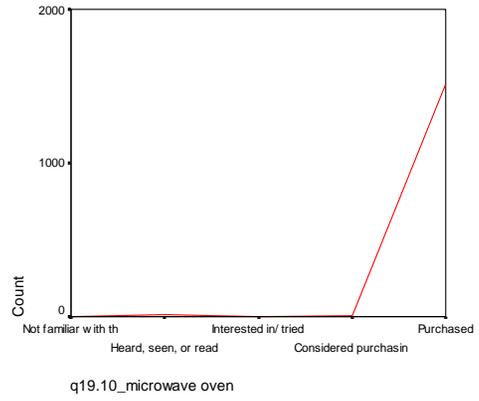
Figure 5. Innovation-Decision Process.

Pattern 1 (see Figure 6) can be considered as survival technology in terms of the adoption rate, because a majority of respondents (92% over) had purchased these technology products or services (e.g., microwave ovens, VHS players, CD players). This means the majority of the respondents were in the implementation stage by purchasing the technology.

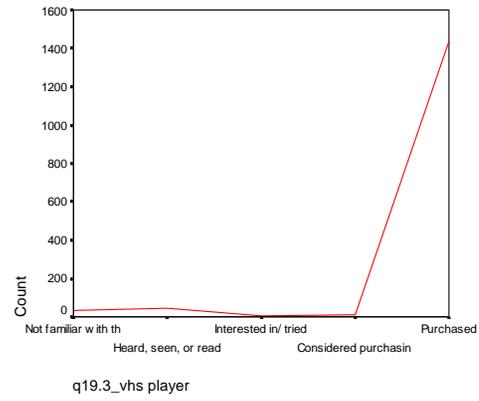
Pattern 2 (see Figure 7) can be considered as basic technology in terms of the adoption rate, because some respondents were interested in this technology, a few were considering purchasing, and most respondents (from 47.9% to 87.8%) had purchased the technology. This distribution of responses means that except for late adopters who were at

the knowledge stage, a majority of respondents went through the decision stage and purchased this technology, such as cellular phone, DVD players, or fax machine.

Microwave oven



VHS players



CD players

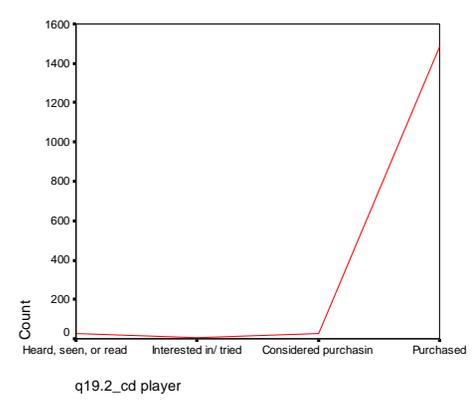


Figure 6. Pattern 1.

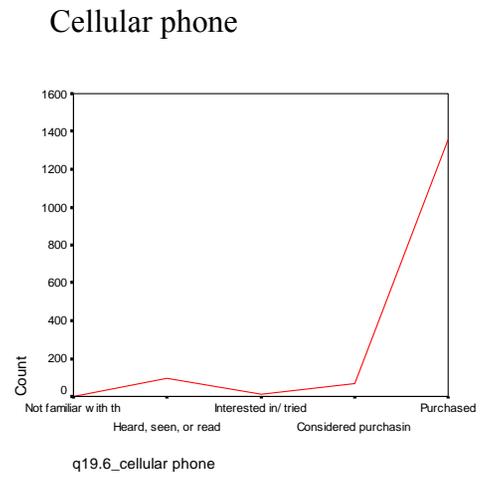
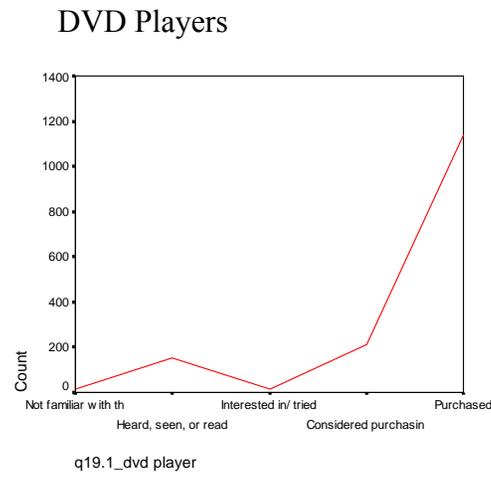
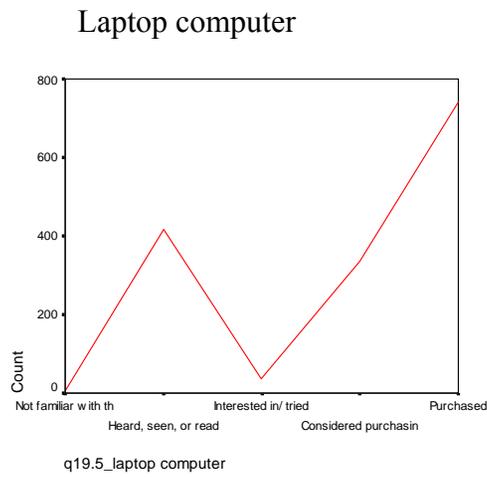
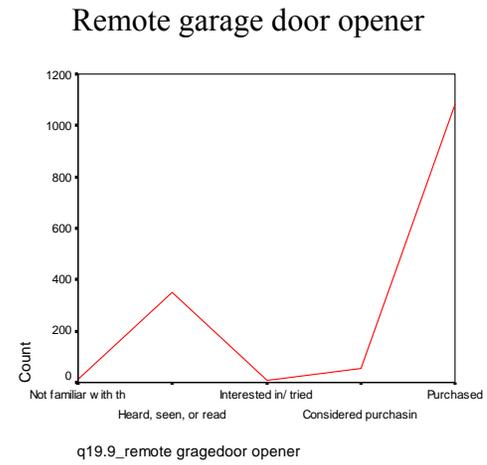
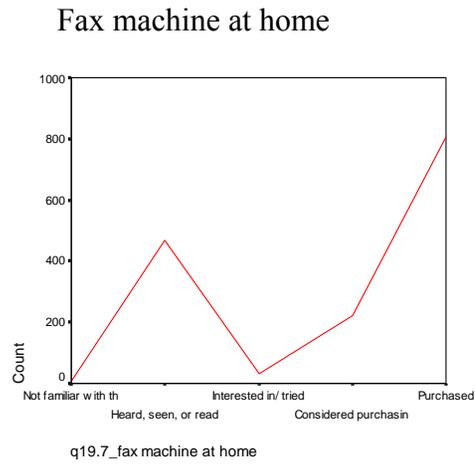
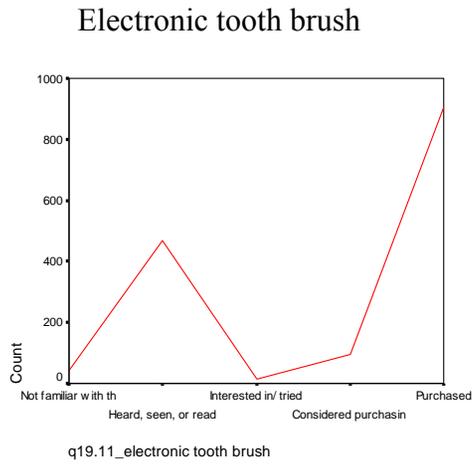
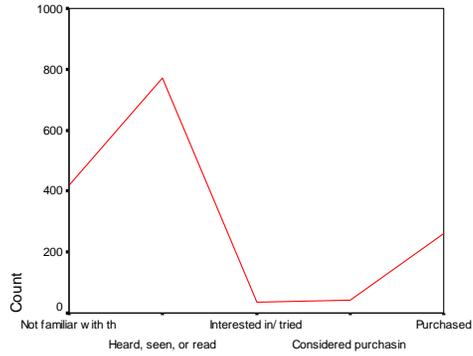


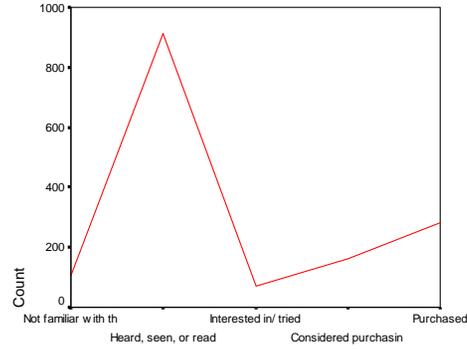
Figure 7. Pattern 2.

Remote controls for temperature or humidity



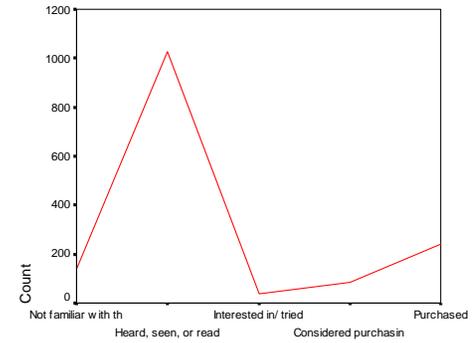
q19.17_remote controls for temperature or humidity

Home theater system



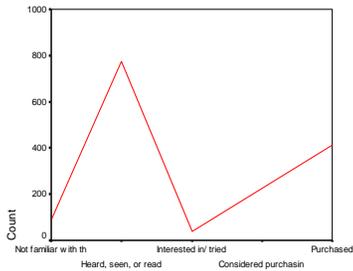
q19.21_home theater system

Remote controls for turning on/off Lighting & dimming lamps



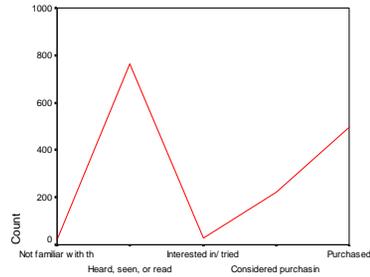
q19.18_remote controls for turning on/ off lighting & dimming la

PDA's



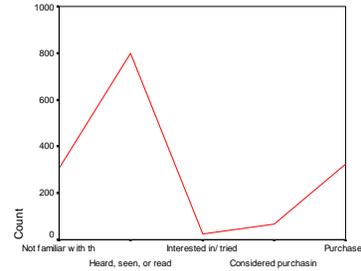
q19.4_pdas

Burglar alarm



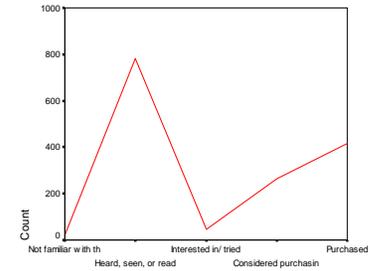
q19.14_burglar alarm

Gas leak detector alarm



q19.16_gas leak detector alarm

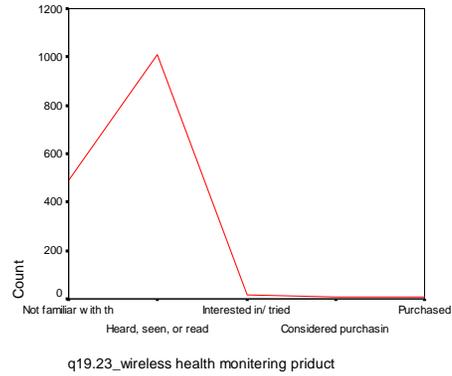
Satellite TV



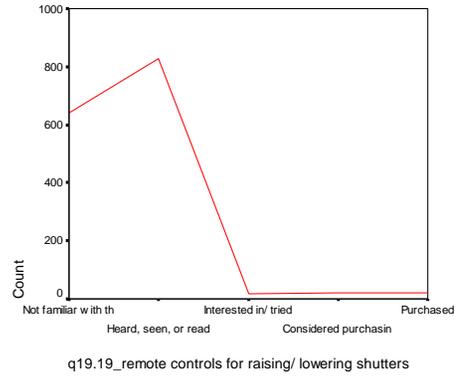
q19.8_satellite tv

Figure 8. Pattern 3.

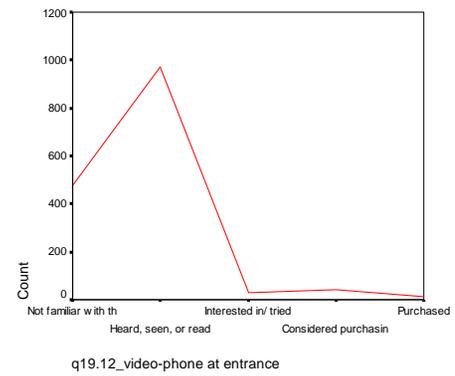
Wireless health monitoring system



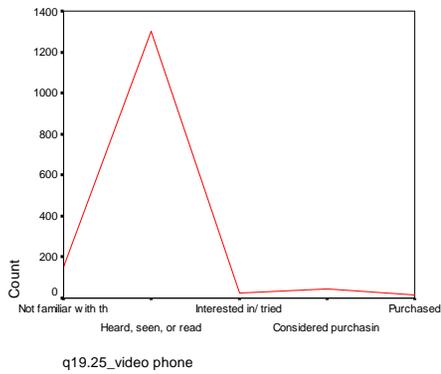
Remote controls for rising/ lowering shutters



Video phone at entrance



Video phone



Emergency alert products

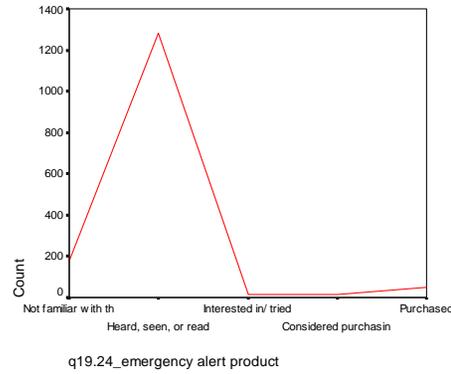
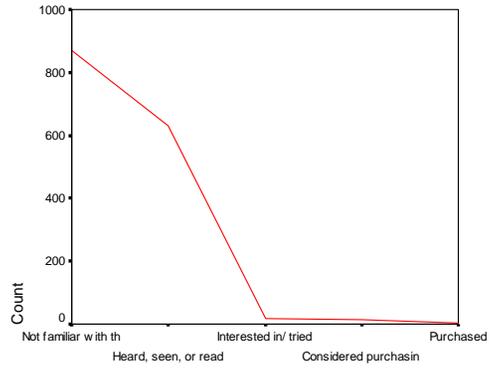


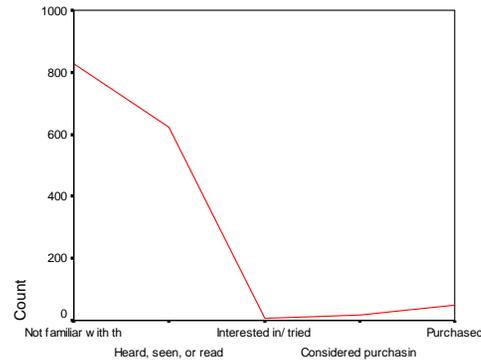
Figure 9. Pattern 4

Voice-recognition door opener



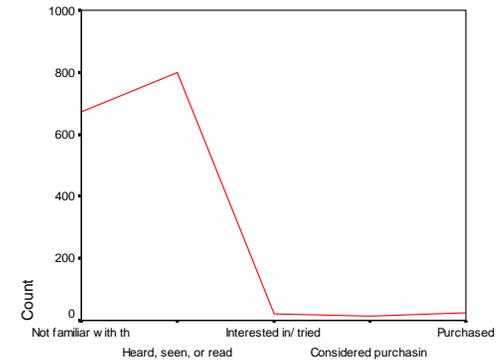
q19.13_voice-recognition door opener

Flood alarm



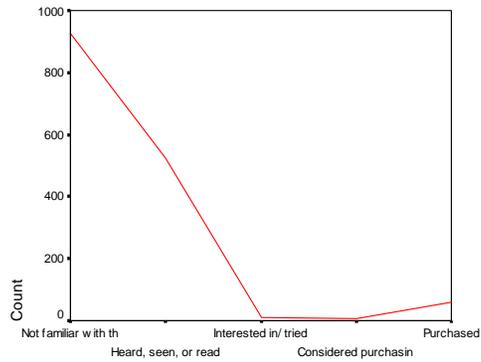
q19.15_flood alarm

Remote controls for home appliance



q19.20_remote control for home appliance

Personal health remote diagnostic product



q19.22_personal health remote diagnostic product

Figure 10. Pattern 5.

Patterns 3, 4, and 5 (see Figures 8 to 10) can be considered high technology categories in terms of the adoption rate. A majority or some of the respondents were not familiar with the technology, some had not heard, seen, or read about the technology, and few respondents purchased this technology (from 0.2% to 32.1%). Distribution of the responses means most respondents were at the initial knowledge stage. It had not lead to an innovation-decision process such as persuasion or decision stage. High technology categories include video-phone at entrance, video-recognition door opener, remote controls of temperature or humidity, and so on. Although three patterns (patterns 3, 4, and 5) showed the common characteristic of a low purchase rate, there were three different categories in terms of the respondent's knowledge stage. The patterns can be summarized as follows.

1. Survival technology (purchase rate: over 92%)

- Pattern 1: A great majority of the respondents had purchased the technology.

2. Basic technology (purchase rate: from 47.9% to 87.8%)

- Patterns 2: Few respondents were not familiar with the technology, and some respondents had heard, seen, or read about this technology. A majority of respondents had purchased this technology.

1. High technology (purchase rate: from 0.2% to 32.1%)

- Patterns 3: Few respondents were not familiar with the technology and a majority of respondents had heard, seen, or read about this technology. Only few respondents had purchased the products.
- Pattern 4: Some respondents were not familiar with the technology and some had heard, seen, or read about this technology. Few respondents had purchased the products.
- Pattern 5: A majority of the respondents (approximately 50%) were not familiar with the technology. Few respondents had heard, seen, or read about this technology. Few respondents had purchased the products.

Examining these patterns is useful in order to compare the proposed conceptual categories of residential technology described in Chapter Two to the survey results. The conceptual categories are divided into survival, basic, and high technology according to the adoption rate. Based on the results from the survey, these categories were matched with response patterns (see Figure 11).

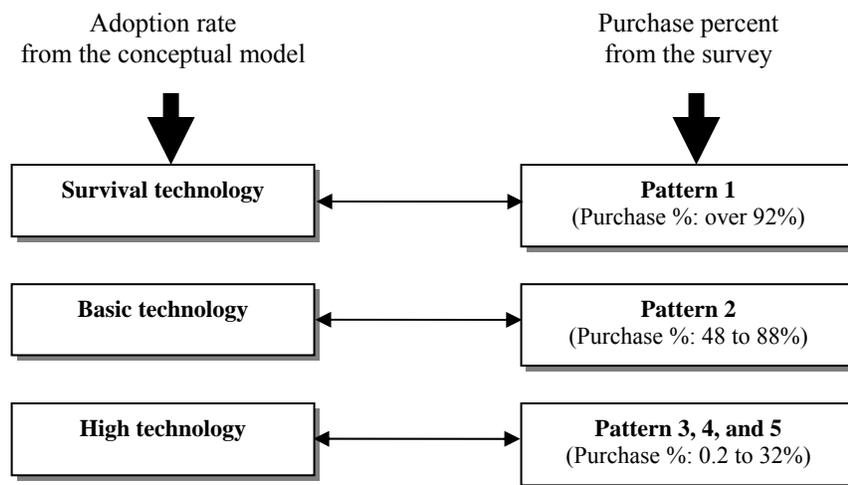


Figure 11. Residential Categories and Response Patterns.

Table 16 shows specific technology products and services investigated in this study under the categories. Technology products under the categories would be different when considering a general older population, especially in terms of high technologies. This sample was unique in terms of attitudes toward computer technology--98% of the respondents had computers in their homes. It is expected that their early adoption of computers influenced their purchase of other high technology products. The purchase rate of the survival technologies would be the same or similar with a general old population. However, some basic technology products, such as cellular phones, DVD players, or remote garage door openers, might be considered high technologies, when considering a general older population in terms of the purchase rate. Also, it is expected that the purchase

rate of high technology products might be lower when compared to a general old population.

Table 16

Categories of Residential Technology

Note.^a Includes “Purchased” and “Purchased but do not use any more”.

		Pattern 1	Pattern 2	Pattern 3,4, & 5
		Survival technology (Purchase % ^a)	Basic technology (Purchase % ^a)	High technology (Purchase % ^a)
Personal & Home Management	Safety & Security			Wireless health monitoring products (0.5%) Video-recognition door opener (0.2%) Video-phone at entrance (0.7%) Emergency alert products (3.1%) Flood alarm (3.3%) Personal health remote diagnostic product (4.0%) Gas leak detector alarm (21.0%) Burglar alarm (32.1%)
	Comfort	Microwave oven (98.0%)	Electric tooth brush (58.6%) Remote garage door opener (69.8%) Laptop computer (47.9%)	Remote controls for rising/ lowering shutters (1.3%) Remote controls for home appliance (1.6%) Remote controls for turning on/off lighting & dimming lamps (15.6%) Remote controls of temperature or humidity (19.9%) PDAs (26.70%)
Communication			Cellular phone (87.8%) Fax machine at home (52.2%)	Video phone (1.1%)
Entertainment		CD player (96.1 %) VHS player (92.9%)	DVD player (73.8%)	Satellite TV ^b (26.9%) Home theater system (18.2%)

^b Purchasing Satellite TV could be understood in a different way. In some places, adopting this technology is not optional. In other word, if cable TV or other options for watching TV are not available, respondents had to choose this option.

Attributes of Innovations

Respondents were asked to measure the impact of the attributes of innovations in purchasing newly introduced technology products. Attributes of innovations variables were modified based on Rogers' (1995) attributes of innovations. According to Rogers (1995), the perceived attributes of an innovation is one important explanation of the rate of adoption of an innovation. From 49 to 87% of the variance in rate of adoption is explained by five attributes: relative advantage, compatibility, complexity, triability, and observability. However, he states that one possible problem with measuring the five attributes of innovations is that they may not in all cases be the five most important perceived characteristics for a particular set of respondents. Six respondent options were created based on Rogers' (1995) five attributes (See Figure 12).

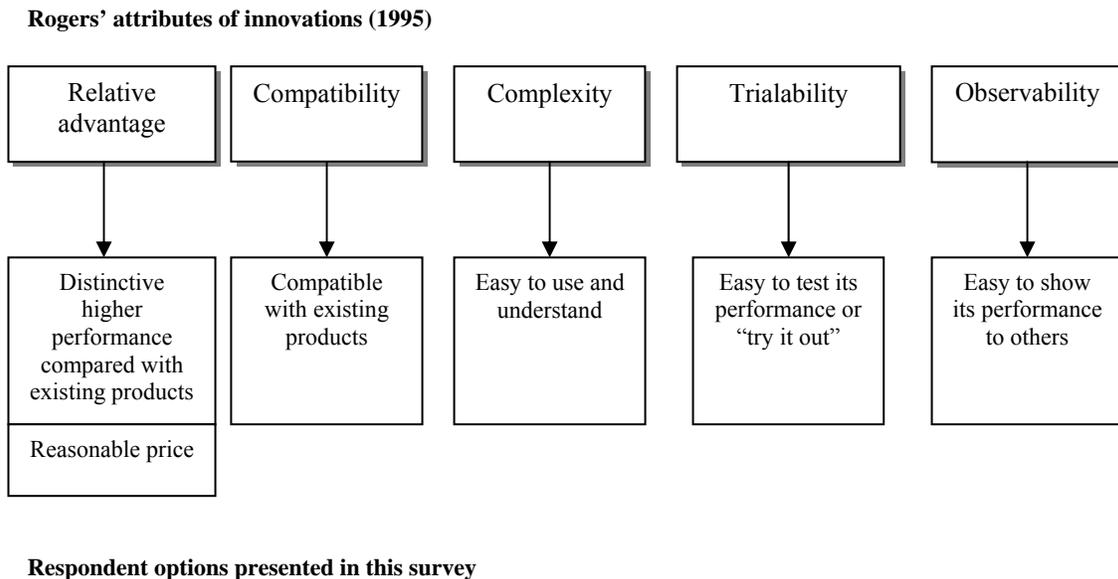


Figure 12. Attributes of Innovations.

Approximately 70% answered *easy to use and understand* was very important, while two percent answered it was not an important factor, when purchasing newly introduced technology products. In terms of *compatibility with existing products*, about

51% answered it was very important, while four percent said it was not important. Approximately 52% of the respondents answered *availability of post-purchased service factor* was very important, while 5% said this factor was not important. About 59% of the respondents answered *reasonable price* was very important, while 1% said it was not important. Approximately 16% answered *distinctive higher performance compared with existing products* was very important, while 2% said it was not important. Approximately, 16% of the respondents said *easily show its performance to others* was very important, while about 39% answered it was not important. Finally, 46% of the respondents answered *easy to test its performance* was very important, while 5% said it was not important. Table 17 summarizes responses about the factors influencing the purchase of newly introduced technology products.

Table 17

Factors Influencing Purchase of Newly Introduced Technology Products

Attributes of Innovation	Very important (%)	Somewhat important (%)	Not Important (%)	No answer (%)
Easy to use and understand	70.4	27.4	1.8	0.3
Compatible with existing products	51.3	44.2	3.9	0.6
Availability of post-purchase service	52.5	41.7	5.4	0.4
Reasonable price	59.1	39.5	1.0	0.4
Distinctive higher performance compared with existing products	52.7	44.6	2.3	0.4
Easy to show its performance to others	15.8	45.2	38.6	0.4
Easy to test its performance or “try it out”	46.4	47.5	5.2	0.9

Based on ANOVA tests, there are mean differences of attributes of innovation by age groups for all categories except *reasonable price* ($F(2, 1534) = 0.449, p > 0.05$) and *ease to show its performance to others* factors ($F(2, 1534) = 0.886, p > 0.05$). Results showed that the *easy to use and understand* factor was most important for all age groups when they purchased new technology products. Older adults were much more likely to consider *easy to use and understand* and *availability of post-purchased service* factors as

important factors than younger adults when purchasing newly introduced technologies.

Table 18 shows the comparisons by age groups.

Table 18
Mean Comparisons: Attributes of Innovation by Age

	Age			Total
	55 to 64 years	65 to 74 years	75 years and older	
Easy to use and understand*	2.66	2.73	2.76	2.69
Compatible with existing products*	2.45	2.53	2.50	2.48
Availability of post-purchase service*	2.43	2.51	2.59	2.47
Reasonable price	2.58	2.60	2.56	2.58
Distinctive higher performance compared with existing products*	2.48	2.56	2.50	2.51
Easy to show its performance to others	1.75	1.80	1.80	1.77
Easy to test its performance or “try it out”*	2.36	2.49	2.48	2.42

* $p < 0.05$.

Computer and Internet Use

Approximately 98% of the respondents reported they had computers at home. This figure was much higher than the national average of 33% reported by the U.S. Department of Commerce in 2000. Among those in this survey who have computers, 35% answered they had two computers, while 22% said they had more than two computers at home.

Approximately 98% of the respondents reported that they were very familiar with computers (56%) or somewhat familiar with computers (42%), while only two percent said they were not familiar with computers.

As for familiarity with the Internet, 60% said that they were very familiar with the Internet and 38% responded that they were somewhat familiar with the Internet, while only twenty respondents reported that they were not familiar with the Internet. When asked about the comfort level with the Internet, 74% of the respondents said they were comfortable with the Internet and 23% responded that they were somewhat comfortable with the Internet. Table 19 shows the familiarity of respondents with computers and the Internet.

Table 19

Familiarity with Computers and Internet

Familiarity with computers and the Internet	Very familiar (%)	Somewhat familiar (%)	Somewhat unfamiliar (%)	Unfamiliar (%)	No answer (%)
Familiarity with computers	56.2	41.8	1.2	0.1	0.6
Familiarity with the Internet	60.2	38.2	1.2	0.1	0.3

ANOVA tests show the significant difference of familiarity with computers ($F(2, 1531) = 42.107, p < 0.01$), familiarity with the Internet ($F(2, 1534) = 29.519, p < 0.01$), and comfort level with the Internet ($F(2, 1535) = 43.613, p < 0.01$) by age groups at the level of $p < 0.01$. Results showed that younger people were more familiar with computers and the Internet. Table 20 shows the difference by age groups.

Table 20

Mean Comparisons: Familiarity with Computer and Internet

Familiarity with computers and Internet	55 to 64 years (M^a)	65 to 74 years (M^a)	75 and older (M^a)	Total (M^a)
Familiarity with computers**	3.65	3.43	3.33	3.55
Familiarity with the Internet**	3.68	3.47	3.35	3.59
Comfort level with the Internet**	3.79	3.62	3.51	3.71

Note: ^aNot familiar=1, Somewhat unfamiliar=2, Somewhat familiar=3, Very familiar=4

Uncomfortable=1, Somewhat uncomfortable=2, Somewhat comfortable=3, Comfortable=4

** $p < 0.01$.

Table 21 shows the various computer and Internet activity patterns. Over 80% of the respondents reported they used e-mails on a daily base, while about 47% said they use the Internet to get news daily. Approximately 62% of the respondents reported that they never or rarely used computers and the Internet for fun or hobbies, followed by online banking (55.5%). In addition, 46% of the respondents said that they never or rarely used online shopping.

Table 21

Computer and Internet Activities

	Use Daily (%)	Use a few times a week (%)	Use a few time a month (%)	Rarely Use (%)	Never Use (%)	No answer (%)
Word processor	44.4	30.5	15.6	7.8	1.4	0.3
E-mails	88.4	9.3	1.5	0.6	0.1	0.2
Online shopping	1.0	8.7	44.2	37.3	8.3	0.4
Online banking	9.6	16.0	18.5	13.3	42.2	0.5
To get news	46.8	20.3	13.9	15.0	3.7	0.3
To get information	19.4	32.4	38.0	9.2	0.5	0.5
Fun	13.1	11.6	12.7	36.4	25.6	0.6
Hobbies	9.2	9.2	14.6	36.4	25.6	0.6

Approximately 83% of the respondents reported that they started using the Internet five or more years ago, while only four respondents said they started using the Internet within the past year. Work (58%) was the most frequently mentioned motivation for starting to use the Internet, followed by family member's use (16%), and friends' use (10%). Table 22 shows the summary of other information about respondents' use of the Internet.

Table 22

Other Information about the Internet

Other information about the Internet	Frequency (<i>n</i>)	Percent (%)
Length of time using the Internet		
5 or more years ago	1,276	82.5
3 to 5 years ago	222	14.4
1 to 3 years ago	37	2.4
Within 1 year	4	0.3
No answer	7	0.5
Motivation for starting to use the Internet		
Family members' use	243	15.7
Friends' use	159	10.3
Advertising	35	2.3
Sales personnel	2	0.1
Work	897	58.0
Other	200	12.9
No answer	10	0.6

Tests of the Hypotheses

Nine hypotheses were proposed in this research. The following hypotheses were tested.

Hypothesis 1

H1: Demographic and housing characteristics will significantly influence the desire to age in place.

This hypothesis was tested using ANOVA. The desire to age in place was measured by question nine: the degree of agreement with this statement, *I'd really like to live in my current residence as long as possible*. The options for the answers ranged from strongly disagree (value=1) to strongly agree (value=4). The 32 responses of don't know (2%) were excluded (recoded as "system missing value") in this analysis.

For demographic characteristics, gender, age, number of household members, employment status, health condition, marital status, education level, race, and income were

used. For housing characteristics, housing type, tenure type, length of residence in current dwelling, the age of dwelling, and location were used. In every question, no responses were excluded from the analysis. Total mean of the desire to age in place was 3.28 with 1,509 valid responses.

ANOVA test revealed significant differences in the desire to age in place variable by age ($F(2, 1534) = 26.629, p < 0.01$), the number of household members ($F(2, 1534) = 5.548, p < 0.05$), employment status ($F(2, 1533) = 11.263, p < 0.01$), and income ($F(5, 1444) = 2.861, p < 0.05$). Results revealed that older adults showed a stronger desire to age in place than younger adults. As for housing characteristics, tenure type ($F(2, 1527) = 6.233, p < 0.05$), length of residence in current dwelling ($F(6, 1533) = 3.251, p < 0.05$), and location ($F(3, 1528) = 14.825, p < 0.01$) influenced the degree of the desire to age in place. Tables 23 and 24 show the mean comparisons of the desire to age in place according to demographic and housing characteristics.

Table 23

Mean Comparisons: Desire to Age in Place by Demographic Characteristics

Demographic Characteristics		<i>M</i>	<i>N</i>	<i>SD</i>
Gender ^a				
	Male	3.28	1,388	0.95
	Female	3.26	117	1.00
Age [*]				
	55-64 years	3.13	895	1.01
	65-74 years	3.45	463	0.84
	75 years or older	3.68	148	0.66
Number of the household members [*]				
	1	3.11	331	1.06
	2	3.33	1,151	0.91
	More than 2	3.25	24	0.98
Employment status ^{**}				
	Employed or self employed full time	3.11	594	1.01
	Employed or self employed part-time	3.28	46	1.02
	Retired and employed part-time	3.39	290	0.89
	Retired and not working	3.43	566	0.87
	Unemployed	2.27	11	1.10
Health condition				
	Excellent	3.27	765	0.99
	Good	3.34	670	0.92
	Fair	3.53	66	0.78
	Poor	3.67	6	0.51
Marital status ^a				
	Married	3.33	1360	0.95
	Widowed	3.40	41	0.88
	Divorced	3.03	71	1.06
	Separated	3.30	9	1.26
	Never married	3.35	24	0.83
Education				
	Some college	3.28	18	0.82
	College graduate	3.35	569	0.91
	Post graduate study	3.29	915	0.97
Number of physical problems				
	None	3.32	1,146	0.95
	1	3.24	191	0.97
	2	3.44	92	0.85
	3	3.49	37	0.98
	4	3.57	6	1.21
Race ^a				
	White or Caucasian	3.31	1,477	0.95
	Blacks or African	2.80	5	1.09
	American Indian	4.00	3	0.00
	Asian or Pacific islander	4.00	2	0.70
	Mixed race	3.00	1	.
	Other	3.44	8	1.38
Income [*]				
	Under \$50,000	3.49	156	0.86
	\$50,000 to less than \$75,000	3.39	335	0.91
	\$75,000 to less than \$100,000	3.30	313	0.95
	\$100,000 to less than \$125,000	3.28	245	0.93
	\$125,000 to less than \$150,000	3.18	133	1.07
	\$150,000 or above	3.19	242	1.02

^a These variables include too few responses to compare with other responses. Therefore, the results of the ANOVA tests was reported but not interpreted with significance.

* $p < .05$. ** $p < .01$.

Table 24

Mean Comparisons: Desire to Age in Place by Housing Characteristics

Housing Characteristics	M	N	SD
Housing type			
A single-family detached home	3.29	1,385	0.95
A multi-unit building	3.17	30	1.02
A mobile home	3.00	2	1.41
A semi-detached home	3.13	64	0.98
Other	3.30	23	0.87
Tenure type *			
Own	3.30	1,467	0.94
Rent	2.67	27	1.24
Other	3.20	5	0.83
Length in current dwelling *			
Less than 5 years	3.31	311	0.97
6 to 10 years	3.31	257	0.94
11 to 20 years	3.17	373	0.97
21 to 30 years	3.20	328	0.97
31 to 40 years	3.44	200	0.88
41 to 50 years	3.76	34	0.55
Over 50 years	3.83	6	0.40
Age of dwelling			
Before 1950	3.29	136	0.98
1951 to 1960	3.46	124	0.78
1961 to 1970	3.35	242	0.91
1971 to 1980	3.25	340	0.94
1981 to 1990	3.10	278	1.07
1991 to 2000	3.31	285	0.92
After 2000	3.42	100	0.91
Don't know	2.75	4	0.95
Location **			
Rural area	3.53	337	0.81
Small town	3.40	332	0.88
City suburb	3.10	654	1.00
City	3.27	179	1.01

* $p < .05$. ** $p < .01$.Hypothesis 2

H2: Demographic and housing characteristics will significantly influence older people's perception of residential technology.

In order to measure older people's perceptions of residential technology, a new variable was created. This variable was made by summing the familiarity with technology products for the home variable (Q18), familiarity with computers variable (Q23), and familiarity with the Internet variable (Q19). Answering options were coded as not familiar=1, somewhat unfamiliar =2, familiar =3, and very familiar =4. A higher score means respondents were more familiar with technology products or service including computers and the Internet. The total mean of perception of residential technology was 10.14 with 1,546 valid responses.

In order to test hypothesis 2, means of perception of the residential technology variable according to demographic and housing characteristics were compared. The results of ANOVA tests showed that there were significant differences in perception of residential technology among variables related to demographic characteristics including age ($F(2, 1540) = 14.957, p < 0.01$), employment status ($F(4, 1538) = 8.088, p < 0.01$), health status ($F(3, 1538) = 19.816, p < 0.01$), number of physical problems ($F(4, 1502) = 3.142, p < 0.05$), education ($F(2, 1536) = 12.728, p < 0.01$), and income ($F(5, 1450) = 8.872, p < 0.01$). Results showed that younger adults with better health conditions and higher education levels had higher perception scores than older people with poorer health conditions and lower education levels. People having incomes that ranged from \$100,000 to \$124,999 had the highest perception scores among respondents in other income ranges. People employed or self employed full time had the highest perception scores among respondents in other employment status categories.

Among housing variables, it seems only one variable, length of residence in current dwelling ($F(6, 1539) = 3.148, p < 0.01$), might influence perception of residential technology. Table 25 and 26 present the results of the mean comparisons of perceptions of residential technology according to demographic and housing characteristics.

Table 25

Mean Comparisons: Perceptions of Residential Technology by Demographic Characteristics

	Demographic Characteristics	<i>M</i>	<i>N</i>	<i>SD</i>
Gender^a	Male	10.1	1,418	1.38
	Female	10.2	122	1.30
Age^{**}	55-64 years	10.33	920	1.30
	65-74 years	9.93	470	1.38
	75 years or older	9.64	153	1.57
Number of the household members	1	10.18	341	1.33
	2	10.14	1,178	1.39
	More than 2	10.08	24	1.05
Employment status^{**}	Employed or self employed full time	10.35	610	1.34
	Employed or self employed part-time	10.06	46	1.35
	Retired and employed part-time	10.19	297	1.40
	Retired and not working	9.92	579	1.37
	Unemployed	9.45	11	1.12
Health status^{**}	Excellent	10.40	783	1.28
	Good	9.89	685	1.42
	Fair	9.75	68	1.39
	Poor	9.66	6	1.03
Marital status^a	Married	10.15	1,392	1.37
	Widowed	9.73	42	1.41
	Divorced	10.18	71	1.35
	Separated	10.45	11	1.50
	Never married	10.19	26	1.26
Education^{**}	Some college	9.38	18	0.91
	College graduate	9.95	584	1.43
	Post graduate study	10.27	937	1.33
Number of physical problems^{a*}	None	10.21	1,170	1.36
	1	9.92	196	1.32
	2	9.94	96	1.54
	3	9.86	38	1.78
	4	9.57	7	1.27
Race^a	White or Caucasian	10.14	1,512	1.37
	Blacks or African	9.8	5	1.92
	American Indian	11.33	3	1.15
	Asian or Pacific islander	11.00	3	0.00
	Mixed race	11.00	1	.
	Other	9.55	9	1.66
Income^{**}	Under \$50,000	9.63	161	1.51
	\$50,000 to less than \$75,000	9.97	344	1.32
	\$75,000 to less than \$100,000	10.17	321	1.28
	\$100,000 to less than \$125,000	19.31	248	1.40
	\$125,000 to less than \$150,000	10.36	136	1.41
	\$150,000 or above	10.41	246	1.32

^a These variables include too few responses to compare with other responses. Therefore, the results of the ANOVA tests was reported but not interpreted with significance.

* $p < .05$. ** $p < .01$.

Table 26

Mean Comparisons: Perception of Residential Technology by Housing Characteristics

Housing Characteristics		M	N	SD
Housing type				
	A single-family detached home	10.14	1,416	1.37
	A multi-unit building	9.93	31	1.18
	A mobile home	9.00	2	0.00
	A semi-detached home	10.28	67	1.63
	Other	10.20	25	1.19
Tenure type				
	Own	10.14	1,504	1.38
	Rent	10.07	27	1.14
	Other	10.40	5	1.67
Living length in current homes**				
	Less than 5 years	10.29	317	1.28
	6 to 10 years	10.20	263	1.37
	11 to 20 years	10.05	387	1.51
	21 to 30 years	10.22	336	1.34
	31 to 40 years	10.01	203	1.24
	41 to 50 years	9.38	34	1.43
	Over 50 years	10.16	6	1.72
Age of dwelling				
	Before 1950	10.06	141	1.46
	1951 to 1960	9.99	124	1.32
	1961 to 1970	10.10	245	1.39
	1971 to 1980	10.16	352	1.34
	1981 to 1990	10.09	290	1.45
	1991 to 2000	10.28	287	1.34
	After 2000	10.29	102	1.26
	Don't know	9.00	5	1.22
Location				
	Rural area	10.19	342	1.33
	Small town	10.09	341	1.36
	City suburb	10.09	671	1.40
	City	10.30	184	1.36

** $p < .01$.Hypothesis 3

H3: Demographic and housing characteristics will significantly influence older people's acceptance of residential technology.

In order to investigate the acceptance of residential technology, a new variable was created based on existing variables. The acceptance variable was created by summing 25 questions asking about respondents' perceptions and experiences regarding technology products and services (Q 19.1 to Q 19.25). Answering options were made based on Rogers' (1995) innovation-decision process that consists of a series of actions and choices over time through which an individual evaluates a new idea and decides whether or not to incorporate the innovation into the ongoing process. Answering options were coded as not familiar with this product or service=1, heard, seen, or read about=2, interested in/ tried looking for information=3, considered purchasing=4, purchased=5, and purchased but do not use or rarely use=5. Fifth and sixth options were coded 5. Therefore, a higher score means respondents were at a later stage of the innovation-decision process. The total mean of acceptance of residential technology was 74.2 with 1,546 valid responses.

Means of acceptance of the residential technology variable were compared for demographic and housing characteristics. Thirteen responses of no answer (1%) were deleted for this analysis. The demographic characteristics of gender, age, number of household members, employment status, health condition, marital status, education level, race, and income were used. As for housing characteristics, housing type, tenure type, length of residence in current dwelling, the age of dwelling, and location were used. For every question, no responses were excluded from the analysis.

ANOVA tests revealed significant differences in acceptance of residential technology among variables related to demographic characteristics including age groups ($F(2, 1540) = 22.454, p < 0.01$), employment status ($F(4, 1538) = 10.080, p < 0.01$), health condition ($F(3, 1538) = 8.971, p < 0.01$), marital status ($F(4, 1537) = 6.209, p < 0.01$), education ($F(2, 1536) = 17.079, p < 0.01$), and income ($F(5, 1450) = 36.145, p < 0.01$). Among housing variables, it seems that the length of living in one's current dwelling ($F(6, 1539) = 8.463, p < 0.01$), age of the dwelling ($F(7, 1538) = 9.221, p < 0.01$), and location ($F(3, 1534) = 5.202, p < 0.01$) might influence acceptance of residential technology. Tables 27 and 28 present the results of the mean comparisons of acceptance of residential technology

according to demographic and housing characteristics. Results showed that younger males with higher education had higher acceptance scores than older females with lower education.

Table 27

Mean Comparisons: Acceptance of Residential Technology by Demographic Characteristics

Demographic characteristics		<i>M</i>	<i>N</i>	<i>SD</i>
Gender ^a	Male	74.3	1418	10.1
	Female	72.7	122	10.9
Age ^{**}	55-64 years	75.3	920	10.1
	65-74 years	73.4	470	9.8
	75 years or older	69.7	153	10.1
Number of the household members				
	1	74.0	341	10.4
	2	74.3	1178	10.1
	More than 2	70.0	24	10.6
Employment status ^{**}				
	Employed or self employed full time	75.9	610	10.2
	Employed or self employed part-time	73.7	46	10.0
	Retired and employed part-time	74.7	297	9.6
	Retired and not working	72.2	579	10.0
	Unemployed	74.5	11	11.7
Health status ^{**}				
	Excellent	75.5	783	10.2
	Good	72.9	685	9.9
	Fair	72.5	68	9.3
	Poor	76.5	6	13.6
Marital status ^{**}				
	Married	74.6	1392	10.0
	Widowed	69.3	42	10.6
	Divorced	71.2	71	9.0
	Separated	76.5	11	11.6
	Never married	69.1	26	14.1
Education ^{**}				
	Some college	70.6	18	7.7
	College graduate	73.1	584	9.6
	Post graduate study	74.9	937	10.5
Number of physical problems ^a				
	None	74.5	1170	10.2
	1	72.7	196	10.4
	2	73.6	96	9.2
	3	73.9	38	10.0
	4	74.4	7	6.3
Race				
	White or Caucasian	74.2	1512	10.1
	Blacks or African	73.8	5	7.2
	American Indian	99.0	3	6.0
	Asian or Pacific islander	74.0	3	16.5
	Mixed race	72.0	1	.
	Other	77.0	9	10.1
Income ^{**}				
	Under \$50,000	68.7	161	9.7
	\$50,000 to less than \$75,000	71.3	344	9.3
	\$75,000 to less than \$100,000	73.9	321	9.6
	\$100,000 to less than \$125,000	75.2	248	10.2
	\$125,000 to less than \$150,000	78.1	136	8.4
	\$150,000 or above	79.3	246	9.6

^aThese variables include too small responses to compare with other responses. Therefore, the results of the ANOVA tests was reported but not interpreted with significance.

^{**} $p < .01$.

Table 28

Mean Comparisons: Acceptance of Residential Technology by Housing Characteristics

Housing Characteristics		M	N	SD
Housing type^a				
	A single-family detached home	74.3	1416.0	10.1
	A multi-unit building	70.6	31.0	9.7
	A mobile home	68.0	2.0	14.1
	A semi-detached home	73.2	67.0	11.1
	Other	74.2	25.0	10.8
Tenure type^a				
	Own	74.2	1504.0	10.2
	Rent	73.1	27.0	9.5
	Other	67.8	5.0	11.4
Living length in current dwelling^{**}				
	Less than 5 years	76.2	317.0	10.4
	6 to 10 years	75.7	263.0	10.0
	11 to 20 years	74.1	387.0	9.5
	21 to 30 years	73.4	336.0	10.1
	31 to 40 years	71.8	203.0	9.5
	41 to 50 years	66.9	34.0	11.8
	Over 50 years	74.7	6.0	18.0
Age of dwelling^{**}				
	Before 1950	71.3	141.0	10.4
	1951 to 1960	73.4	124.0	9.9
	1961 to 1970	72.1	245.0	9.2
	1971 to 1980	73.4	352.0	9.9
	1981 to 1990	75.0	290.0	10.0
	1991 to 2000	77.2	287.0	9.7
	After 2000	76.8	102.0	11.6
	Don't know	64.8	5.0	13.6
Location^{**}				
	Rural area	74.4	342.0	9.6
	Small town	72.7	341.0	10.0
	City suburb	75.1	671.0	10.1
	City	73.0	184.0	11.0

^a These variables include too small responses to compare with other responses. Therefore, the results of the AMOVA tests was reported but not interpreted with significance.

^{**} $p < .01$.

Hypothesis 4

H4: There will be a significant relationship between older people's perceptions and acceptance of residential technology.

To investigate the relationship between perceptions and acceptance of residential technology, Pearson’s correlation was used.

Assumptions of Pearson’s Correlation

Distributions of both variables related by the coefficient of correlation should be linear, normal, and homoscedastic. For data sampled from a normal distribution, normal probability plots should approximate straight lines, and box plots should be symmetric (median and mean together, in the middle of the box) with few if any outliers. Normal probability plots show approximately straight and box plots show approximately symmetric. Additional normality tests such as the Shapiro-Wilk test were not employed because when diagnosis from graphic tests is valid, it is usually considered that this test does not need to be used.

Perceptions and acceptance of residential technology variables are summarized in Table 29. Pearson’s correlation supported the hypothesis that there is a relationship between perceptions and acceptance of residential technology. Therefore, the results can be interpreted to indicate that people having a higher perception score tended to have a higher acceptance score, whereas people having a lower perception score tended to have a lower acceptance score, $r(1541) = 0.344, p < 0.05$. In other words, people who are more familiar with computers, the Internet, and residential technology are more likely to purchase technology products or services.

Table 29
Perception and Acceptance (N=1,541)

Variable	N	M	S
Perception	1546	10.14	1.38
Acceptance	1546	74.20	10.06

Hypothesis 5

H5: There will be significant relationships between attributes of innovations and older people's perceptions of residential technology.

In order to test hypothesis 5, ANOVA tests were used. Means of the perceptions of residential technology were compared according to innovation attributes (Q 20.1 to 20.7). ANOVA tests show that the ease to use variable ($F(2, 1538) = 27.793, p < 0.01$), availability of post purchase service variable ($F(2, 1537) = 10.938, p < 0.01$), and reasonable price variable ($F(2, 1537) = 8.236, p < 0.01$) influenced the respondents' perceptions of residential technology. Respondents who have high perception scores did not tend to consider ease of use, post-purchase service, and price factors when they purchased technology products or services (see Table 30).

Table 30

Mean Comparisons: Perception of Residential Technology by Attributes of Innovations

Attributes of innovation	M	n	SD
Easy to use and understand**			
Very important	9.98	1089	1.40
Somewhat important	10.47	424	1.25
Not important	11.14	28	1.04
Compatible with existing products			
Very important	10.16	793	1.56
Somewhat important	10.14	683	1.34
Not important	10.08	61	1.56
Availability of post-purchase service**			
Very important	10.00	812	1.30
Somewhat important	10.26	644	1.31
Not important	10.58	84	1.30
Reasonable price**			
Very important	10.04	914	1.38
Somewhat important	10.27	610	1.36
Not important	11.00	16	1.03
Distinctive higher performance compared with existing products			
Very important	10.16	814	1.39
Somewhat important	10.13	690	1.33
Not important	9.88	36	1.68
Easy to show its performance to others			
Very important	10.11	245	1.38
Somewhat important	10.06	699	1.35
Not important	10.24	596	1.40
Easy to test its performance or “try it out”			
Very important	10.14	717	1.33
Somewhat important	10.11	734	1.43
Not important	10.6	81	1.17

** $p < .01$.Hypothesis 6

H6: There will be significant relationships between attributes of innovations and older people’s acceptance of residential technology.

In order to test hypothesis 6, ANOVA tests were used. ANOVA tests revealed that the ease of use variable ($F(2, 1538) = 15.891, p < 0.01$) and reasonable price ($F(2, 1537) = 23.630, p < 0.01$) influenced the acceptance of residential technology. Respondents who

have high acceptance scores did not tend to consider ease of use and price factors (see Table 31).

Table 31

Means Comparisons: Acceptance of Residential Technology by Attributes of Innovations

Attributes of innovation	M	n	SD
Easy to use and understand**			
Very important	73.25	1087	10.07
Somewhat important	75.95	421	9.80
Not important	79.46	28	8.91
Compatible with existing products			
Very important	74.02	790	10.11
Somewhat important	74.47	681	9.87
Not important	73.10	61	9.75
Availability of post-purchase service			
Very important	73.99	810	10.67
Somewhat important	74.05	642	9.40
Not important	75.70	83	8.59
Reasonable price**			
Very important	72.81	913	10.16
Somewhat important	75.87	607	9.50
Not important	81.33	15	13.57
Distinctive higher performance compared with existing products			
Very important	74.26	811	10.30
Somewhat important	74.13	688	9.82
Not important	70.53	36	8.94
Easy to show its performance to others			
Very important	73.55	243	10.39
Somewhat important	74.34	699	10.33
Not important	74.03	593	9.62
Easy to test its performance or “try it out”			
Very important	73.47	716	10.26
Somewhat important	74.63	730	9.95
Not important	75.10	81	9.25

** p < .01.

Hypothesis 7

H7: There will be a significant relationship between the desire to age in place and older people’s perceptions of residential technology.

In order to examine the relationship between the desire to age in place and perception of residential technology, Pearson’s correlation was employed. The desire to age in place variable and perception variable are summarized in Table 32. Pearson’s correlation supported the hypothesis that there is a relationship between the desire to age in place and the respondents’ perceptions of residential technology. The result from Pearson’s correlation implies that people with a higher desire to age in place tended to have a lower perception score, whereas people with a lower desire to age in place tended to have a higher perception score, $r(1540) = -0.70, p < 0.05$.

Table 32

The Desire to Age in Place and Perception of Residential Technology (N=1,540)

Variables	N	M	SD
Desire to age in place	1540	3.31	0.98
Perception	1540	10.14	1.38

Hypothesis 8

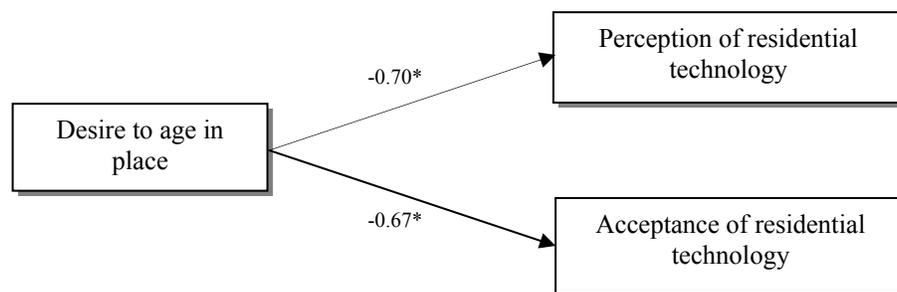
H8: There will be a significant relationship between the desire to age in place and older people’s acceptance of residential technology.

In order to examine the relationship between the desire to age in place and the acceptance of residential technology, Pearson’s correlation was employed. The desire to age in place variable and the acceptance variable are summarized in Table 33. Pearson’s correlation supported the hypothesis that there is a relationship between the desire to age in place and the acceptance of residential technology. The result from Pearson’s correlation implies that people with a higher desire to age in place tended to have a lower acceptance score, whereas people with a lower desire to age in place tended to have a higher acceptance score, $r(1535) = -0.67, p < 0.05$. The relationship between perceptions and acceptance and the desire to age in place is shown in Figure 11.

Table 33

The Desire to Age in Place and Acceptance of Residential Technology (N=1,535)

Variable	N	M	SD
Desire to age in place	1535	3.31	0.98
Acceptance	1535	74.16	10.02



*p<0.05

Figure 13. Pearson's Correlation: Relationship of the Desire to Age in Place and Perception and Acceptance of Residential Technology.

Hypothesis 9

H9: The desire to age in place will be more directly related to perceptions and acceptance of residential technology than other variables such as demographic characteristics or housing characteristics.

To examine hypotheses 9, path analysis was employed. Path analysis was developed as a method of studying direct and indirect effects of variables hypothesized as causes of variables. Path analysis is intended not to discover causes but to shed light on the tenability of the causal models a researcher formulates based on theoretical considerations (Pedhazur, 1997). Multiple regression analysis can be viewed as a special case of path analysis. However, one of the advantages of path analysis is that it affords the decomposition of

correlations among variables, thereby enhancing the interpretation of relations as well as the pattern of the effects of one variable on another.

Assumptions for Path Analysis

Basic assumptions underlying the application of path analysis are linearity, independence of each residual, and a one-way causal flow. The linear relationship between two variables and a one-way causal flow were assumed based on theoretical backgrounds.

Assumptions for Regression Analysis

Regression analysis assumes the residuals (predicted minus observed values) are normally distributed. As for the perception variable, it does not appear that there is normal distribution of the residuals shown in the histogram. However, the normal probability plot of the residual showed they fell in a fairly straight line. In terms of the acceptance variable, relatively normal distribution of the residuals was shown in the histogram. Also, a normal probability plot of the residual showed they fell in a fairly straight line. Therefore, the assumptions for normality were met.

Prior to conducting the regression analysis, multicollinearity diagnostics were performed. The variance inflation factor (VIF) and tolerance were examined for multicollinearity diagnostics. The VIF for each independent variable was less than 10, which is the cut-off value beyond which multicollinearity would be indicated. The tolerance for each independent variable was greater than 0.01, which is conventionally used as a default cutoff for entering variables in the analysis. Therefore, the result from the diagnostics implied that there is no serious multicollinearity. Gender and race variables were excluded because some categories of these variables were too small to conduct statistical tests.

In order to explore relationships proposed in the theoretical framework (Figure 14), five regression analyses were employed.

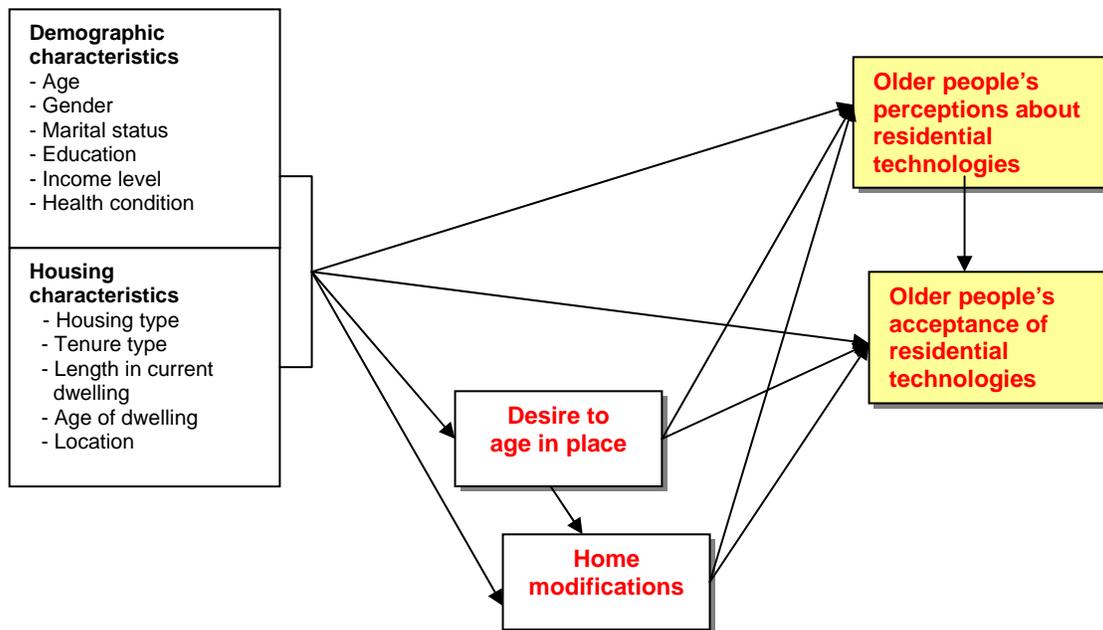


Figure 14. Hypothesized Relationships between Variables.

To explore this influence, path analysis was employed. Five regression models were tested. The first model for testing the relationships of demographic and housing characteristics (independent variables) and the desire to age in place (dependent variable) was significant at the level of $p=0.000$. The results of regression analysis showed three significant variables ($p<0.05$). The variables were age group ($\beta= 0.184$), tenure type ($\beta= -0.089$), and location ($\beta= -0.138$) (see Table 34). Standardized coefficients showed that age had the biggest impact on the desire to age in place among other variables. The direct effect of these variables on the desire to age in place is shown in Figure 13. Table 34 presents the result of the multiple regression analysis.

Table 34

Path Analysis Result: Coefficients of Path Model 1

Model 1	Standardized Coefficients (Beta)	t-value
(Constant)		9.836
Housing type	.004	.130
Tenure type	-.089	-3.284***
Length in current dwelling	-.054	-1.664
Age of dwelling	-.059	-1.835
Location	-.138	-5.112***
Gender	.018	.658
Age	.184	5.890***
Number of household members	.021	.701
Employment status	.021	.658
Health condition	-.018	-.620
Number of physical problems	-.012	-.422
Marital status	-.013	-.420
Education	-.012	-.449
Race	.033	1.256
Income	-.034	-1.121

Note. Dependent Variable: the desire to age in place

*** $p < .001$.

The second path model for investigating the relationships of demographic, housing characteristics, and the desire to age in place (independent variables) and home modification variable (dependent variable) was significant at the significance level $p=0.000$. Regression shows that there are three significant variables having direct effects on the home modification variable ($p=0.000$). The variables were age of dwelling ($\beta= -0.134$), tenure type ($\beta= -0.060$), and number of physical problems ($\beta= 0.074$). Standardized coefficients showed that age of dwelling had the biggest impact on home modifications among other variables. Table 35 presents the result of the multiple regression analysis.

Table 35

Path Analysis Result: Coefficients of Path Model 2

Model 2	Standardized Coefficients (Beta)	t-value
(Constant)		3.144
Housing type	-.022	-.810
Tenure type	-.060	-2.154*
Length in current dwelling	-.025	-.757
Age of dwelling	-.134	-4.073***
Location	-.047	-1.683
Gender	.009	.330
Age	-.016	-.484
Number of household members	.000	-.007
Employment status	-.013	-.384
Health condition	.007	.237
Number of physical problems	.074	2.582**
Marital status	-.015	-.461
Education	.016	.572
Race	.046	1.714
Income	.022	.706
Aging in place	.022	.783

Note. Dependent Variable: Home modifications

* $p < .05$. ** $p < .01$. *** $p < .001$.

The third path model for investigating the relationship of demographic, housing characteristics, the desire to age in place, and home modification variable (independent variables) and perception of residential technology (dependent variable) was significant at the significance level $p=0.000$. Regression shows four significant variables. These variables were age ($\beta = -0.120$), health condition ($\beta = 0.135$), education ($\beta = 0.106$), and income ($\beta = 0.072$) ($p < 0.05$). Standardized coefficients showed that age had the biggest impact on explaining perception of residential technology among other variables. Table 36 presents the results of the multiple regression analysis.

Table 36

Path Analysis Result: Coefficients of Path Model 3

Model 3	Standardized Coefficients (Beta)	t-value
(Constant)		13.975
Housing type	.027	.986
Tenure type	.047	1.724
Length in current dwelling	.001	.018
Age of dwelling	.026	.805
Location	.005	.195
Gender	.030	1.108
Age	-.120	-3.798***
Number of household members	.033	1.067
Employment status	-.025	-.759
Health condition	.135	4.751***
Number of physical problems	-.029	-1.026
Marital status	.009	.277
Education	.106	3.996***
Race	.028	1.072
Income	.072	2.410*
Aging in place	.019	.713
Home modification	.022	.836

Note. Dependent Variable: Perception of residential technology

* $p < .05$. *** $p < .001$.

The fourth path model for investigating the relationship of demographic, housing characteristics, the desire to age in place, and home modification variable (independent variables) and acceptance of residential technology (dependent variable) was significant at the significance level $p=0.000$. Regression reveals that there were five significant variables. These variables were age ($\beta = -0.061$), education ($\beta = 0.055$), income ($\beta = 0.281$), age of dwelling ($\beta = 0.134$), and home modification variable ($\beta = 0.105$) ($p < 0.05$). Standardized coefficients showed that income had the biggest impact on explaining acceptance of residential technology among other variables. Table 37 presents the results of the multiple regression analysis.

Table 37

Path Analysis Result: Coefficients of Path Model 4

Model 4	Standardized Coefficients (Beta)	t-value
(Constant)		16.864
Housing type	-.029	-1.120
Tenure type	.002	.062
Length in current dwelling	-.043	-1.384
Age of dwelling	.134	4.354***
Location	-.010	-.369
Gender	-.006	-.249
Age	-.061	-2.027*
Number of household members	.005	.170
Employment status	.016	.515
Health condition	.025	.931
Number of physical problems	.015	.540
Marital status	-.048	-1.616
Education	.055	2.171*
Race	.019	.759
Income	.281	9.741***
Aging in place	-.043	-1.664
Home modification	.105	4.121***

Note. Dependent Variable: Acceptance of residential technology

* $p < .05$. *** $p < .001$.

The last path model for investigating the direct effect of perceptions of residential technology on acceptance of residential technology was significant ($p=0.000$). The direct effect of perception of the residential technology on acceptance of residential technology was positive ($\beta= 0.344$) and significant at the significant level $p < 0.05$. Table 38 presents the result of the regression analysis.

Table 38

Path Analysis Result: Coefficients of Path Model 5

Model 5	Standardized Coefficients (Beta)	t-value
(Constant)		27.197
Perception	.344	14.379***

Note. Dependent Variable: Acceptance of residential technology
 *** $p < .001$.

The significant relationships from the tests are presented in Figure 15. Although many significant relationships ($p < 0.05$) were supported by the analysis, not all (noted by dotted line in Figure 15) relationships were strong enough to warrant definite conclusions about the direct effect of the desire to age in place on attitudes toward residential technology.

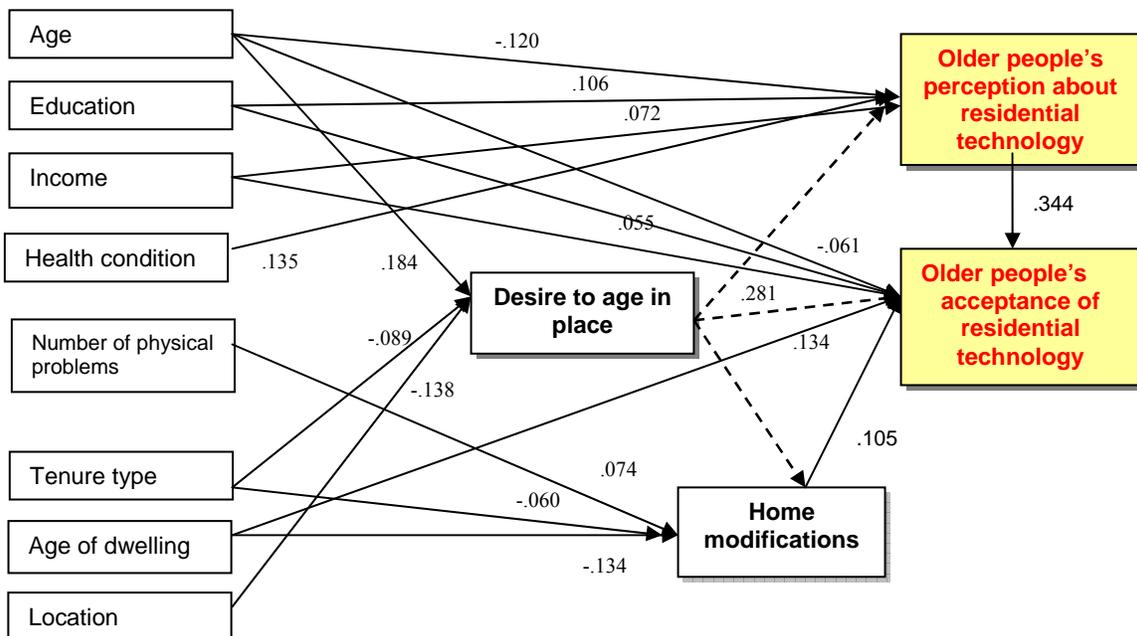


Figure 15. Significant Paths from Regression Analysis ($p < 0.05$).

Summary

This section includes results and findings from the online survey, summary of demographic and housing characteristics of the sample, perceptions and behaviors related to the desire to age in place. In addition, perceptions related to home modifications and perceptions, and acceptance of residential technology, and results from the nine hypotheses are summarized.

Online questionnaires were distributed to a potential sample of 9,789 e-mail addresses who were 55 and older through the Virginia Tech alumni list serve on February 3, 2004. The response rate was 15.8% with 1,546 eligible responses returned by February 27.

Respondents can be described as Caucasian married males, age 55 to 74 years of age, with excellent or good health and a post bachelor's education. The majority of respondents lived in owned single-family detached homes.

Attitudes toward aging in place were significantly different by age groups. Older adults were more likely to agree with the statement: *I'd really like to live in my current residence for as long as possible.*

Over half of the respondents answered that they had not made home modifications within the last five years. Although there were differences in how the questions were asked, this figure was lower than that of the national sample conducted by the AARP in 2000 (Bayer & Harper, 2000). According to this survey, 90% of the respondents had made at least one simple change or major home modification.

A majority of the respondents answered that they learned about newly introduced home technology products from traditional media such as magazines, television, and newspapers. The majority of the respondents reported that they were very familiar or somewhat familiar with technology products. Familiarity with computers and the Internet were different by age groups. Younger adults showed more familiarity with computers and the Internet. Easy of use was the most important factor for all age groups when they

purchased new technology products. Older adults were much more likely than younger adults to consider easy of use and availability of post-purchase service as important factors when purchasing newly introduced technologies.

A large majority of the respondents had purchased microwave ovens (98%), CD players (96%), VHS players (93%), cellular phones (88%), and DVD players (74%). Many respondents showed their interest in high-technology products. Response rates showed specific patterns according to the innovation-decision stages. The patterns were divided into five groups, matched with proposed residential technology categories: survival technology; basic technology; and high technology. Technology products under the three categories would be different when compared to a general older population, especially in terms of adoption of high technologies, because this sample was unique in terms of attitudes toward computer technology -- 98% of the respondents had computers in their homes. It is expected that their early adoption of computers influenced their purchase of other high technology products.

Results from the proposed hypotheses presented support for eight of the nine hypotheses. Although many significant relationships ($p < 0.05$) were supported by the analysis, not all relationships were strong enough to warrant definite conclusions about the direct effect of the desire to age in place on attitudes toward residential technology. Table 39 shows a summary of the results.

Table 39

Summary of the Results from Hypotheses Tests

Hypotheses		Result
H1:	Demographic and housing characteristics will significantly influence the desire to age in place.	Supported
H2:	Demographic and housing characteristics will significantly influence older people's perception of residential technology.	Supported
H3:	Demographic and housing characteristics will significantly influence older people's acceptance of residential technology.	Supported
H4:	There will be a significant relationship between older people's perception and acceptance on residential technology.	Supported
H5:	There will be significant relationships between attributes of innovations and older people's perception of residential technology.	Supported
H6:	There will be significant relationships between attributes of innovations and older people's acceptance of residential technology.	Supported
H7:	There will be a significant relationship between the desire to age in place and older people's perceptions of residential technology.	Supported
H8:	There will be a significant relationship between the desire to age in place and older people's acceptance of residential technology.	Supported
H9:	The desire to age in place will be more directly related to older people's perceptions and acceptance of residential technology than other variables such as demographic characteristics or housing characteristics.	Not Supported

CHAPTER 5. DISCUSSION AND IMPLICATIONS

This chapter summarizes the research, presents major findings, discusses implications of the findings and conclusions, and provides suggestions for future research.

Summary of the Research

The purpose of this study was to investigate older people's attitudes toward adopting residential technology that could improve the residents' quality of life and assist in aging in place. This study had a two-stage approach. First, in order to investigate behaviors of older people who want to age in place, attitudes toward aging in place were investigated. The relationships between the desire to age in place and selected demographic and housing variables were examined. Second, perceptions and acceptance of residential technologies by older people were examined. The influence of selected characteristics, including technology adopters' characteristics, attributes of innovations, and the desire to age in place on older people's perceptions and acceptance of residential technologies was examined. The assumption of this study was that housing design and supportive technology, called residential technology in this research, could play a major role in supporting older people to live independently, especially those who want to stay in their homes as they age. Therefore, the desire to age in place was assumed to be a main factor in motivating older people to adopt residential technology. Under this assumption, the purpose of this study was to examine the relationships among technology, the environment, and users.

To investigate older people's attitudes toward residential technology, two theoretical frameworks were employed in this research: the person- environment interaction model (Lawton & Nahemow, 1973) and the diffusion of innovations theory (Rogers, 1995; Rogers & Shoemaker, 1971). The research framework was set up based on these theoretical backgrounds.

Data for this study were gathered using an online survey during February 2004. Prior to conducting the survey, a pre- test and a pilot test with a small sample were conducted. Online questionnaires were distributed to the potential sample of 9,789 e-mail addresses who were age 55 and older through the Virginia Tech alumni list serve on February 3, 2004. The response rate was 15.8% with 1,546 eligible responses returned by February 27. Questionnaires were not directly distributed by the researcher, but through the alumni list serve. This idea was suggested by the alumni association in order to protect e-mail addresses of the alumni and to encourage participation. However, the impact of this procedure cannot be measured. The response rate was not high. Although lower than some mail surveys, it is hard to say this response rate was due only to the online data collection method. Other factors might include the high education level of respondents, the predominance of male respondents, and the large number of e-mails that many of the sample receive on a daily basis. Additionally, there was no follow-up e-mail reminding them to complete the survey.

Nine hypotheses were proposed based on the research framework. Descriptive statistics, chi-square test, Pearson's correlation, ANOVA, and path analysis were employed to describe data and examine hypotheses.

Major Findings and Implications

Respondents can be described as Caucasian (97.8%) married (90%) men (91.7%), age 55 to 74 years old (89.9%), with excellent or good health (94.9%) and a post bachelor education (60.6%). Only eight percent of the respondents were female and two percent were non-white. This fact reflects predominance of the Caucasian male student population at Virginia Tech during the time the alumni were in college. For this reason, analysis by gender and race were presented, but not significantly interpreted. Almost 43% were employed and 38% were retired and not working. Although a majority of the respondents

represented the younger old population (under 75 years), demographic findings showed that there were a surprisingly high percentage of non-working retirees.

In terms of housing conditions, a majority of the respondents lived in owned (97.3%) single-family detached homes (91.6%). Almost half of the respondents lived in city suburban areas (43.4%), followed by rural areas (22.1%), small towns (22.1%), and city areas (11.9%). The length of living in their current dwelling ranged from less than 5 years to 40 years. The dwelling age ranged from 4 to 43 years.

Although the demographic profile of the respondents was homogeneous, Caucasian, male, and highly educated, attitudes toward aging in place varied by age. The desire to age in place was significantly different among age groups according to the results of the chi-square. The older respondents showed a stronger desire to age in place. As for future housing plans, there were differences among age groups as well. However, there was no specific response pattern according to age. A higher percentage of the older adults compared to the younger adults stated that they have not really thought about where they would live in the next 10 years.

Respondents stated that the most influential factor in their decision to age in place was community/ neighborhood quality and a majority (73%) foresaw no particular problems related to their neighborhood as they age in place. Respondents indicated that an inconvenient house design (24%) might present a problem to aging in place. When asked what they would do when they faced difficulties in their current dwellings, they answered by saying they would move to a different house (24%), move where they were able to receive assistance (21%), or continue to live without any changes (4%). Approximately 20% responded they would consider repairs and renovations. This answer was consistent with the result of the question about home modification.

When asked about home modifications within the last five years, approximately 20% said they have considered making modifications, while 35% reported that they had made modifications within the last five years. This figure was lower than the national survey conducted by the AARP in 2000 (Bayer & Harper, 2000). According to this study,

90% of the respondents have made at least one simple change or major home modification. Home modifications were mainly made in the bathroom, bedroom, and kitchen. Respondents made home modifications for comfort and convenience. As for other reasons for making home modifications, they responded that they made home modifications to improve home resale value or to have a maintenance-free home environment.

A majority of the respondents answered that they learned about newly introduced home technology products from the traditional media, such as magazines, television, and newspapers. Fourteen percent of the respondents stated that the Internet was the source of information. Although, some respondents gathered information from the Internet or through word of mouth, the older population seems to prefer more traditional media to obtain information. Although respondents in this study reported that they were familiar with the Internet and actively used computers and the Internet, results showed they prefer traditional media channels to obtain new information. This fact implies that marketers advertising their new products or services, or government agencies announcing new information for the general older population are recommended to use traditional media channels as the main communication channel.

Respondents showed similar attitudes toward computer and Internet technology. This fact was not surprising, since the sample was composed of those with e-mail addresses. A great majority of the respondents (98%) reported they had computers at home -- an extremely high figure compared to that of the national survey (33%). Among those who have computers, 22% said they had more than two computers at home. Not surprisingly, a majority of the respondents reported that they were familiar with computers and the Internet. Although, this sample showed similar attitudes toward computers and the Internet, familiarity with computers and the Internet showed a significant difference by age groups. Although the difference was not large, the younger respondents were more familiar. Approximately 88% use e-mails daily, 83% started using the Internet five or more years ago, 58% said work motivated them to start using the Internet. Ease of use was the most important factor for all age groups when they purchased new technology products. Older

adults were much more likely than younger adults to consider ease of use and availability of post-purchase service as important factors when purchasing newly introduced technologies.

A majority of the respondents had purchased microwave ovens (98%), CD players (96%), VHS players (93%), cellular phones (88%), DVD players (74%), and remote garage door openers (70%). Many respondents showed their interest in high-technology products. Five types of response patterns regarding residential technology emerged based on the innovation-decision process. These patterns were matched with proposed categories of residential technology: survival technology; basic technology; and technology. Technology products under the three categories would be different when compared to a general older population, especially in terms of adoption of high technologies, because this sample was unique in terms of attitudes toward computer technology -- 98% of the respondents had computers in their homes. It is expected that their early adoption of computers influenced their purchase of other high technology products. The purchase rate of the survival technologies would be the same or similar with a general old population. However, some basic technology products, such as cellular phones, DVD players, or remote garage door openers, might be considered high technologies when considering a general older population in terms of the purchase rate. Also, it is expected that the purchase rate of high technology products might be lower in the general older population.

Approximately 9% of the respondents reported they purchased DVD players but did not use or rarely used them followed by VHS players (8%), CD players (7%), fax machine (6%), PDAs (6%), and electronic tooth brushes (5%). It is assumed that there are many factors influencing their decision not to use these technology products. For some products, such as VHS players, CD players, and fax machines, respondents might find more convenient alternate products. However, for more recently introduced products such as, PDAs, DVD players, and electronic tooth brushes, they might stop using them, because they were not as satisfied with these products as they expected to be. Their lifestyle, especially the way they spend their leisure time, might influence their decision as well.

People who prefer reading, travel, or outdoor activities might not feel a need to upgrade home entertainment systems, such as DVD players or home theater systems.

Nine research hypotheses were proposed to examine the relationship of variables. Hypothesis 1 concerned the relationship between demographic and housing characteristics and the desire to age in place. This hypothesis was examined by ANOVA. The results showed that there were significant differences in the desire to age in place by age groups, number of household members, employment status, income, tenure type, length in current dwelling, and location. Older adults showed a stronger desire to age in place than younger adults. Given the results of testing hypothesis 1, other housing characteristics, such as housing type and age of dwelling, do not appear to affect the degree of the respondent's desire to age in place. Other demographic factors such as health conditions, marital status, education, and race do not seem to affect the degree of the desire to age in place.

Hypothesis 2 and 3 dealt with older people's attitudes toward residential technology. Attitudes were examined in terms of perceptions and acceptance. Hypothesis 2 examined the relationships between demographic and housing characteristics and perceptions of residential technology. To measure the perceptions of residential technology, a new variable was created by summing three questions. The results of ANOVA showed there were significant differences in the perceptions of residential technology by age groups, employment status, health condition, number of physical problems, education, income, and length of residence in current dwelling. Results indicated that younger adults with better health conditions and a higher education showed higher perception score than older people with poorer health conditions and a lower education. People having incomes between \$100,000 and \$124,999 showed the highest perception score among respondents. Also, people who were employed full time had the highest perception scores among respondents as compared to those who were employed part time or retired.

Hypothesis 3 examined the relationship between demographic and housing characteristics and acceptance of residential technology. To represent the acceptance of technology, a new variable was created by summing twenty-five questions. These questions

dealt with the degree of the adoption process for about twenty-five residential technology products or services. ANOVA revealed that there were significant differences related to acceptance of residential technology by age groups, employment status, health condition, marital status, education, income, length of residence in current dwelling, age of dwelling, and location. Results showed that younger males with a higher education had higher acceptance scores than older females with lower education.

The results from hypotheses 3 and 4 showed that there were differences in influential factors between perceptions and acceptance. Most variables influenced both perceptions and acceptance of residential technology. However, some variables influenced only perceptions or acceptance. Among the demographic variables, marital status influenced only acceptance, while the number of physical problems only influenced perceptions. In terms of housing characteristics, location and age of the dwelling influenced only acceptance. These differences might imply that different marketing strategies will be needed when new technology products or services are introduced to the older population. For example, location of shops might influence older consumers' purchases.

Hypothesis 4 concerns the relationship between older people's perceptions and acceptance of residential technology. The result of Pearson's correlation showed there was a significant linear relationship between the two variables. Therefore, the result implies that people having higher perception scores tended to have higher acceptance scores.

Hypothesis 5 and 6 dealt with the relationship between attributes of innovations and older people's perceptions and acceptance of residential technology. Hypothesis 5 concerned the relationship between attributes of innovations and perceptions of residential technology. The results from the ANOVA showed that ease of use, post-purchase service, and price influenced perceptions of residential technology. The results indicated that respondents who have high perception scores do not tend to consider ease of use, post-purchase service, and price factors.

Hypothesis 6 examined the relationship between attributes of innovations and acceptance of residential technology. The results from the ANOVA demonstrated that ease

of use and price influenced acceptance of residential technology. The results indicated that respondents who have high acceptance scores did not tend to consider ease of use and price factors.

Hypotheses 7 and 8 dealt with the relationship between the desire to age in place and older people's perceptions and acceptance of residential technology. Hypothesis 7 examined the relationship between the desire to age in place and perceptions of residential technology. The result of Pearson's correlation indicated that there was a negative linear relationship. The result implies that people with a higher desire to age in place tended to have a lower perception value, whereas people with a lower desire to age in place tended to have a higher perception value.

Hypothesis 8 examined the relationship between the desire to age in place and acceptance of residential technology. The result of Pearson's correlation revealed a negative linear relationship. The result implies that people with a higher desire to age in place tended to have a lower acceptance score, whereas people with less desire to age in place tended to have a higher acceptance score. These results imply that age is the important factor for both perceptions and acceptance of residential technology, because the desire to age in place was greatly influenced by age. Age negatively influenced perceptions and acceptance of residential technology. Thus people who were older showed lower perception and acceptance scores. This result influenced the interpretation of hypothesis 9 as well.

Hypothesis 9 examined the direct effect of the desire to age in place on attitudes toward residential technology. The result of path analysis showed that there was not a significant direct effect of the desire to age in place on attitudes toward residential technology. Results from regression revealed that the most influential factors at each path model with the power of standardized coefficients. These results were: age had the greatest impact on the desire to age in place; age of dwelling had the biggest influence on home modifications; age had the greatest impact on perception of residential technology; and income had the greatest impact on acceptance of residential technology. Although many

significant relationships were supported by the path analysis, not all relationships were strong enough to warrant the definite conclusion that there is a direct effect of the desire to age in place on attitudes toward residential technology.

A proposed theoretical framework was tested with 9 hypotheses as well. Although the major assumption tested by hypothesis 9 was not supported, this proposed research framework has numerous implications. Until now, there has been little research to investigate the relationship between the desire to age in place and attitudes toward residential technology based on a theoretical framework. The results from the test of hypothesis 9 showed there is no direct impact on the desire to age in place and perceptions and acceptance of residential technology. Age, education, and income appear to have a direct effect on perceptions and acceptance of residential technology, while age, tenure type, and location have a direct effect on the desire to age in place. Age was revealed as an important factor for both the desire to age in place and attitudes toward residential technology as a direct effect. If other factors such as, education, income, health conditions, and number of physical problems, strongly influenced the desire to age in place, the desire to age in place could have a strong direct impact on attitudes toward residential technology. It is assumed that different results can be drawn from different samples, such as a sample with various education levels, different health conditions, or a varied income level, because the sample for this study was homogenous in terms of these conditions. Results from this study stated that young older people having a high income and good health conditions have a weaker desire to age in place. This fact might lead to the conclusion that the desire to age in place has no direct impact on attitudes toward residential technology. This result also can be applied to interpret the relationship between home modifications and the desire to age in place: few respondents had made home modifications compared to the national population.

Suggestions for Future Study

Based on the results and implications of this study, the following suggestions and recommendation are presented.

1. As early adopters, the sample for this study has some uniqueness. They are mainly white, married, relatively young old men with good health and a high level of education. Although this has important implications, it limits the generalizations of the results. Future research should include people with various demographic backgrounds including gender, race, and education levels. Especially future research that can investigate gender differences toward residential technology is recommended.
2. An online survey was employed to collect data in this study. However, no attempt was made to determine what influenced people's responses. Future research that can measure the differences between traditional surveys and online survey techniques will be needed to improve the response rate. For example, research that employs both traditional mail surveys and on line surveys will be needed to compare the advantages and disadvantages.
3. Although age appears to be a very influential factor in the desire to age in place and attitudes toward residential technology, other variables, such as the number of children, ownership of a second home, or spouse's health conditions, should be examined in future research. Although the purpose of this research was not to create or test the index to predict older people's attitudes toward technology, possible variables based on different theoretical frameworks will enhance the understanding of the relationships. In particular, how respondents spend their leisure time might be a predictor in understanding why older adults accept or reject newly introduced technology products or services.
4. In this study, specific response patterns toward the acceptance of residential technologies emerged. The patterns were divided into five groups, matched with proposed residential technology categories. It is expected that technology products

under the categories would be different when considering a general older population, especially in terms of high technologies, because this sample is unique in terms of attitudes toward computer technology. Respondents' early adoption of computers was expected to influence their purchase of other high technology products and services. However, in this study, the influence of early adoption of computers on the purchase of other high technologies could not be measured. Further research employing samples of computer adopters and non-adopters to investigate this influence will be needed

5. The results of the hypotheses test indicate perceptions and acceptance of residential technology appear to be different. They are influenced by different variables. This might have resulted partly from marketing approaches to older consumers. Future research should examine whether a lack of consumer need for the technology results in low perceptions or whether problems with obtaining needed information about the product or difficulty in obtaining the product results in low perception about the technology products.
6. Differentiated marketing strategies should be examined in order to approach older consumers. Older adults showed high interest levels in newly introduced technology products such as wireless health monitoring systems, remote controls for raising/lowering shutters, video-phones at entrance, video phones, and emergency alert products. It can be interpreted that they were interested in these products because they feel they might need these technologies now or in the future. However, they did not consider purchasing these products. The reasons might be high price, poor design, difficulties in finding the product, or a perception that they were difficult to operate. This research could result in recommending new design and marketing strategies. Marketers should consider traditional communication channels, such as magazines or newspapers, as a main communication channel, to introduce new products.

7. In order to examine the attitudes toward residential technology, other theoretical backgrounds such as economics related theories or marketing related theories should be applied to propose broader research models.
8. Although residential technology was defined in this research, this attempt can be considered as an initial try to categorize technology related to the home in order to understand the relationship between residents and technology. Many assistive technology products or technology related to outdoor maintenance such as automatic lawn mowers were not included. In future research, more organized and specific technology categories based on this study should be considered.

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APPENDIX A

HUMAN SUBJECT APPROVAL

Institutional Review Board

Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice Provost for Research Compliance
CVM Phase II - Duckpond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
e-mail: moored@vt.edu

September 9, 2003

MEMORANDUM

TO: Rosemary Goss Near Environments 410
Mira Ahn NE 0410

FROM: David M. Moore 

SUBJECT: IRB EXEMPTION APPROVAL – “The role of Technology in assisting
older people to age in place” – IRB # 03-429

I have reviewed your request to the IRB for exemption for the above referenced project.
I concur that the research falls within the exempt status. Approval is granted effective as
of September 9, 2003.

cc: file
Department Reviewer: LuAnn Gaskill NE 0410

APPENDIX B

ONLINE QUESTIONNAIRE AND COVER LETTER

Attitudes toward Residential Technology Survey

Dear Virginia Tech Alumni.

Hello! This is Mira Ahn, a Ph.D. candidate in housing at Virginia Tech. I am doing research about the influence of technology on helping people to stay in their homes as they get older.

The purpose of this research is to investigate people's attitudes about adopting technology as it relates to the home that could improve the quality of life and assist in aging in place. This study is an important one that will help designers and housing professionals understand people's attitudes toward technology. In order to investigate attitudes toward residential technology, I am doing an online survey. This survey is composed of questions relating to housing, housing preferences, technology, and demographics.

You are receiving this e-mail from the Virginia Tech Alumni Association if you graduated in or prior to 1970. I extend my appreciation to Dr. Thomas C. Tillar, Jr., vice president for alumni relations, for his support and willingness to distribute this survey via the Virginia Tech Alumni Association. The Virginia Tech Alumni Association has assisted graduate student research in the past; however, you will be a part of the first online survey.

Let me assure you of complete confidentiality. The information gathered from this survey will be used only for research purposes and your e-mail address will never be distributed for any other purpose.

If you are **UNDER 55 YEARS of age or live in an ASSISTED LIVING FACILITY**, please do not begin this survey. Just ignore this e-mail. Thank you for your assistance!

As a small token of appreciation for assisting with this research, I will randomly draw four questionnaires from those returned, and the respondents will receive a \$100 gift certificate that can be used in either the on-campus or online Virginia Tech bookstore.

The questionnaire will take approximately 10 to 15 minutes to complete.

If you have any questions about the survey, please contact me by e-mail at mahn@vt.edu.

Thank you for your time and assistance. It's only with the help of people like you that this research can be successful.

To start this survey, please click on the website below!

<https://survey.vt.edu/survey/entry.jsp?id=1066241828551>

Mira Ahn

Ph.D. Candidate in Housing
Apparel, Housing & Resource Management
Virginia Tech

Dr. Rosemary Goss

Professor of Housing and Ph. D. Advisor
Apparel, Housing & Resource Management
Virginia Tech

Let's begin with a few questions about your current housing situation.

1. What best describes your home?

- A single-family detached home
- A multi-unit building (apartment, either low-rise or high-rise)
- A mobile home
- A semi-detached home (Ex. townhouse, or duplex)
- Other. Please specify. _____

2. Do you live in an assisted living facility?

- Yes (if **YES**, please stop and return the survey. To return this survey, please hit the SUBMIT button at the end of this survey)
- No (if **NO**, please continue with Question 3)

3. Do you own or rent your place of residence?

- Own
- Rent
- Other. Please specify. _____

4. How long have you lived in your current residence?

- Less than 5 years
- 6 to 10 years
- 11 to 20 years
- 21 to 30 years
- 31 to 40 years
- 41 to 50 years
- Over 50 years

5. When was your home built?

- Before 1950
- 1951 to 1960
- 1961 to 1970
- 1971 to 1980
- 1981 to 1990
- 1991 to 2000
- After 2000
- Don't know

6. How would you describe where your home is located?

- Rural area
- Small town
- City suburb
- City

7. Do you think you will continue to live in your current residence for more than 10 years?

- Yes
- No
- Don't know

8. Have you made any plans for where you will live 10 years from now?

- Yes, I (we) have fairly definite plans
- I (we) have explored options
- I (we) have begun to talk about it
- No, I (we) haven't really thought about it

9. What best describes your reaction to the following statement?

I'd really like to live in my current residence for as long as possible.

- Strongly Agree
- Somewhat Agree
- Somewhat Disagree (If you answered this, go to **Question11**)
- Strongly Disagree (If you answered this, go to **Question11**)
- Don't Know (If you answered this, go to **Question11**)

10. If you answered "strongly agree" or "somewhat agree" in Question 9, what most influenced your decision to stay in your current residence? (Please choose one).

- Housing quality
- Community/ neighborhood quality
- Health status
- Marriage status
- Climate
- Distance from other family members
- Economic conditions

11. If you think you will continue to live in your current residence in the future but there are some constraints, how might you overcome this situation? (Please choose one).

- Make plans to move (includes moving to a facility such as assisted living where care is provided or home of a family member or friend)
- Consider repairs or renovations
- Continue to live without any changes
- Get help from family
- Get help from other personnel resources
- Other. Please specify. _____
- Don't Know

12. What is the MAIN REASON your home might present problems if you continue to live in your current home in the future? (Please choose one).

- Hard to maintain current home
- Inconvenient because of design (Ex: bedroom in the second floor, steep stairways, etc.)
- Too old to fix or remodel home
- Too small for me
- Too big for me
- The house is not a problem
- Other. Please specify. _____

13. What **OTHER PROBLEM** might you face as you continue to live in your current home in the future? (Please choose one).

- Hard to get medical services
- Hard to get house keeping related services
- Hard to get emergency services
- Safety
- Bad location
- The neighborhood and community is not a problem
- Other. Please specify. _____

Home modifications that vary from small changes to major modifications make it easier for you to live in your home as you grow older. Some examples include adding grab bars, replacing round doorknobs with lever handle, adding rooms, or installing ramps.

14. Have you considered home modifications within the last 5 years?

- Yes
- No (**SKIP Question 16**)

15. Have you already made home modifications within the last 5 years?

- Yes. If YES, please describe. _____
- No (**SKIP Question 16**)

16. If you **HAVE CONSIDERED** or **MADE** home modifications, what was the *major reason*? (Please choose one).

- For safety
- For comfort and convenience
- To live independently
- Other. Please specify. _____

Now let's talk about residential technology.

Residential technology is defined as a system of ICT (Information and Communication Technology) components (products & services) in housing that enhance and promote convenience, safety, security, communication, and comfort. It includes both basic low technology such as televisions or washers, and high technology such as voice-activated lighting control systems.

17. How do you most often learn about newly introduced technology products for your home? (Please choose one).

- Newspapers
- Magazines
- Friends
- Family
- Salesman/ Store
- Radio
- Television
- Internet
- Other. Please specify. _____

18. How would you describe your familiarity with the array of technology products for homes today?

- Very familiar
- Somewhat familiar
- Somewhat unfamiliar
- Not familiar

19. The following questions seek to determine your attitude toward residential technologies. For each product or service, please answer based on your perceptions and experiences (1 through 25).

		Not familiar with this product or service	Heard, Seen, or Read about	Interested in/ tried looking for information	Considered purchasing	Purchased	Purchased, but do not use or rarely use
1	DVD Player						
2	CD Player						
3	VHS player						
4	PDA's (Personal Digital Assistants) (eg. Palm Pilot)						
5	Laptop computer						
6	Cellular phone						
7	Fax machine at home						
8	Satellite TV						
9	Remote garage door opener						
10	Microwave Oven						
11	Electronic tooth brush						
12	Video-phone at entrance						
13	Voice-recognition door opener						
14	Burglar alarm						
15	Flood alarm						
16	Gas leak detector alarm						
17	Remote controls for temperature or humidity						
18	Remote controls for turning on/off lighting & dimming lamps						
19	Remote controls for rising/ lowering shutters						
20	Remote control for home appliance (eg. oven, range, etc.)						
21	Home theater system						
22	Personal health remote diagnostic product (eg. diabetes check of urine by a special toilet)						
23	Wireless health monitoring product (eg. necklace or watch that can monitor and send alert if unsafe heartbeats are detected)						
24	Emergency alert product (eg. pendant that can send a signal)						

	by pressing the button, in the event of an emergency)						
25	Video phone						

20. When you consider purchasing newly introduced technology products for your home, how important is each of the following factors to you? (1 through 7).

		Very important	Somewhat important	Not important
1	Easy to use and understand			
2	Compatible with existing products			
3	Availability of post-purchase service			
4	Reasonable price			
5	Distinctive higher performance compared with existing products			
6	Easy to show its performance to others			
7	Easy to test its performance or “try it out”			

The following questions deal with your computer use.

21. Do you have a computer at home?

- Yes
- No

22. How many computers do you have at home?

- One
- Two
- More than two

23. How would you describe your familiarity with computers?

- Very familiar
- Somewhat familiar
- Somewhat unfamiliar
- Not familiar

24. How would you describe your familiarity with the Internet?

- Very familiar
- Somewhat familiar
- Somewhat unfamiliar
- Not familiar

25. How do you describe your comfort level with using the Internet?

- Comfortable
- Somewhat comfortable
- Somewhat uncomfortable
- Uncomfortable

26. How would you describe your frequency of computer use for each of the following activities?

		Use Daily	Use a few times a week	Use a few time a month	Rarely Use	Never Use
1	Word processor					
2	E-mails					
3	Online shopping					
4	Online banking					
5	To get news (eg. weather)					
6	To get information (eg. travel, health, new product information, etc.)					
7	Fun (eg. listening to music, downloading music, game etc.)					
8	Hobbies (eg. regular visits to cyber communities, etc.)					

27. When did you start to use the Internet?

- 5 or more years ago
- Between 3 and 5 years ago
- Between 1 and 3 years ago
- Within the year

28. What motivated you to start using the Internet?

- Family members' use
- Friends' use
- Advertising
- Sales personnel
- Work
- Other. Please specify. _____

Finally, the following questions are about you.

29. You are

- Male
- Female

30. How old are you?

- 55 to 64 years
- 65 to 74 years
- 75 to 84 years
- 85 years or older

31. How many people in your household are age 55 years or older (including you)?

- One
- Two
- More than two

32. What is your current employment status?

- Employed or self-employed full-time
- Employed or self-employed part-time
- Retired and employed (or self-employed) part-time
- Retired and not working
- Unemployed

33. What best describes your overall health condition?

- Excellent
- Good
- Fair
- Poor
-

34. What conditions do you have that makes it difficult to get around your home (if any)? (Mark all that apply).

- Arthritis
- Back problems
- Knee problems
- Stroke
- General lack of mobility
- Use a wheelchair
- Vision problems/ blind
- Hearing problems/ deaf
- None
- Other. Please specify. _____

35. What is your marital status?

- Married
- Widowed
- Divorced
- Separated
- Never married

36. What is the highest level of education you have completed?

- Some college
- College graduate
- Post graduate study

37. What is your race?

- White or Caucasian
- Black or African American
- American Indian
- Asian or Pacific islander
- Mixed race
- Other. Please specify. _____

38. What is your current annual household income including all sources of income from contributing adults, such as social security, retirement, alimony, etc.?

- Less than \$50,000
- \$50,000 to less than \$75,000
- \$75,000 to less than \$100,000
- \$100,000 to less than \$125,000
- \$125,000 to less than \$150,000
- \$150,000 or above

39. Finally, is this your first experience with an online survey?

- Yes
- No

Thank you for your assistance!

If you would like to include your name in the drawing for the four \$50 gift certificates, please type your e-mail address here. _____

If you would like to share your comments about this online survey, please feel free to contact me by e-mail at mahn@vt.edu.

Please hit the Submit button at the end to complete this survey!

APPENDIX C

CODING SCHEME FOR THE QUESTIONNAIRE

Question Number	Variable Name	Variable Label	Value	Value Label
1	H1	Housing type	1 2 3 4	A single-family detached home A multi-unit building A mobile home A semi-detached home
2	H2	Whether to live ALFs or not	1 0	Yes No
3	H3	Homeownership	1 2	Own Rent
4	H4	Length in current dwelling	1 2 3 4 5 6 7	Less than 5 years 6 to 10 years 11 to 20 years 21 to 30 years 31 to 40 years 41 to 50 years over 50years
5	H5	Age of dwelling	1 2 3 4 5 6 7 8	Before 1950 1951 to 1960 1961 to 1970 1971 to 1980 1981 to 1990 1991 to 2000 After 2000 don't know
6	H6	Location	1 2 3 4	Rural areas Small city City suburban areas City
7	A1	Intention to living longer in current dwelling	1 0	Yes No
8	A2	Housing plans in future	1 2 3 4	Yes, I (we) have fairly definite plans I (we) have explored options I (we) have begun to talk about it No, I (we) haven't really thought about it
9	A3	Desire to age in place	1 2 3 4 5	Strongly disagree Somewhat disagree Somewhat agree Strongly agree Don't know (Recoded as “.a”)
10	A4	Factors influenced on decision of aging in place	1 2 3 4 5	Housing quality Community/ neighborhood quality Health conditions Marital status Climate

			6 7	Distance from other family members Economic conditions
11	A5	Way to overcome constrains related to housing	1 2 3 4 5 6 7	Make plans to move Consider repairs or renovations Continue to live without any changes Get help from family Get help from other personnel resources Other Don't know
12	A6	Major problems might be presented related to housing	1 2 3 4 5 6 7	Hard to maintain current home Inconvenient because of design Too old to fix or remodel home Too small for me Too big for me The house is not a problem Other
13	A7	Major problems might be presented related to other than housing	1 2 3 4 5 6	Hard to get medical services Hard to get house keeping related services Safety Bad location The neighborhood and community is not a problem Other
14	A8	Home modification experiences	1 0	Yes No
15	A9	Home modification consideration	1 0	Yes No
16	A10	Reasons	1 2 3 4	For safety For comfort and convenience To live independently Other
17	T1	Information sources	1 2 3 4 5 6 7 8 9	Newspaper Magazines Friends Family Salesman/ store Radio Television Internet Other
18	T2	Familiarity with residential technology	1 2 3 4	Not familiar Somewhat unfamiliar Somewhat familiar Very familiar
19.1 – 19.25	T3	Residential technology	1 2 3	Not familiar wit this product or service Heard, seen or read about Interested in tried looking for information

			4 5 6	Considered purchasing Purchased Purchased, but do not use or rarely use (Recoded as "5")
20.1 – 20.7	T4.1-7	Attributes of innovation	1 2 3	Not important Somewhat important Very important
21	T5	computer	1 0	Yes No
22	T6	Number of computers	1 2 3	One Two More than two
23	T7	Familiarity with computer	1 2 3 4	Not familiar Somewhat unfamiliar Somewhat familiar Very familiar
24	T8	Familiarity with the Internet	1 2 3 4	Not familiar Somewhat unfamiliar Somewhat familiar Very familiar
25	T9	Comfort level with using the Internet	1 2 3 4	Uncomfortable Somewhat uncomfortable Somewhat comfortable Comfortable
26.1-26.8	T10.1-8	Computer use	1 2 3 4 5	Never use Rarely use Use a few times a month Use a few times a week Use daily
27	T11	When to start to use the Internet	1 2 3 4	5 or more years ago Between 3 and 5 years ago Between 1 and 3 years ago Within the year
28	T12	Motivation to starting the Internet	1 2 3 4 5 6	Family members' use Friends' use Advertising Sales personnel Work Other
29	D1	Gender	1 2	Male Female
30	D2	Age	1 2 3 4	55 to 64 years 65 o 74 years 75 to 84 years 85 years or older (Recoded as "3")
31	D3	Number of household member	1 2 3	One Two More than two
32	D4	Employment status	1 2	Unemployed Retires and not working

			3 4 5	11 Retired and employed part-time Employed or self-employed part-time Employed or self-employed full-time
33	D5	Health conditions	1 2 3 4	Poor Fair Good Excellent
34	D6	Physical problems	1 2 3 4 5 6 7 8 9 10	Arthritis Back problems Knee problems Stroke General lack of mobility Use a wheelchair Vision problems/ blind Hearing problems/ deaf None Other
35	D7	Marital status	1 2 3 4 5	Married Widowed Divorced Separated Never married
36	D8	Education	1 2 3	Some college College graduate Post graduate study
37	D9	Race	1 2 3 4 5	White or Caucasian Blacks or African American American Indian Asian or Pacific Islander Mixed race
38	D10	Income	1 2 3 4 5 6	Under \$50,000 \$50,000 to less than \$75,000 \$75,000 to less than \$100,000 \$100,000 to less than \$125,000 \$125,000 to less than \$150,000 \$150,000 or above
39	E1	Online survey experience	1 0	Yes No
.	New1_di	Number of disease converted from variable D6	0 1 2 3 4	None One Two Three Four or more
.	New2_hmo	Home modifications A8 +A9		Continuous variable
.	New3_ai	Attributes of innovation: Sum of T4.1 to T4.7		Continuous variable
.	New4_per	Perception: T2 + T7 + T8		Continuous variable
.	New5_acc	Acceptance:		Continuous variable

		Sum of T3.1 to T3.25		
.	New6_dr	Drawing participation from whether presented e-mail addresses or not	1 0	Yes No

“.” Is considered as a system missing value.

APPENDIX D

VITA

MIRA AHN

EDUCATION

- Ph.D.** 2004 Virginia Polytechnic Institute & State University
Major area: Housing
Dissertation: Older People's Attitudes toward Residential Technology: The Role of Technology in Aging in Place
- M.A.** 1995 Chung-Ang University, Seoul, Korea
Major area: Residential Design
Thesis: A Study on the Improvement of Inner space of Small-Sized Apartments
- B.S.** 1992 Ehwa Women's University, Seoul, Korea
Major area: Statistics

PROFESSIONAL EXPERIENCES

- 2000-2004 Department of Apparel, Housing, and Resource Management, Virginia Tech
Research Assistant: Assisted with research projects by helping with survey design, statistical analysis, literature reviews, and report writing.
Teaching Assistant: Assisted with courses in house planning and residential property management.
- 1996-1997 National Housing Research Institute: Housing Planning Division, Seoul, Korea
- Worked on a team to participate in the whole research process
- Provided research design, quantitative data analysis, and final reports.
- 1996-1997 EWES Design, Seoul, Korea, October 1995 – March 1996.
- Worked as an intern interior designer.

RESEARCH PROJECTS

- 2003-2004 **Kitchen Storage Research Project**, Funded by the National Kitchen and Bath Association (NKBA)
- Helped to design a survey, analyzed quantitative data, and did statistical tests with SPSS.

- 2002-current **Best Practices in Assisted Living Facilities**, Funded by USDA.
 - Helped provide theoretical framework by reviewing related literature.
 - Assisted with data collection.
 - Provided quantitative data analysis with SPSS.
- 2001-2002 **Kitchen Space Planning & Storage Research Project**, Funded by National Kitchen and Bath Association (NKBA).
 - Provided statistical data analysis with SPSS.
- 2001 **Residential Technologies in Multi-Family Housing**.
 - Provided theoretical base.
 - Analyzed quantitative data and did statistical tests with SPSS.
- 1996-1997 **A Pre-Estimation Model of Construction Cost for Economical Design I**
 - Worked on a team to provide the research design.
 - Collected data, and analyzed quantitative data with SAS.
- 1997 **Design Guideline for Small-Sized apartments Adopted the Systematic Built-In Storage**
 - Worked on a team to provide the research design.
 - Supervised field research.
 - Participated in qualitative data collecting such as site visits, observation, and interviews.

PUBLICATIONS

Referred Journals

- Beamish, J. O., Ahn, M., & Seiling, S. (2001). Housing, equipment, and design research and scholarship: A family and consumer sciences perspective. *Family and Consumer Science Research Journal*, 30 (2), 240-255.
- Kim, S., Park, K., & Ahn, M. (2001). Study in the conditions of storage in small size apartments: Focused on 49m² and 59m² units. *Journal of the Architectural Institute of Korea*, 17 (11), 3-8.
- Kim, S., Park, K., & Ahn, M. (1998). Planning guidelines of storage space in small-sized apartments. *Journal of the Architectural Institute of Korea*, 14 (4), 191-200.

Referred Conference Papers

Beamish, J. O., Goss, R. C., Ahn, M., & Andes, G. (2003). Best practices in assisted living: Dining facilities. *Housing Education and Research Association Referred Papers*. Washington, D. C. June 2003.

Ahn, M. & Parrott, K. (2001). Trends of Korean apartment housing planning appearing in advertisements: Spring 2000. *American Association of Housing Educators Referred Papers*. Big Sky, Montana. July 2001.

AWARDS

May 1996 **Graduate Thesis Contest: the 2nd Prize** by Korean National Housing Co.
: Study on the Improvement of Inner space of Small-Sized Apartments

Dec. 2003 **Graduate Research Development Project (GRDP) Research Fund** from
Graduate Student Assembly of Virginia Polytechnic Institute & State University
: Older People's Attitudes toward Residential Technology

January 2004 **Paolucci Research Grant for 2004** from Kappa Omicron Nu Honor Society
: Older People's Attitudes toward Residential Technology

PROFESSIONAL ASSOCIATIONS

2000 – Present Housing Education and Research Association (American Association of
Housing Educators).

2002 – 2003 American Association of Family and consumer Sciences.

1998 – 2001 The Architectural Institute of Korea.