

EXAMINATION OF UNIVERSAL DESIGN IN KITCHENS AND BATHROOMS OF THE  
HOUSING AND URBAN DEVELOPMENT DEMONSTRATION PROGRAM:  
ELDERLY COTTAGE HOUSING OPPORTUNITY

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In

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**ABSTRACT:**

Appropriate housing for the aging American population is a timely topic of research in both housing and gerontology. Universal design is an innovation in housing design that is gaining interest from both industries.

This research examines the effectiveness of universal design features that have been identified by experts in the field of aging, housing, and universal design as important to resident and caregiver participants of the ECHO demonstration housing program.

A national survey was conducted that included all available current residents of the HUD ECHO houses and their caregivers. The relationships between age, effectiveness of universal design features, health and dependency were investigated. Quantitative results include some confounding relationships, and plausible explanations.

A qualitative analysis, based on on-site and telephone interviews, and tape recordings of those interviews with residents and their caregivers, as well as architectural drawings, observation, and photographs of the ECHO houses provided additional details. The qualitative approach indicated that many of the universal design features recommended by the experts consulted satisfactorily met the needs of residents and/or their caregivers. It also revealed, however that some features were not considered important by residents and caregivers, some were not reported as present (when they were documented by the researcher as present), and at least one HUD-specified universal design feature was not provided by ECHO houses.

Another aspect of the qualitative perspective addressed the health of the residents. Health characteristics are presented in the context of their effect on dependency. Phase II dependency task information was compared to that reported in phase I, and improvement and decline was noted.

Conclusions, and Implications that elaborate on findings, and future research is recommended for taking this research to the next level.

## Acknowledgments

This research has truly been a labor of love. The love I have for learning, the application of that learning to a pragmatic purpose, and the love of so many people who have supported me in any and every way I needed during the process. The process has resulted in this body of work. Without their sincere gestures of care and kindness, my work would have been so much more difficult.

I am so grateful to all my Florida friends who have so consistently encouraged me to “go confidently in the direction of my dreams... to live the life I have imagined”, and my Georgia, family who have remained faithful to our relationships despite my lack of participation for the last eight years. And gratitude goes to my children -Bonni, Lance, Rich, Jill, Sydney, and Halle - who have endured my long absences, minimal participation in weddings and babies, and sometimes Christmases and birthdays - all the while continuing to encourage me to "stay the course".

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I am also thankful for the invaluable support I have received from faculty and staff who have also become my friends. Thank you Caryl, for all the assistance you provided with my research. Thank you Roxanna for patiently (most of the time) reminding me how to make CAD do what I needed it to do. Thank you Dr. Galway, Dr. Skaggs, and Dr. Koebel for sharing your expertise and insight with me. Each of you have inspired me to stretch beyond what I thought was my capability. I hope our connections won't end with my graduation.

Thank you Betsy, Chris, Tori, Abby, and Michael - first for providing a place to lay my weary head, and for bringing so much joy and laughter into my life.! Betsy and Chris's southern hospitality, Tori's bright smile, Abby's gentle gestures of love, and Michael's special hugs have kept me grounded, and provided the reprieves I so badly needed - so I could return to the arduous task of writing.

I realized during the process that the research I had undertaken was inspired by my mother, Mary. Her valiant and creative efforts to maintain her independence in her home despite years of illness and decline are admirable. She always encouraged me to follow my bliss, and she continues to do so today. I am profoundly grateful.

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## Chapter I

### INTRODUCTION

A “home” is an intensely personal space. Precious resources, time, money, energy, and emotions are invested in the home, and are reflected in the spaces that sustain and nurture the occupants throughout life. Alterations are made to both the home and the approach to tasks that take place in the home as the family configuration and lifestyle require. The alterations address perceived deficiencies in aesthetics, efficiency, comfort, and safety, as these issues affect function in the home (Balchin, 1998). The intersection of the characteristics of the physical environment and an occupants’ physical capability is a critical factor in the interpretation of deficiency. The ability to function appropriately in the home is dependent on the compatibility or “fit” of the physical environment and the physical capacity. Early in adult life, compatibility usually presents few problems due primarily to a high level of physical capacity that allows the young occupant to comply with the demands of the environment. However, aging has a dramatic and generally negative effect on physical capacity. Thus, aging can significantly limit the options available to the elderly person in meeting the demands of the physical environment. The limitations can, and often do, result in a re-evaluation of the home as an appropriate environment in which the elderly person thrives. It is at this point in the life course that a review of housing options is appropriate.

Living arrangements for the aging population in the United States are defined by several interrelating factors. Decisions involve marital status, level of independence of the occupant, and the design characteristics and physical condition of the dwelling. Finances and affordability are considerations that impact each of these decisions. The complex interplay of these factors creates a relationship between the structure/house and the occupant of the structure/house.

The majority of aging people in the United States would prefer to remain in the homes they occupy as they grow older (Wagnild, 2001), a popular phenomenon frequently referred to as “aging in place”. However, the physical characteristics of much of the existing housing stock do not support this preference (Pynoos and Leibig, 1995; Robinson, Nicholson, & Barker, 1997), and kitchens and bathrooms, in particular, can be dangerous (Beamish, 2003). Aging in place also requires a minimal level of independence in the performance of tasks required for self maintenance, also referred to as activities of daily living (ADL) (Faletti, 1984a). Basic ADLs are

the routine tasks involved in personal care such as feeding, dressing, bathing, transferring, toileting and walking (Wiener, Hanley, Clark, & Van Nostrand, 1990). Instrumental activities of daily living (IADLs) are more cognitively complex tasks, such as use of the telephone (look up numbers, dial, answer), traveling via car or public transportation, food or clothes shopping (regardless of transport), meal preparation, housework, medication use (preparing and taking correct dosage), and management of money (write checks, pay bills) (Lawton, 1969). Physical or mental disabilities that frequently accompany aging can restrict a person's ability to perform ADLs and IADLs (Falletti, 1984b). The successful accomplishment of ADLs and IADLs is criterion for living independently, and the inability to perform those basic, but critical, tasks constitutes criterion for institutional care (Schafer, 1999).

The phenomenon of aging in place and the dramatic increase in the number of people 65 years of age and older has inspired vigorous research in elderly housing options for older adults. Research and development of several strategies have produced some promising innovative ideas and options for consideration. These strategies address the discrepancy that exists between the housing that the aging population prefers and current, as well as projected, housing availability. Most of the housing options are compromises that fall short of the clear preference of older people to remain in their existing homes, and involve relocation to a different residential or institutional setting. Some of the institutional settings include nursing homes, health care facilities, board-and-care facilities, and family foster homes. Some of the residential settings include group homes, independent and assisted living facilities, shared housing, accessory apartments, and Elderly Cottage Housing Opportunity (ECHO) housing.

The ECHO house is a compromise that typically requires an older person to relocate, but not to an institutional setting. The move is to a small home that is located in close proximity to the home of a close family member or friend. The physical design of the structure accommodates predictable physiological needs of an older person. The positioning of the ECHO house near family and friends caters to psychological needs, facilitating convenient caregiving by people familiar to the resident.

Another innovative idea that has potential for enhancing the future of aging in place, and positively influencing the compromising alternatives noted above, is universal design. Universal design is a concept and philosophy that grew out of previous recommendations for barrier-free design. Housing design that employs the principles of universal design addresses barriers to

successful independent accomplishment of ADLs and IADLs in subtle ways. Ron Mace, the founder of the universal design philosophy defines the concept as "...the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Mace, 1997, p.1). In its simplest form, "universal design is good design" (Beamish, 2003, p.43) working from and incorporating a person-centered approach to the design process (Adaptive Environments, n. d.; Preiser & Ostroff b, 2001).

The United States Department of Housing and Urban Development (HUD) operates an ECHO demonstration housing program designed specifically for the frail elderly population. The program has been operating in five states for approximately ten years, and has been effective in addressing some of the problems inherent in housing for the aging population. ECHO housing is an appropriate platform for the use of universal design principles in housing for the aging population. The use of universal design in the ECHO house and the exclusive occupancy by the frail elderly population provides a unique opportunity to evaluate the benefit of universal design to frail older adults.

### **Statement of the Problem**

Most elderly people are reluctant to move from the homes that they have occupied for long, and often emotionally significant, periods of their lives. There are many reasons for resistance to relocation at this time in life. One prominent issue involves the realistic perception of limited housing options, and the fear that their needs can only be met in an institutional setting. Supportive housing environments, such as ECHO housing, may be an alternative to meeting the physical and emotional needs of an older person. ECHO housing provides a manageable environment that encourages family caregiving. While there are many issues that influence the viability of ECHO housing, one important aspect that needs attention is the design of the home to support independence and enhance caregiving. The kitchen and bathroom are critical rooms that can influence a person's ability to maintain independence in their home. The use of universal design in kitchens and bathrooms has potential for making these spaces usable by residents for longer periods of time. An evaluation of the universal design features in the kitchens and bathrooms of ECHO homes would assist in understanding the effectiveness of universal design features by frail older adults.

## **Purpose of the Study**

The purpose of this research is to determine if universal design features in the kitchens and baths of ECHO housing are effective in meeting the needs of the residents and caregivers.

## **Objectives of the Study**

The specific objectives of the study are to identify universal design features of kitchens and bathrooms that are widely valued by researchers, designers, and other experts in the fields of housing and universal design. The research will additionally determine which of the identified kitchen and bath universal design features are present in ECHO demonstration houses, and evaluate reported effectiveness of the universal design features of kitchens and bathrooms for current residents and their caregivers in ECHO houses.

## **Significance of the Study**

Universal design and ECHO housing design are two related phenomena in senior housing research. An evaluation of the juncture of these two innovations in ECHO houses provides an opportunity to validate the hypothesis that the presence of universal design features in the kitchens and bathrooms of the ECHO units is an effective method of supporting the occupants. Although anecdotal accounts indicate that the presence of universal design features in residential environments benefit the occupants, little scientific research has been done to support this theory.

The broader significance of validating universal design as a viable design concept is anchored in the versatile problem-solving potential inherent in the universal design concept. Universal design is a design philosophy based on sensitivity to the experience of end users and is reflective of a responsibility to them (Adaptive Environments, n.d.). The universal design approach goes beyond a static, predetermined list of requirements to a broader concept that acknowledges and responds empathetically to individual characteristics (Houser, 1995). It is the proactive approach to problem solving within a mainstream context that distinguishes universal from previous, more stigmatizing strategies such as barrier-free and accessible design approaches (Preiser & Ostroff, 2001). This research has potential to systematically examine the universal design philosophy and contribute to the formation of defined criteria for universal design in housing. This research may contribute findings that can enhance the lives of the aging population. Quantifying the benefits of universal design features in the kitchens and bathrooms of living environments has potential to enhance residents' functional

independence, safety, comfort, and quality of life. Additionally, the findings from this research can impact the family and friends of residents by providing a higher degree of security and “peace of mind”, as well as enhancing the ability of community-based caregivers to assist the resident when needed. On a broader scale, research addressing the effectiveness of universal design features in the living environments of the frail elderly population informs social science and design professionals who work in concert to positively influence the aging process. Design education that employs the philosophy of inclusion and emphasizes the impact of thoughtful design enhances the receiver of that education, and the end user of the products they design. Design education that provides information gained from lessons of experience is important in addressing relevant need (Fletcher, 2002a).

Another aspect of the importance of research on the effectiveness of universal design involves policy making. Predecessors of universal design such as the Americans with Disabilities Act (ADA) have no jurisdiction in private sector housing. The Fair Housing Amendments Act of 1988 affects new multifamily housing and addresses many of the same accessibility issues and the Uniform Federal Accessibility Standards (UFAS) has impacted the design of federally supported housing. By examining the effectiveness of universal design features in the kitchens and baths of frail older adults, support for policies that encourage universal design in housing may be enforced.

The clear preference of older people is to age in place. Approximately eighty million young-old (65-74) will move into the ranks of the middle-old (75-84) in the near future, and their influence will shape housing demand (Joint Center for Housing Studies of Harvard University, 2003). One example of this influence is seen in the final conference recommendations issued at the “Expanding Housing Choices for Older People” White House Conference on Aging Mini-conference sponsored by AARP in 1995. The recommendation began with the statement “Federal, state, and local policy should support and reward the development of suitable and safe communities that include affordable, supportive, and accessible housing choice for older people” (AARP, 1995, p. 27). Housing policy that addresses homes for older adults will impact the elderly population dramatically, and research that informs the design of housing can be an effective tool in the promotion of healthy aging in the United States.

### **Theoretical Framework**

The housing theories most appropriate for framing this research are The Environmental Press Theory, The Model on Person-Environment Transaction, and Selective Optimization Theory (SOC). Each of these theories addresses the relationship between the environment and the functioning capacity of users within the environment from a unique perspective.

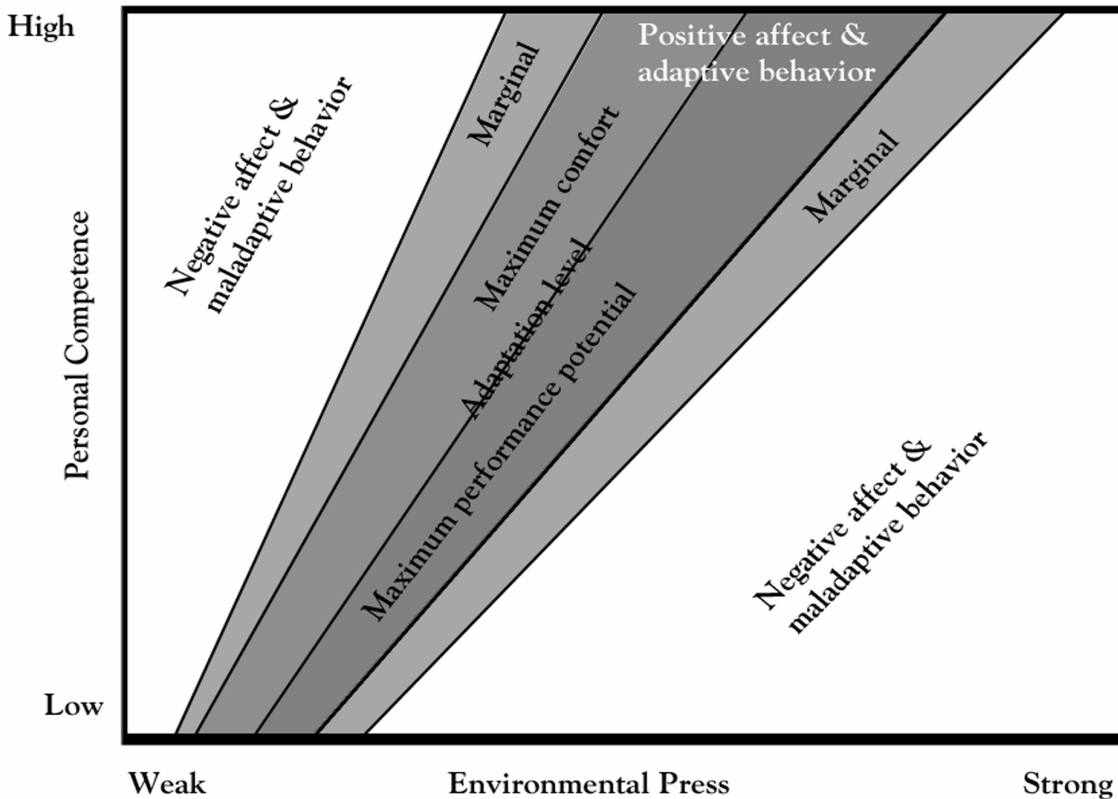
#### **Environmental Press Theory**

Lawton and Nahemow's (1973) Environmental Press Theory (Figure 1) addresses the "demand" that is imposed by the built environment, the physical capacity of occupants to respond to that demand, and the compatibility of those two components. The Environmental Press Theory is based on Kurt Lewin's psychological studies in regression. The formula states "behavior (B) is a function (F) of the relationship between a person (P) and their environment (E)" (Lewin, 1951, p. 97), and was originally expressed as the equation:  $B = F(P, E)$ . Lawton and Nahemow specified that this represented a person-environment fit that could be applied to older adults. They concluded that behavior is the consequence of the interaction between perceived personal competency (person fit) and environmental press (contextual demand). Competencies are defined in terms of biological health, sensory perceptual capacities, motor skills, cognitive capacity, and ego strength. The competency level reflects a range of lower to upper limit of capacity in each of these areas, as determined by the Assessment, Integration and Environments of Older People test, developed by Lawton and Nahemow (1973). This classic test of Environmental Fit is used to assess ability to live independently, but was not used as a specific assessment in this research. Their model identifies a range of defined areas of low to high environmental demand/environmental press, with low to high personal capacity/personal competency. Environmental press refers to an environmental factor that can be physical, interpersonal, or social. Lawton and Nahemow's research in the environmental press concept led to the development of the theory and model (Figure 1) that graphically represents changes in competencies and their impact on related environmental demands (Lawton & Nahemow, 1973).

#### **Faletti's Human Factors Model of Person-Environment Transaction**

Martin Faletti's (1984a) Human Factors Model of Person-Environment Transactions (Figure 2) presents a human factors perspective to the study of ADLs. Faletti's model is unique in that it presents personal and environmental characteristics in terms of their relationship to a task.





**Figure 1 – The Lawton and Nahemow Competence-Press Model**

Lawton, M. P. & Nahemow, L. (1973). Ecology and the aging process. In C. Eisdorfer and M. P. Lawton, (Eds.). *The Psychology of Adult Development and Aging*. Washington: American Psychological Association. (661) (Printed with permission.)

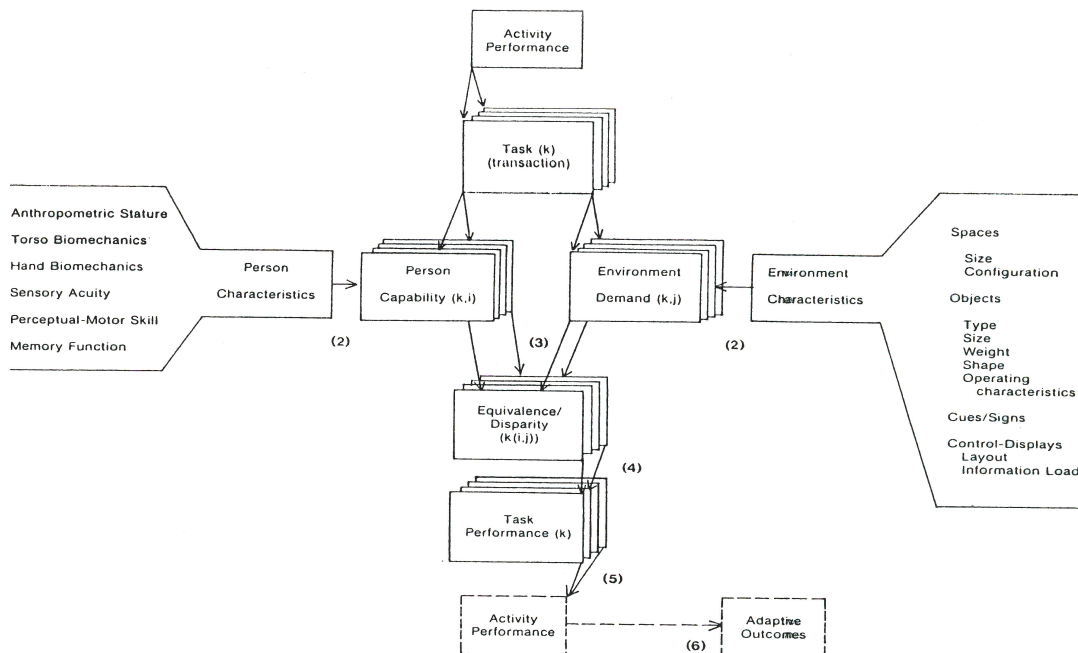
Personal characteristics and environmental characteristics are then examined at comparable points in the performance of the task to determine equivalences and disparities in task performance. The theory makes no assumptions based on generalities, such as age, and focuses instead on defined physical capabilities and environmental criteria related to task performance. This approach allows for flexible assessment that reveals appropriate changes to enhance the accomplishment of the task. Anthropometric and biomechanical considerations are important in formulating strategy that provides congruence between physical capacity, environmental characteristics, and task requirements. Environmental properties of the environment and capacity to process the information are also part of the model.

Dissection and analysis of paired (physical and environmental) comparisons of a basic ADL task provides a systematic approach for the scientific investigation of the elements of the activity. The purpose of investigation is to determine the effect of the interaction of physical

capability and environmental elements in the performance of a basic ADL. One aspect of Faletti’s model that makes it particularly appropriate for this research is that it is based on one of the IADLs chosen for this research. The activity chosen for Faletti’s research was meal preparation (Faletti, 1984a).

**Theory of Selective Optimization with Compensation**

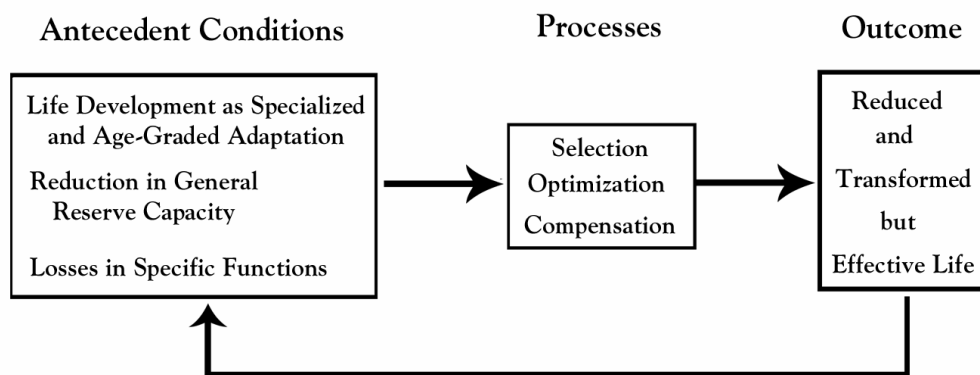
Another theory with characteristics that make it appropriate for this study of effective living environments is Baltes theory of Selective Optimization (Figure 3) with Compensation (SOC) (Baltes & Baltes, 1990). One of the premises of SOC is that inherent in the aging process are changing components and strategies for achieving goals. In youth, this process is considered growth and is seen as positive. In late life, although the process is the same as in youth, the enhancement of capacity is not as obvious an acquirement of new skill because effort is often focused on maintaining previously achieved levels of function. This focus, when related to the living environment, can manifest itself in a desire to down-size or reduce the living space. A smaller living space allows the resident to maintain involvement with his/her residential environment on a similar level as in previous years despite diminished resources of all kinds. Maintenance of the living environment supports independence.



**Figure 2 – Faletti’s Human Factors Approach to Person-Environment Transactions.** Faletti, Martin V. (1984a). Human Factors Research and Functional Environments for The Aged. In Altman, I, & Werner, C. (Eds.), *Elderly People and the Environment*. (p. 202). New York: Plenum Press (Printed with Permission).

The ability to make adjustments in living arrangements in order to continue an independent lifestyle is considered a gain in late life. The Selective Optimization with Compensation Theory deals with issues of primary control through the effective manipulation of available (albeit diminishing) options. SOC makes use of a life-course perspective through carefully focused scrutiny of frequently changing aging issues in a way that is simultaneously broad and personal; broad in its application for entire age-matched populations, and personal in its ability to allow for individual idiosyncrasies. This approach provides a life-management strategy that can inform the critical process of making choices with regard to the likely life trajectory of the aging individual.

Selective optimization with compensation is an elective and loss-based reactive behavior based on acknowledgment of identified loss, exploitation of remaining options, and development of newly discovered skills that together provide the means for achieving desired outcomes. The selective operation identifies loss in functional capacity and existing capability. Optimization maximizes viable extant behaviors, and the compensation aspect of the operation ascertains novel behaviors with potential for supporting the original level of function. SOC is a developmental construct that addresses life strategy with potential to support optimal independent function at a time in life when losses often predominate (Smith & Baltes, 2002).



**Figure 3 – Baltes Theory of Selective Optimization with Compensation**

Baltes, P. and Baltes, M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. From Baltes, P. & Baltes, M. (Eds.) *Successful aging: Perspectives from the behavioral sciences* (pp. 1-36). Cambridge: Cambridge University Press (Printed with permission.)

### **Limitations to the Present Study**

The research conducted for the present study had the following limitations.

1. This study does not evaluate universal design features located throughout the ECHO house, but focuses on features present in the kitchens and baths only.
2. This study considers only ADLs and IADLs that routinely occur in kitchens and bathrooms. These include preparing food, feeding, bathing, walking, toileting, dressing, and house cleaning. It does not include traveling via car or public transportation, and food or clothes shopping (regardless of transport).
3. This study investigates the experience of current residents of ECHO demonstration housing and their caregiving host families, but does not address the experience of other previous residents of ECHO housing. Because the sample used in this research is limited to a discreet group of the frail elderly population who currently occupy HUD ECHO housing, and their caregivers, it does not consider occupants of other senior housing products, and the findings generated by this research are not generalizable to all housing for the elderly.

### **Delimitations**

Evaluation of effectiveness of universal design features present in the kitchens and bathrooms of HUD ECHO houses is limited to researcher a) evaluations of floor plans and photographs; and b) face-to-face and phone interviews with residents and caregivers.

### **Definition of Terms**

#### **Activities of Daily Living (ADL)**

Activities of daily living are routine tasks involved in personal care. These tasks include feeding, dressing, bathing, transferring, toileting, and walking (Wiener, Hanley, Clark, & Van Nostrand, 1990).

#### **Adaptive/Adaptable Housing**

Adaptive or adaptable housing is housing that, while maintaining a traditional appearance, is consciously designed to provide accessible features when they are needed by a person with changing needs (Null & Cherry, 1998).

#### **Dependency**

Dependency is determined by the frequency that assistance is required to successfully accomplish defined ADLs and IADLs.

### **ECHO House**

“... a small, self-contained, barrier free, energy efficient, and removable dwelling unit (ECHO unit)” (U.S. Department of Housing and Urban Development, 1993, p. 45384).

### **Granny Flat**

The Granny Flat is a small detached house designed and built for the use of elderly Australians. It is customarily positioned near the home of family and/or close friends who agree to care for the elderly person living in the Granny Flat. The Granny Flat was the model that inspired the ECHO house.

### **Institutional Settings**

Institutional settings are settings, such as a nursing home, any health care facility, board-and-care facilities, family foster homes, and group homes (Tatara, 1992). For the purposes of this research, the term “Institutional Setting” refers to any facility that houses unrelated people in a structure that exhibits aesthetically commercial attributes.

### **Instrumental Activities of Daily Living (IADL)**

Instrumental activities of daily living are cognitively complex activities that are often required in life. They include use of the telephone (look up numbers, dial, and answer), traveling via car or public transportation, food or clothes shopping (regardless of transport), meal preparation, housework, medication use (preparing and taking correct dosage), management of money (write checks, pay bills) (Lawton, 1969).

### **Long-Term Care**

Long-term care is a comprehensive term that refers to the type of care available as opposed to the housing type involved. The term “Long Term Care” references both facilities and services that support at-home and away-from-home residential care. Residential care is loosely defined by the individual needs of the resident (Virginia Department for the Aging, 1998)

### **Universal Design**

Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Mace, 1988).

### **Visitability**

Visitability is a term that refers to a movement that synthesizes the use of universal design philosophy, and uses only a small number of access issues (basic access 32” door clearance, comfortably positioned wall switches and outlets, and bathroom walls that are reinforced for the future placement of grab bars wherever they are needed). These features make houses accessible to all people, particularly those with accessibility issues, for comfortable visitation purposes (Ervin, 1997).

## **Chapter II**

### **REVIEW OF LITERATURE**

In order to examine universal design features in ECHO housing, several aspects of aging and housing will be reviewed. The topics in this chapter include aging, ADLs, IADLs, aging in place, and adaptive housing. Kitchen and bath design for older persons and universal design features in these areas will be examined. This chapter also describes the list of universal design features and the criterion used to evaluate the ECHO houses in this study. This chapter concludes with background information on the HUD demonstration housing program ECHO.

#### **Aging**

Although aging is sometimes treated as a phenomenon in the popular press, aging is actually a process. The process of aging begins at birth and ends with death (Pastalan, 1990). Inherent in the process of aging are physiological and cognitive changes that impact literally every part of life, including routine activity. Early in life these changes are commonly referred to as growth and are interpreted as positive because they involve expanding acumen and competency. Late in life, however, the physiological and cognitive changes that are part of the healthy aging process are interpreted by most people as negative in that they often involve limitations and restricted ability. However, similar expansion of acumen and competency are required late in life to remain independent while maintaining, to the extent possible, previous levels of engagement. Growth occurs when control, sometimes seen as wisdom, and change intersect. Interpreting these changes as growth is often missed at this stage of life. This is a basic premise of the selective optimization with compensation theory.

Elderly people are the fastest-growing segment of the populations in industrialized nations. The fastest-growing subgroup of the elderly category is composed of those in their upper seventies and eighties. Pynoos and Liebig (1995) state "... by the year 2040, the population under 65 in the United States is expected to grow by only 11 percent. By contrast, the 65 + age group is projected to grow by 111 percent. Even more astounding are the projections for the population aged 80+, whose numbers will escalate by an impressive 287 percent between 1990 and 2040!" (p. 4). Pynoos and Liebig's observation about the next 45 years is now 10 years old. The profound effects of their population predictions are increasingly becoming a

focus for health care professionals. The anticipated explosive growth of the old-old (85+) in the next ten years has inspired interest in the health characteristics of this generation.

Health characteristics are the strongest predictors of independence in the performance of ADLs and IADLs. Most studies of health characteristics rely on a combination of self-report and caregiver report that may be skewed by a desire for a positive perspective. Sensory perception begins to decline at around the age of forty, and other noticeable physiological deterioration occurs soon after. These changes in perception and physical ability often restrict the aging occupant's mobility, resulting in more time spent in the home environment (Koncelik, 1976). A recent health and housing survey of 1,775 community-dwelling respondents, with a mean age of 72, found that the respondents considered their health to be excellent (84%). Arthritis was the most frequently noted health problem (47%), followed closely by hypertension (32%), hearing loss (28.2%), vision loss (25.6%), and heart disease (16.2%). A small percentage (1.5%) reported difficulties with ADLs, and a slightly larger percentage (5.5%) noted problems with at least one IADL (Wagnild, 2001). It should be noted that self-perceptions are the least reliable, and at least somewhat subjective. They often contradict the objective criteria of ADL and IADL evaluation.

### **ADLs and IADLs**

The relationship between independence and housing is often a more important factor than age in influencing the successful performance of ADLs and IADLs. Therefore it is important to consider ADLs, IADLs, independence, and housing simultaneously, since they work together to provide for the needs of the elderly population in their efforts to remain independent while aging. Decline in ability to accomplish ADLs and IADLs occurs slowly and subtly, with one problem initiating or exaggerating another to the point of creating a serious, sometimes life-threatening situation. Decline of functional ability in ambulation, vision, and hearing are inherent in the natural course of aging. Often a decline in cognition also impacts an older person's ability to function effectively. The well-honed practice of compensation, sometimes quite creatively, is familiar to many older people. When decline is minimal, compensation allows the continuance of independence, including the completion of most ADLs and IADLs. However, with advanced age comes an increased risk of loss of independence. Although advanced age does not necessarily equal infirmity, an old person can become less able to complete tasks, less adept at subtle compensation strategies, and more vulnerable to a loss of independence in late life.



Some conditions and diseases that are frequently associated with advanced age present symptoms that would inhibit the successful accomplishment of ADLs and/or IADLs are loss of visual acuity, loss of hearing, arthritis, Parkinson's disease, and Alzheimer's disease (AD). Heart disease, while presenting no observable symptoms that would initially interfere with ADLs and IADLs, can do significant damage to vital organs before being detected. Each of these conditions and diseases is associated with numerous characteristics that disrupt routine life and often dictate dramatic changes in life-sustaining routines. Symptoms distract attention from the task at hand, and can, in the extreme, render a person experiencing the symptoms unable to complete the task.

Loss of visual acuity causes anxiety about falling as well as increased risk of falling. This loss leads to decreased activity levels, which affect strength, balance, and endurance. Muscle strength and balance are factors that impact coordination and mobility. Approximately one third of the over-sixty-five population suffers from some degree of vision loss, according to a study by Ganley and Roberts as cited in Quillen (1999). Loss of vision at any level can affect walking in a profound way, and can turn a familiar home into a frightening place.

More than 25 million Americans experience hearing loss at some level. (Virginia Merrill Bloedel Hearing Research Center, n. d.). Hearing loss is age-related, which means that as the aging population grows, hearing loss will be a more prevalent issue with far-reaching ramifications. Besides the obvious problematic issue of diminished hearing, hearing loss can negatively affect balance and bring on episodes of vertigo. Hearing loss is often congenital, but not apparent until late in life. Loss of hearing is bewildering to persons experiencing it. It tends to isolate them primarily because they are not able to connect with the world around them as they once did. Isolation can lead to decrease in physical activity, lethargy, and depression. Isolation and the litany of complications that follows often culminate in a critically impaired immune system that sets the older person up for any number of problems, according to a Hebert and Spiegelhalter study (as cited in Suslow & Hinners, 1999).

Vision and auditory deficits can lead to social isolation and depression that cause a lack of interest in routine activities, loss of appetite, decline in caloric intake, and an alteration in cognitive status. These symptoms are often accompanied by a loss of self-esteem, physical injury, malnutrition, and medication errors. In scientific research vision and hearing impairment is associated with decline in functional status.

Hypertension is a condition caused when the force of blood against artery walls is too strong. High blood pressure, as hypertension is sometimes called, damages the heart, and can impair kidneys and eye function. Another cardiovascular impairment, atherosclerosis, compromises the function of arteries in delivering blood to vital organs. When the flow of blood does not occur as it should to the brain, the result is a stroke. When the problem is lack of blood going to the heart, a heart attack may occur. Pain is experienced, and dexterity and mobility are impaired when circulation problems take place in the extremities. However, pain and impairment are not always the first symptoms. Hypertension is often referred to as the “silent killer” because there are no symptoms in early stages. It can do much damage to critical organs of the body before it is diagnosed. Often the first symptoms observed are the result of the damaged organs as opposed to the hypertension. Approximately 50 million people, or 1 in 4 of the American population, are living with hypertension, and it will develop in ninety percent of people who do not have the disease at age 55. Although age is a risk factor for hypertension, research indicates that hypertension is not associated with accelerating declines in mental performance (WebMD, 2005). A statistically significant correlation (0.32) has, however, been found between hypertension and Alzheimer’s disease and dementia (Kaieda, Nagatsumi, & Terashi, 1995). Cardiovascular diseases such as hypertension are associated with “weakness, fatigue, reconditioning, limitation in and decreased occupational performance of ADLs, decreased ambulation distance and functional mobility. These impairments result in a decreasing level of independence with ADLs and psychosocial implications affecting the patient and/or the family” (Creighton University Medical Center, nd, section 3).

Arthritis is a disease affecting joints and connective tissue. Approximately one-third of the 70 million people over sixty-five suffer from arthritis (Centers for Disease Control, 2003). Sixty percent of older people with arthritis, or approximately 14 million, are women. Osteoarthritis is a noted issue of concern in postmenopausal women (Arthritis Foundation, 2004). Each of the 100 diseases we call arthritis produces pain that ranges from minor to severe. Arthritis can have a debilitating effect on function and mobility. It can negatively impact successful performance of routine activities to the point of preventing them altogether (Arthritis Foundation, n.d.).

Parkinson’s disease is a neurodegenerative movement disorder. It afflicts one to one and a half million United States citizens. Slightly more men than women are diagnosed with

Parkinson's disease each year. Some of the prevalent symptoms of the disease, and/or the medication prescribed for Parkinson's disease, are diskinesia, Bradykinesthesia, tremors, rigidity, poor balance, and Parkinsonian gait. Diskinesia, or involuntary muscle movement, and Bradykinesthesia, the slow response of voluntary muscle action, are the two symptoms most familiar to the general population. Tremors, which are associated with diskinesia, can affect appendages when at rest, but can often be controlled when involved in performance of a task. Diskinesia can result in muscle pain and a mask-like facial expression. Poor balance is a function of lost reflexes. Healthy reflex action assists in maintaining an upright body position when walking. Another neurosensory-associated age-related condition often associated with Parkinson's disease is proprioception. Proprioception is the ability to be aware of the location and motion of the body (Hyperdictionary, nd.). Proprioception, also known as the sixth sense, is characterized by a decline in tactile sensitivity (Lee, 2002). One prominent issue that arises from proprioception is lack of awareness of foot position. This can lead to increased risk of falls and injury (Suslow & Hinnert, 1999.). Parkinsonian gait is characterized by reduced or absent arm swing, a forward or backward leaning posture when walking, and small, shuffling steps known as festination. These symptoms impede any ADL or IADL requiring use of the hands or mobility (Neurology Channel, 2004).

The problematic consequences of Alzheimer's disease (AD) are well known, due to the recent and growing increase in the aging population. Although AD is not a part of the normative aging process, age is the most prevalent risk factor. Four and a half million members of the aging American population suffer from AD, and the number of people diagnosed with AD doubles every five years. Alzheimer's disease presents symptoms that begin as subtly as mild forgetfulness and progress to difficulty in remembering how to perform routine tasks such as teeth brushing. In later stages clear thinking, verbal communication, comprehension, reading, and writing become problematic. Attempts to function with these impediments can lead to anxiety, frustration, and a tendency to wander. The frustration is sometimes mistaken for mild to extreme aggression. The final stages of AD often require continuous care (Alzheimer's disease Education and Referral Center, 2003). Alzheimer's disease often affects every part of the human experience. However, it is often a slowly progressing disease in the elderly, and intervention can be effective in assisting elderly persons to maintain their independence in the early stages by customizing the environment to address the pertinent needs.

It is important to consider prevalent health - and housing-related issues in conjunction with ADLs and IADLs because it is this connection that is directly related to independent function, or lack thereof. A criterion for determining the ability to function independently is often based on how many of the ADLs and IADLs an individual can perform independently. The successful performance of ADL and IADL tasks is also directly related to the demands imposed by the physical environment in which the tasks take place. Falletti's theory is supportive of the process that analyzes ability. It breaks down the characteristics of the physical environment and the skills involved in the task to identify precise elements of the transaction. This human-factors approach identifies positive connections as well as deficits.

### **Aging in Place**

The overwhelming preference of the aging population (83%) in America today is to age in place (Robinson, Nicholson & Barker, 1997). Aging in place is not a static term. It is used in a variety of circumstances to mean a variety of different things. It is defined by Leon Pastalan, as "not having to move from one's present residence in order to secure necessary support services in response to changing needs" (Pastalan, 1990, p. ix).

Aging in place is a more complicated concept than it might seem at first glance. The problems with aging in place become apparent when age-related changes occur. The changes are often a function of a decline in personal health or the health of a spouse, change in marital status, and deterioration of occupied housing. As a result, the house fails to support the occupants at previous levels, and the occupants are unable to manipulate the available resources to meet their needs. Optional housing and supportive services that sustain self maintenance become an issue of primary importance late in life in that they often represent independence and, in some cases, psychological ties with significant periods in the life course.

One support service that provides for aging in place is the design of a physical environment that appropriately addresses the physical capabilities of the inhabitant(s). Creative approaches to make aging in place a viable alternative that joins housing and health promotion are currently receiving considerable attention in the fields of housing, architecture, interior design, and gerontology. Mounting support for a connection to be made between housing and service provision continues. In the mid 1990s, modest strides were being made in policy-making positions to advance housing policy addressing the needs of the frail elderly. Attempts were being made to move beyond the traditional approaches that had characteristically focused only

on the production of decent and affordable housing for elderly people. The approach expanded the concept of senior housing to combine housing with the services required to support an independent lifestyle with dignity, responding realistically to the holistic needs of the elderly (Pynoos & Liebig, 1995). The next ten years saw increased interest from industries that provided both products and services providers.

The Center for Home Care Policy and Research recently concluded a study that addressed funding for services that benefit home-based care. The Home Care Research Initiative (HCRI) is a program of the Center for Home Care Policy and Research conducted between 1997 and 2002. It facilitated research and analysis of activities targeting home-and-community-based programs supporting home care (American Association of Homes and Services for the Aging, 2004b). The HCRI goals were to synthesize available information, reveal gaps in policy-related knowledge, and distribute findings to professional researchers and policy makers (Center for Home Care and Policy Research, n.d.). Some of the home care-based programs offered at the federal level are a function of the Older Americans Act (OAA) administered by the U.S. Administration on Aging. Programs that support the community-based elderly population address such issues as transportation, home health, homemaker and chore services, and home-delivered meals (Administration on Aging, nd.).

Section 202 is another federal program associated with elderly housing. Section 202 is a public-private partnership that supports the provision of housing for the elderly and encourages independent living in an environment that offers supportive services (American Association of Homes and Services for the Aging, 2004a). The Section 202 Supportive Housing for Elderly Program provides financing for construction, rehabilitation, or acquisition of housing for the very low-income elderly population (U.S. Department of Housing and Urban Development, n.d.). It also funds project rental assistance contracts (PRAC). The Commission on Affordable Housing and Health Facility Needs for Seniors in the 21<sup>st</sup> Century determined that thirty-three percent of the 1.4 million senior citizens in rent-assisted housing find ADLs difficult to perform. Difficulty that could develop into inability threatens their community dwelling status. Section 202 supports the elderly population's attempts to age in place by providing subsidized housing in a service-enriched environment. The current (2006) funding for HUD included an 11.5% (5 million) cut from 2005 numbers, which had been cut by \$38 million in 2005. This is one of the largest cuts in the history of the department and will affect Section 202 programs. Housing for the elderly is

losing ground in America and, along with it, the provision to accommodate the needs of one of our most vulnerable populations (American Association of Homes and Services for the Aging, n.d.). Interest in the connection between healthy aging and housing that was gaining support in the mid-nineties may lose momentum as programs lose funding.

### **Adaptive/Adaptable Housing**

Adaptive or adaptable housing design is planned to provide accessible features only when they are needed by a person with a disability. The housing unit looks like any other housing unit until adaptations need to be made, and then it can easily be modified. However, the adaptable home is flexible to the extent that some items with potential for ameliorating physical and cognitive limitations or disabilities are easily altered or concealed until they are needed. This flexibility provides for a traditional appearance, while simultaneously addressing the changing needs of various occupants of the home (Mace, 1990). Adaptable design denotes a conscious effort to “serve the majority of individuals who have a variety of changing needs” (Null & Cherry, 1998, p. 28).

Adaptability is a function of removing barriers that interfere with routine activities and supporting independent functioning (California Real Estate Kid’s Corner, 2002). Some examples of adaptive housing features include break-away base cabinetry, reinforced walls, and strategic placement of wall studs. When removed, break-away base cabinetry creates knee space. The installation of reinforced walls in bathrooms facilitates the safe and effective installation of grab bars. Careful positioning of wall studs allows for the creation of a doorway between two rooms at a future date without major construction alterations to support members. The creation of an opening that connects two rooms could provide comfort and establish a level of security and peace of mind for both the vulnerable older person, as well as the caregiver, while simultaneously maintaining the privacy of each. Another example of an adaptive housing feature is stacking seventy-two-inch-square closets on the ground and upper floors to accommodate the installation of a residential elevator at a future date.

### **Visitability**

Visitability is a term that refers to a movement to make houses accessible primarily for visitation purposes. The idea is that people with accessibility issues would be comfortable in a home built with visitability in mind. Visitability incorporates the universal design philosophy and synthesizes it in addressing only a small number of access issues. Recent efforts in state

legislation to require visitability or universal design in state-supported housing are significant accomplishments in the advancement of these two concepts. The concept of visitability was begun in Atlanta, Georgia, in the 1980s and resulted in the adoption of a “visitability” ordinance in 1993. This ordinance is the only one of its kind in America. Atlanta’s visitability ordinance calls for basic access for nearly all new single family construction in Atlanta. Basic access is defined as including at least one level entry, doors that provide 32” clearance, wall switches and outlets that are located at a comfortable height for use, and reinforced bathroom walls that provide for the future need to place grab bars wherever they are needed. These features would not only make it more comfortable for people with mobility limitations to visit in these homes, but would also increase the likelihood of current inhabitants ability to remain in the houses as they grow older (Ervin, 1997).

### **Kitchen and Bath Design**

Before the subject of kitchens and baths designed specifically for older adults is addressed, a look at basic kitchen and bath design is appropriate. The design of kitchens and bathrooms is complicated, and planning these two rooms follows a similar design process. The considerations vary according to the activities that typically occur in each room, and the attributes of the users, but the steps are basically parallel. The collection of detailed programming information lays the groundwork for a good design. In the programming process, the particular age-related characteristics of the elderly user are addressed. The activities that take place in the kitchen and bath define the space, and the attributes of the user to some extent define the activity. Many of the design considerations also include construction components, and require construction-related infrastructure that calls for thoughtful consideration and careful communication.

Well-planned kitchens and bathrooms begin with knowing the space available and the occupants’ needs and preferences. Other important factors are the number of people who will be using the space (simultaneously or individually), their general anatomy, and the routine activities of the users of the spaces. Specific details such as handedness and anatomical characteristics are pertinent factors to be considered. Some of the elements that are common to kitchen and bath design are storage, mechanical systems, and safety. Storage considerations are similar for kitchens and baths. Adequate storage space should be strategically located for efficient use to provide accessibility, convenience, and safety. Mechanical considerations take into account the

placement of safety features, ventilation, electrical and plumbing requirements. The placement of appliances or fixtures, water and lighting systems are also mechanical issues. At this point in the design process, the different activities that take place in the kitchen or the bathroom come into play (Cheever, 1997).

### **Kitchen Planning**

Kitchen activities are primarily related to food preparation, although entertaining guests and taking medication are also occurring in the kitchen (Emmel et al., 2001). The activities typically occur at three kitchen work areas. These areas are cooking, chilled storage, and clean up. The appliances that typically anchor these work centers are the range, the refrigerator, and the sink, respectively. Another important factor is the activities other than food preparation that take place in the kitchen. Current trends include socializing and paying bills. Efficient and productive functioning of a kitchen requires attention to a multitude of factors.

Some of the more prominent considerations in a well-executed kitchen are the work triangle, walkway and work aisle, and landing-space recommendations. The work triangle is composed of the shortest distances between the three major appliances in a kitchen: the range, the sink, and the refrigerator. The work triangle should not exceed 26' total with no section less than 4' or greater than 9' with measurements taken from the middle of each appliance to the middle of the next appliance. No major traffic pattern should intersect the work triangle. The sink should be located between the range and the refrigerator. A 36" preparation space should be located on 1 side of the sink. Walkways are passage areas. There should be 36" clearance for all walkways. Work aisles should provide a minimum of 42" clearance for one cook and be 48" wide when two cooks work simultaneously in the kitchen. A clear 30" X 48" approach space is recommended in front of the range, refrigerator, dishwasher, and sink (Galvin & Cheever, 1995).

Landing-space requirements provide safe and convenient locations to place items when they are being relocated from one place to another. The landing areas of the sink should include a minimum of 24" on one side and 18" on the other. A minimum of 15" is recommended on the latch side of the refrigerator. If the refrigerator is a side-by-side, the landing space can be on either side. The 15" landing space can also be across from the refrigerator if the distance between the refrigerator and the 15" landing space does not exceed 48". A minimum of 9" on one side of the range and 15" on the other is recommended at the range or cooktop. A minimum of 15" adjacent to or above the oven is recommended if the oven door opens into a traffic



pattern. The 15” landing space can also be across from the oven if the distance between the oven and the 15” landing space does not exceed 48” and the door does not open into a traffic pattern. A minimum of 15” of landing space is recommended adjacent to, above or below a microwave oven. Storage recommendations are 186” of wall cabinets and 192” of base cabinets in a kitchen with more than 150 square feet (Cheever, 1997).

### **Bathroom Planning**

The bathroom is a personal space. Care of private, personal issues such as hygiene, grooming, and elimination needs are bathroom centered activities. Space and equipment (fixtures, fittings, and ventilation) need to be provided for each activity, and storage for the implements that support the activity. Adequate space is an issue of primary importance in maneuvering the limited space available in traditional bathrooms, doorways, and passage areas. A 32” wide clearance and a 24” long clear path should be provided on the “push” side of a bathroom doorway, and wider on the “pull” side. The definition of the “wider” space will be determined by the type of door and the details of the area of approach. The lavatory should be placed so that the centerline is at least 15” from a side wall. A 30” X 48” clear space either perpendicular or horizontal in front of the bathroom lavatory is recommended. It is acceptable for this space to project under the lavatory when a clear knee space is provided. The toilet should be placed so that its centerline is at least 16” from any obstruction. A 48” X 48” clear space is recommended in front of the toilet. This space can be floor space under another fixture when total access knee space is provided. The minimum clear floor space recommended at a bathtub is 30” X 60”. Stipulations for showers vary according to the dimension of the shower. The minimum clear floor space at the entrance of a shower less than 60” wide is recommended to be 36” wide and the width of the shower plus another 12” to 18” on the seat end of the opening. It is desirable to have another 12” to 18” on the opposite side of the shower (where controls are located) to facilitate access of controls. This type of shower is sometimes called a “transfer shower”. The approach for a shower that is 60” wide is 36” X 60”. It is desirable to have an additional 12” to 18” on the control side (Cheever, 1997). This size shower is sometimes referred to as a “curbless” shower. An alternative to the traditional 60” turn-around space is a rectangular space 30” X 60”. Clear floor space at each fixture may overlap. Center lines that guide the installation of fixtures also affect comfortable use. The minimum

recommendation for lavatory installation is 15” from any side wall. The center line for toilet installation is a minimum of 16” (Cheever, 1997).

Privacy is a factor associated with bath design. It is addressed from the perspectives of vision and acoustics. The privacy needs of each bathroom-centered activity will vary according to user physical characteristics and preferences (Peterson, 1996).

### **Guidelines and Evaluation**

Good kitchen and bath design is driven by user directives. It is enhanced by a strong foundation in knowledge concerning research recommendations and products. The National Kitchen and Bath Association publishes guidelines for every aspect of kitchen and bath design. The NKBA kitchen and bath guidelines are used by design professionals to ensure functional integrity based in grounded research. NKBA published a 40-item set of guidelines for kitchen design (Cheever, 1996), and a 41-item set of guidelines for bathroom design (Cheever, 1997). At the time this research began (2003), the 1996 kitchen and 1997 bathroom information, which included clear space recommendations for the first time, were the most current guidelines. Both sets of guidelines have recently been updated, but were not yet available for use in this research.

Ten items from the kitchen guidelines and eight from the bathroom guidelines have been selected for evaluation of the ECHO house kitchens and baths. The areas addressed are primarily related to space planning. For the kitchen, the items are 1) no traffic pattern through the work triangle; 2) Work triangle total no more than 26’ with no single leg shorter than 4’; 3) Wall cabinet frontage of 186”; 4) Base cabinet frontage of 192”; 5) Landing space beside the range 9” and 15”, 6) Landing space beside the refrigerator 15”; 7) Clear floor space of 30” X 48” at sink, range and refrigerator; 8) Sink located between range and refrigerator; 9) 36” work centers adjacent to water source; 10) Sink with 24” of landing space on one side and 18” on the other at same level. The bathroom items are: 1) Clear floor space of 48” X 48” in front of the toilet; 2) Clear floor space 30” X 48” at the lavatory; 3) Clear floor space 30” X 60” at the bathtub; 4) Minimum space from center-line of sink to side-wall 15”; 5) Tub/Shower controls accessible from inside and outside the fixture; 6) Minimum center-line of toilet to obstruction 16”; 7) Minimum shower interior dimension 34” X 34”; 8) Tub/Shower controls accessible from inside and outside the fixture (Cheever, 1997). A checklist of guidelines has been created for the kitchen evaluations, and another for the bathrooms. They are presented with the findings from kitchen and bath evaluations in Chapter IV.

## Universal Design

Universal design has the potential to address problematic issues of independent function. Universal design is a design philosophy that comes out of the studies of human factors, anthropometrics, and ergonomics. It was developed as part of an attempt to address access and builder issues that include American National Standards Institute (ANSI) (International Code Council, 1998), Uniform Federal Accessibility Standards (UFAS) (General Services Administration, 1989), and Fair Housing Act Accessibility Guidelines (FHAG) (Stratton, 2001). Universal design is supposed to address the needs of 90% of the population according to anthropometric data and to omit the design-criteria-related characteristics of the 0-5% and the 95 – 100% groups. Universal design addresses limitations that frequently accompany the aging process, making the universal design philosophy particularly appropriate for housing designed for the frail elderly population. Universal design features have potential for ameliorating declines in physical and cognitive performance that can support an individual's efforts to maintain an existing level of independence far into maturity. This maintenance becomes an issue of paramount importance when the existing level of performance represents the minimum required for independence. The universal design philosophy is governed by seven principles, developed by the Center for Universal Design, that address a wide range of physical and cognitive characteristics. Table 1 presents these principles and provides researcher-designated design applications to illustrate them.

Although universal design is not barrier-free or accessible design, it does draw from several access-related guidelines that have evolved over the years. The American National Standard for Accessible and Useable Building and Facilities (ANSI A117.1) in 1961, UFAS in 1984, the FHAG in 1991, and the Americans with Disabilities Act Accessibility Guidelines of 1991 have all been influential in the development of the universal design concept.

The current trend is to emphasize the appeal of universal design to all populations (Center for Universal Design, 1997a, *Universal Design Offers Something for Everyone*, 2000); however, because this study focuses on the benefit of kitchen and bath features to the frail elderly, that application dominates this research. The aesthetic integration of universal design into the traditional residential setting is one of the concept's most desirable and critical characteristics (National Association of Home Builders, 1996). One major national distributor of kitchen

cabinetry has developed a line of cabinets that is visually attractive and simultaneously incorporates such universal design features as increased height of the toe

**Table 1 – Seven Principles of Universal Design & Examples of Design Application in Kitchens and Baths**

<u>Universal Design Principle</u> (Center for Universal Design, 1997b)	<u>Researcher Designated Design Applications</u>
<p>1. <b>Equitable Use:</b> Design is useful and marketable to people with diverse abilities. Provide the same means of use for all users: identical whenever possible, equivalent when not.</p> <ul style="list-style-type: none"> <li>• Avoid segregating or stigmatizing any users.</li> <li>• Provisions for privacy, security, and safety should be equally available to all users.</li> <li>• Make the design appealing to all users.</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Staggered range heating elements</li> <li>2. Bottom mounted freezer</li> <li>3. Sit to work task space</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Soft surfaced bathtub</li> <li>2. Hand-held water source</li> <li>3. Water-controlling flooring</li> </ol>
<p>2. <b>Flexibility in Use:</b> Design accommodates a wide range of individual preferences and abilities.</p> <ul style="list-style-type: none"> <li>• Provide choice in methods of use.</li> <li>• Accommodate right or left-handed access and use.</li> <li>• Facilitate the user’s accuracy and precision.</li> <li>• Provide adaptability to the user’s pace.</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Multiple level task spaces</li> <li>2. Hand-held water source</li> <li>3. Movable cabinet shelving</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Grab bars</li> <li>2. Hand-held water source</li> <li>3. Knee space under vanity</li> </ol>
<p>3. <b>Simple and Intuitive Use:</b> Design is easy to understand, regardless of the user’s experience, knowledge, language skills, or current concentration level.</p> <ul style="list-style-type: none"> <li>• Eliminate unnecessary complexity.</li> <li>• Be consistent with user expectations and intuition.</li> <li>• Accommodate a wide range of literacy and language skills.</li> <li>• Arrange information consistent with its importance</li> <li>• Provide effective prompting and feedback during and after task completion.</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Single-lever controls on water source and doors.</li> <li>2. Large (one and a half times larger) and high contrast display of directional information</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Predictable and traditional positioning of hot water control on the left (indicated in red), and cold water controls on the right (indicated in blue).</li> <li>2. Clear and simple display of drain procedures.</li> <li>3. Grab bars at tub/shower and toilet</li> </ol>
<p>4. <b>Perceptible Information:</b> Design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.</p> <ul style="list-style-type: none"> <li>• Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.</li> <li>• Provide adequate contrast between essential information and its surroundings.</li> <li>• Maximize “legibility” of essential information.</li> <li>• Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).</li> <li>• Provide compatibility with a variety of techniques or devices used by people with</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Open or clear glass door fronts on cabinetry</li> <li>2. Visual &amp; audible process cuing (pictures indicating procedure, i.e. light, fan, etc.) on appliances.</li> <li>3. Auto shut-off range heat source.</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Motion sensor controls (water, light, heat).</li> <li>2. Increased (3X) task area lighting.</li> <li>3. High contrast finish materials on counter edges, back splash, top and flooring.</li> </ol>

## UNIVERSAL DESIGN AND ECHO HOUSING

sensory limitations.	
<u>Universal Design Principle</u> (continued)	<u>Researcher Designated Design Applications</u> (continued)
<p>5. <b>Tolerance for Error:</b> Design minimizes hazards and the adverse consequences of accidental or unintended actions.</p> <ul style="list-style-type: none"> <li>• Arrange elements to minimize hazards and errors: most-used elements, most accessible; hazardous elements eliminated, isolated, or shielded.</li> <li>• Provide warnings of hazards and errors.</li> <li>• Provide fail-safe features. (Discourage unconscious action)</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Staggered positioning of range heating elements.</li> <li>2. Auto shut-off of heat sources.</li> <li>3. Water temperature controls</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Insulation for exposed water pipes.</li> <li>2. Water temperature controls at faucet.</li> <li>3. Slip resistant and/or soft bathtub surface.</li> </ol>
<p>6. <b>Low Physical Effort:</b> Design can be used efficiently and comfortably and with a minimum of fatigue.</p> <ul style="list-style-type: none"> <li>• Allow user to maintain a neutral body position.</li> <li>• Use reasonable operating forces.</li> <li>• Minimize repetitive actions.</li> <li>• Minimize sustained physical effort vigilance.</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Maximum of 5 lbs. pressure to open doors and/or windows.</li> <li>2. Careful and conscious selection and positioning of major appliances.</li> <li>3. Sit-to-work task space.</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Walk/Roll in shower</li> <li>2. Seat in tub</li> <li>3. Gated bathtub</li> </ol>
<p>7. <b>Size and Space for Approach and Use:</b> Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.</p> <ul style="list-style-type: none"> <li>• Provide a clear line of sight to important elements for any seated or standing user.</li> <li>• Make reach to all components comfortable for any seated or standing user.</li> <li>• Accommodate variations in hand and grip size.</li> <li>• Provide adequate space for the use of assistive devices or personal assistance.</li> </ul>	<p><b>Kitchen</b></p> <ol style="list-style-type: none"> <li>1. Side-mounted water controls on sink.</li> <li>2. Side or front-mounted range heat-element controls on range.</li> <li>3. Considerate space planning reflective of user needs.</li> </ol> <p><b>Bath</b></p> <ol style="list-style-type: none"> <li>1. Front placement of water controls in shower.</li> <li>2. Side placement of water controls at sink.</li> <li>3. Single-lever water &amp; door controls.</li> </ol>

space that accommodates wheelchair foot-rests (9" high by 6" deep), a custom two-part sink base that conceals plumbing and provides access for repair, a raised dishwasher for easy access to lower compartments, a wall-mounted oven cabinet that is safely accessible from a seated height, an appliance garage for easy access and storage of counter-top small appliances, cabinets to accommodate cook tops at any height, fully lighted interiors of all cabinetry, and acrylic shelving that enhances visibility of the contents of cabinetry (Figure 4) (From drawing boards to assembly lines, 1996).

Experts in the field of universal design and housing for the elderly have produced concise lists of universal design features that they consider to be the most important items for

consideration in the design of a home that supports independence. These lists vary in content as well as perspective. Each producer of a checklist for essential universal design features brings a



**Figure 4 – Example of a Kitchen Using Cabinets with Many Universal Design Features (Kraftmaid, 2004)**

unique approach to the task and some distinguish themselves in the field of universal design. These lists have been chosen as sources for items to be included in a comprehensive list of the universal design features used in this study. The twelve expert sources selected for this research were chosen from academia, industry, state governmental agencies, and advocacy perspectives.

The academic contributors were: Kansas State University (nd.), State University of New York Buffalo (SUNY) (Center for Inclusive Design and Environmental Access, 2004), the Center for Universal Design at North Carolina State University (Center For Universal Design, 2000), HomeMods.org in conjunction with the University of Southern California (The National Resource Center on Supportive Housing and Home Modifications, 2003), and Virginia Polytechnic Institute and State University (Demerchant & Beamish, 1995). The industry representatives were: the National Kitchen and Bath Association (NKBA), (Cheever, 1996; Cheever 1997); and the National Association of Home Builders (NAHB) Research Center; NAHB, 1996). The regulatory representation included: Kentucky Housing Corporation (2003),

and the Minnesota Department of Human Services (Wilder Research Center, 2002) . The advocacy perspective was represented by the *Universal Design Handbook* (Mulick, 2001, Mulick & Levine, 2001), EasyLiving<sup>(CM)</sup> (Ervin, 1997), and the AARP (n.d.). These sources were chosen because of their leadership and strength in the research and development of the concept of universal design. A content analysis of these twelve checklists for items recommended by more than half of the experts was used to evaluate the ECHO kitchens and bathrooms. This research investigated the universal design features most widely regarded by researchers, educators, designers, and other housing professionals.

The 12 checklists chosen were analyzed to determine the most frequently recommended universal design features in kitchens and bathrooms. Although universal design serves many populations, some of the resources selected specifically cite the connection between universal design and housing for the elderly. Two hundred and twenty-nine kitchen features and 270 bathroom features were identified, totaling 499 different characteristics of universal design to be considered in this research. A spreadsheet was constructed itemizing each feature, and a notation was made each time the feature was recommended by one of the twelve checklists. Allowing for duplication, the results revealed 20 features in both the kitchen and the bathroom that were noted by six or more of the 12 sources. The 20 features (13 kitchen features and 7 bath features), referred to in this research as the critical list, were used to assess the level of universal design compatibility of the ECHO homes being evaluated. Table 2 contains the 20 features, and the number of times they were recommended.

The universal design items identified on the Universal Design Critical List list were recommended by at least half the experts consulted. Other universal design features cited multiple times, although by less than half of the experts reviewed in this study, are not included in the critical list. They are referred to as the Universal Design Secondary Critical List and presented in Table 3 along with the number of times they were recommended.

The most popular universal design feature in kitchens and bathrooms, according to a content analysis of checklists constructed by twelve experts in the field of universal design, is single-lever controls on doors and water controls. It is interesting to note that these features benefit people with the most prevalent diseases associated with the elderly, arthritis. While 32” door clearances relate most directly to mobility assistance; they are also beneficial to the able-

bodied population. Many people walk through doors carrying household objects such as laundry baskets or bags of groceries, or have need to move furniture from one room to another. Clear

**Table 2 - Universal Design Critical List**

<b>Kitchen</b>	<b># of times recommended</b>
Single-lever controls at all doors	11
Single-lever water controls at all faucets	11
32" door clearance	8
Clear knee space under sink	8
Front-mounted controls on appliances	8
Outlets located between 18" and 22" above the finished floor	7
Wall switches mounted between 42" and 48" above the finished floor	7
Adjustable or variable work center heights ranging between 28" and 45" high	6
Rocker switchplates	6
Dishwasher elevated 6" above the finished floor	6
Non-slip flooring	6
Minimum circulation clearance of 40"	6
Side-by-side refrigerator	6
<b>Bathroom</b>	
Single-lever water controls at all plumbing fixtures and faucets	12
Single-lever controls at all doors	11
Blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars	8
Shower seat	8
Mix valve with pressure balancing and hot water limiter	7
Toilet bowl height between 17" and 19" high.	6
Entry door 32" clearance	6

knee space under the sink, front-mounted controls on appliances, board blocking in the walls around the toilet, tub, and shower, and a seat in the shower are universal design features that are closely associated with preventing falls, a topic of major concern for the elderly. One study of kitchen design recommendations that reflects the needs of the elderly population noted the front placement of appliance controls in the category of safety issues that needed to be addressed more than ten years ago (Guetzko & White, 1991).

**Origins of Critical Universal Design Features List**



ANSI is a national nongovernmental organization that has established a number of recommended standards. ANSI A117.1, “Specifications for Making Buildings and Facilities Accessible to, and Usable by, Physically Handicapped People” was developed in 1961 through consensus of a committee of 52 organizations associated with special needs populations, such as

**Table 3 - Universal Design Secondary Critical List**

<b>Kitchen</b>	<b># of Times Recommended</b>
Plan lower windows – Max 36” above finished floor	5
5’ turn space	5
Smoke detector located near kitchen	5
Pantry storage with easy-access pull-out shelves	5
Pocket doors	4
½” maximum threshold height	4
Staggered heating-element positioning on range	4
Large (1.5” diameter) appliance controls	4
Wall-mounted oven installed at “lower” level (middle shelf at counter height)	4
Wall-mounted oven installed at “lower” level with side opening	4
Contrasting counter top and edges	4
Clear knee space under cooktop	4
Knee space at counter	4
“D” pulls on cabinetry	4
Sink sprays	4
Carbon monoxide detector	4
Maximum of 5 pounds of pressure required to open windows	4
Casement windows	4
<b>Bathroom</b>	
Minimum 5’ X 3’ deep curbless shower	5
Shower controls accessible from inside and outside fixture-between 38” – 48” above finished floor, above grab bar, and offset toward the room.	4
Non-slip surface on tub bottom	4
Knee space (a minimum of 27” above the finished floor) at front edge of vanity decreasing progressively as the depth increases, and a recommended width of 30” wide should be provided at the lavatory	4
Grab bars installed at toilet, tub, and shower at construction	4
Elevated (3X) glare-free lighting (40-50 foot candles)	4

people with handicaps, the medical community via rehabilitation professionals, and the housing industry through design professionals, builders, and manufacturers. The original information served as the technical basis for accessibility standards accepted by both federal and state governments (General Services Administration, Department of Defense, Department of Housing

and Urban Development, & U.S. Postal Service, 1989). The original ANSI Standards have been reviewed periodically since inception. In 1971, the Standards were reviewed and affirmed. Sweeping revisions and the establishment of a new definition of the Standards in 1980 resulted from broad research sponsored by the U. S. Department of Housing and Urban Development beginning in 1974. In 1987, a desire to restructure the standards in a way that would make them compatible with building codes was addressed by the new Secretariat of the organization, Council of American Building Officials (CABO). CABO subsequently became the International Code Council and the ICC/ANSI A117.1-1998 edition of the ANSI Standards was published (International Code Council, 1998).

UFAS was issued by the Federal Government and originally published in the Federal Register on August 1, 1984 (49 FR 31528). UFAS is the result of the collaboration of four standard-setting governmental agencies: The General Services Administration (GSA), the Department of Defense (DOD), the Department of Housing and Urban Development (HUD), and the U.S. Postal Service. The UFAS publication addressed standards for design, construction, and modification of buildings constructed or altered under jurisdiction of the Federal Government. It also applied to those leased by the Federal Government prior to January 1, 1977, or financed by the government after August 12, 1968. Facilities constructed under auspices of the National Capital Transportation Act of 1965, or Title III of the Washington Metropolitan Area Transit Regulation Compact, were also impacted by UFAS. The purpose of UFAS was to make the structures covered accessible to people with a handicap. This definition included Federal housing programs including Section 202.

The 1988 FHAG are based on seven requirements associated with design and construction of private-market multifamily housing built after March 1991. They are as follows: 1) Accessible Building Entrance on an Accessible Route, 2) Accessible and Usable Public and Common Use Areas, 3) Usable Doors, 4) Accessible Route into and through the Covered Unit, 5) Light Switches, Electrical Outlets, Thermostats, and other Environmental Controls in Accessible Locations, 6) Reinforced Walls for Grab Bars, and 7) Usable Kitchens and Bathrooms.

Many of the items present on the critical universal design features list were identified by ANSI 117.1 and UFAS, and some have been included in FHAG. One was associated with the International Residential Building Code (IRC) (International Residential Building Code, 2003).

Table 4 identifies the various sources of the critical universal design features. Note that only one feature (raised dishwasher) is not identified on at least one of these access standards or building codes. ANSI, UFAS, FHAG and IRC set the standards for each item noted in the critical list of

**Table 4 – Origins of Universal Design Features**

<b>Kitchen</b>	<b>ANSI</b>	<b>USAF</b>	<b>FHAG</b>	<b>IRC</b>
Single-lever controls at all doors	X	X		
Single-lever water controls at all faucets	X			
32” door clearance	X	X	X	
Clear knee space under sink	X			
Front-mounted controls on appliances	X			
Outlets located between 18” and 22” above the finished floor	X		X	
Wall switches mounted between 15” and 48” above the finished floor	X	X	X	
Adjustable or variable work center heights ranging between 28” and 45” high	X	X		
Rocker switchplates	X			
Dishwasher elevated 6” above the finished floor				
Non-slip flooring	X			
Minimum circulation clearance of 40”	X			
Side-by-side refrigerator	X	X		
<b>Bathroom</b>				
Single-lever water controls at all plumbing fixtures and faucets	X			
Single-lever controls at all doors	X			
Blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars	X		X	
Shower seat	X	X		
Mix valve with pressure balancing and hot water limiter				X
Toilet bowl height between 17” and 19” high.	X	X		
Entry door 32” clearance	X	X	X	

universal design features. In general, ANSI (International Code Council, 1998), UFAS (General Services Administration, 1989), and FHAG (Stratton, 2001) descriptors are stated in great detail, covering a wide variety of circumstances. Universal design directives present the essence of the information in less detail. This was an intentional stratagem. The purpose was to simplify the instructions so they would be easier for builders to follow. The thinking was that if the standards were more user-friendly, they would be used more often, accomplishing the goal of providing more accessibility (Beamish, J., personal communication, March, 15, 2005). For instance, door widths are stated in universal design guidelines as simply “32” clearance”. ANSI criteria is much more detailed and covers such issues as door swing, maneuvering space on both sides of

the door, and projections into the maneuvering space. A similar comparison of each item of the critical list of universal design features is available in Appendix A

### **ECHO Housing**

#### **Australian Perspective**

The ECHO house evolved from the “granny flat” concept. “Granny flat” was a term that referred to the program, as well as the moveable house, that originated in Victoria, Australia, in the mid 1970s. The house was simply a small dwelling, designed and constructed without internal systems, but containing plumbing and wiring appropriate for attachment to a near-by structure: the host house. The “granny flat” program was an innovative enterprise with no precedents or points of reference. The purpose of the original Australian program was “to make available to pensioners self-contained accommodations which would enable them to live independently but in close proximity to their family” (Lazarowich, 1991, p. 2). Unique in the ability to be integrated subtly into an existing community, the “granny flat” was especially appropriate when an individual’s or couple’s needs could be addressed by family-based services. It was best suited for that segment of the population that was no longer capable of total self-sufficiency, but not in need of extensive medical attention. The “granny flat” was most suitable for the young old (age 65-74) and the middle old (age 75-84) (Lazarowich, 1991).

“Granny flat” housing was appealing to independent and mobile people for several reasons. The unit was located on a relative’s or other person’s property (host’s property), making visits with family feasible for most residents; it was constructed separately from the main structure on the property and connected to that structure’s utilities. This arrangement provided convenience and privacy for the resident and the host. The “granny flat” structure was about 50 square meters in size, and was permitted to be government or privately financed. Ownership, however, was vested in the government which was responsible for transportation and storage of the unit between placements. The units were built to accommodate one to two persons, and the designs provided space for a living room, a kitchen, a bedroom, and a bathroom.

Predictors of Success. Supportive environments and the development of structured arrangements between housing management and care-service providers were becoming the primary focus of innovations in old-age housing in Australia in the mid 1980s. Increasing frailty

of the existing tenants and the relaxation of requirements involving physical attributes upon initial occupancy of the old-age housing units were factors that focused increased attention on the needs of the tenants and enhanced the probability of success for the “granny flat” program.

Many important factors directly influencing the success of the “granny flat” program were outside the control of the Australian agency responsible for administering the program, and these factors caused the operation of the program to be difficult to manage. The program required constant review and adjustment. However, despite the problematic issues that arose, the “granny flat” program grew rapidly in Victoria. In 1989, there were approximately 2,140 units in the metropolitan Melbourne area alone. By 1991, key factors that would be required for success of the “granny flat” program had been identified. These factors were government ownership and control; rental of the units; direct financing and indirect financial assistance to the private sector; various regulatory mechanisms and models of units; appropriate storage of houses; and a system for the dissemination of information (Lazarowich, 1991).

Evaluation. A survey of 538 elderly people living in a variety of housing types in the early 1980s found a significant level of satisfaction with “granny flats.” The predominant reason given for preferring a “granny flat” was the desirability of close proximity to family. Problems in the design of the units were both numerous and serious. This fact caused administrators of the program to consider modifications to future models related to location and design. The redesign of the “granny flat” scheme in 1986 undoubtedly revived the program, which was in great danger of collapsing due to a variety of problems (Lazarowich, 1991).

The general consensus is that the Australian “granny flat” program was a “limited” or “qualified” success. Some of the advantages identified were occupancy by the elderly of previously under-occupied facilities; keeping some older people out of residential care facilities; neighbor involvement in assisting the elderly; clearing of sites for redevelopment by local authorities; and perhaps the most obvious: providing variety and choice to families who wanted a relative near by, but not living in the same house with them. Some of the advantages expressed by the elder people themselves were strengthened links with their own family; helpfulness of neighbors regardless of familial relationship; helpfulness between elderly people; the engendering of a sense of independence; and the experience of satisfaction with their own home (Lazarowich, 1991).

Although the “granny flat” concept is almost 30 years old (Lazarowich, 1991), and it has experienced some initial success, it has lost some of its appeal due to changes in state-planning regulations, which have relaxed the requirements for other more flexible approaches. However, the Australian model is the acknowledged originator on which similar programs were patterned around the world (Pynoos and Liebig, 1995).

Statistics indicate that the decade of the 1990s brought the certainty of more frail elderly people and fewer professional caregivers into the Australian program. Tinker’s (1980) premise was that families were positioned to be the primary source of help, and that this was most likely to continue. Assisting families in caring for their elderly members will become even more important in the future. Fostering a concept that allows elderly people to live next door to a caring relative is an appealing idea and a reasonable policy to which government and families would be attracted.

### **The ECHO Program in the United States**

The ECHO concept in the United States is a variation on the original Australian “granny flat”. The ECHO concept is the product of interest initiated by the AARP in pursuit of innovative living arrangements for older persons. Research done by Lazarowich (1991) revealed that most people over the age of 55 have no children living with them, and persons over 60 years of age have a strong preference for small, owned housing units. People over the age of 65 are likely to need supportive services, but may not require nursing home care. In 1998, 9% of women in the 65-74 age group were divorced, and 32% were widowed and lived alone (Federal Interagency Forum on Aging-Related Statistics, 2005). These factors define criteria for desirable housing for the elderly. “ECHO units are small, attractive manufactured homes that can be leased, installed near a single-family residence, and removed when they are no longer needed” (Hedges, 1991, p. 3).

The most influential forum for ECHO was sponsored by the AARP in 1981, and featured Barry Cooper, the Australian planner responsible for the development of the “granny flat” program in Victoria. Mr. Cooper presented a comprehensive perspective of the Australian program’s success, which led to subsequent publications that further detailed the concept. The publications were primarily the product of two entities: the AARP, and printed media featuring stories about “granny flats”, often initiated by the entrepreneur Ed Guion. Mr. Guion was a specialist in product development for the building industry, and was considered by Lazarowich

(1991) to be the most persistent advocate for “granny flats” or ECHO housing in 1991. The Guion operation used stick-built construction techniques for assembling the units at a factory location. This process, better known as modular construction, allowed the avoidance of restrictions regarding mobile homes since the modular product would meet state building codes.

Three significant public agency projects were developed in Iowa, New Jersey, and New York. These attempts by the public sector to promote the “granny flat” concept were limited by the number of elderly people the program appealed to, as well as by limited resources. The most successful effort occurred in Frederick County, Maryland, when the local government authorized the permits necessary to allow residents to position mobile homes near their existing homes for the purpose of caring for elderly family members. The choice of mobile homes may have been associated with convenience. The mobile home model was an existing product that fit some of the criteria. They were small, self-contained housing units that could be easily positioned and relocated when called for. One of the major drawbacks to this particular variation on the “granny flat” concept stemmed from the fact that the average mobile home was not designed with consideration for the specific needs of the elderly. Therefore, while locating the mobile home conveniently close to the home of the caregiver did resolve a logistics problem; neither the space planning nor the structure of the standard mobile home addressed the needs of the elderly. Lazarowich characterized the success of early “granny flat” programs as limited “... ECHO housing as a formal concept has not been very successful. In contrast, as an informal concept, using the affordable but often less than ideal units, has probably had considerable success” (Lazarowich, 1991, p. 60). This success is more than likely due to their ability to provide a rapid response to a sometimes urgent need for housing for an elderly person in need of assistance and care.

Zoning. Zoning compliance and neighborhood resistance are often cited as barriers to the initial success of the ECHO concept in America. ECHO homes are generally small, so that they are more likely to fit into existing residential neighborhoods. However, positioning them in these spaces may require changes to existing zoning regulations, which can be a complicated procedure (Pynoos & Liebig, 1995) and opposition to zoning changes can be strong. Specifically, the ECHO scheme requires placing two units on a lot that has been zoned for only one unit. The placement of a second house on a lot can violate set-back requirements on the designated lot. The housing policy in a democratic society is often defined by the majority, who

are generally comfortably housed. This same constituency can prevent the less influential minority from building in a particular area, generally referred to as the NIMBY (Not In My Back Yard) phenomenon (Allen, Courtney, Happold, & Wood, 1992). The ECHO house is vulnerable to the NIMBY mind set.

Acceptance. While acceptance of ECHO housing has been sporadic and unpredictable, where it has occurred it has had a profound effect on the entire population including both young and old. "...In every country where they exist, granny flats increase opportunities for greater intergenerational understanding" (Porcino, 1991, p.165).

The trend to invest in and develop non-institutional long-term-care settings began to gain popularity in the United States in the early to mid 1990s. The idea that many people who require help with ADLs, as well as some more intensive health services, are no longer restricted to institutional-type housing was a burgeoning concept. Owing directly to recent advancements in technology related to medical needs, the option of a wide variety of living arrangements was becoming more feasible every day. Because of the growth and availability of home-care services, the person in need of these services had residential options that included individual homes or apartments. Another changing dynamic occurring at that time was recognition of the intimate connection between housing and the health and economic factors that have an impact on the occupants of the housing (Pynoos & Liebig, 1995). The "granny flat" or ECHO housing was among several options that were made more attractive by the combination of these factors. The benefits of ECHO housing most often noted were proximity to caregivers with privacy and the low cost of the unit. Proximity to the caregiver indicates more security regarding support while maintaining, as much as possible, an independent lifestyle. The low cost is a function of the factory-built construction techniques that maximize strict control of construction costs.

A 1992 AARP survey reported moderate interest in the ECHO concept. Consumer attitude and the question of acceptance has been a topic of housing industry discussion, and a major concern for promoters of the concept. Familiarity with the concept is low among consumers, and some who recognize the name appear to accept it for the use of others, but not for themselves. Indications are that the most likely consumer interest would come from Afro-American women between the ages of 60 and 64 who are currently living in mobile homes. Low-income women of fair health appeared to be the most likely acceptors of ECHO housing. A more recent study by Gonyea, Hudson, and Seltzer (1990) cited in Koebel, Beamish, Daniels-



Lang, and Steeves (2003), noted that for vulnerable older people, relocating to a secondary house on another person's property was one of the more desirable housing options considered. ECHO houses were also an attractive consideration for financially secure older adult renters and the socially secluded portion of the elderly population.

The term "granny flat" is still used to describe ECHO housing, even in the United States. An ECHO unit is also sometimes referred to as an "accessory unit" or "accessory dwelling unit". The terms "granny flat" and ECHO unit are usually used when referencing an accessory unit that will house an older person, but some accessory units are not necessarily linked to occupancy by an older person. Other types of accessory units could be an accessory apartment, garage apartment, carriage house, or ancillary unit. (Koebel et al., 2003).

### **HUD Demonstration Program**

The following section highlights the findings of a report, which HUD commissioned to Virginia Polytechnic Institute and State University, evaluating the current status of the ECHO program.

Early in the 1990s HUD became interested in the ECHO concept as part of the Section 202 program. Section 202 requires that participants be "very low income". The ECHO program, however, stipulates only that the occupants be "low income". Low income is defined by HUD to be "annual income that does not exceed 80% of the median family income for the area, as determined by HUD" (Code of Federal Regulations, 2004, p.77); very low income is defined by HUD to be "annual income that does not exceed 50% of the median family income for the area, as determined by HUD" (Code of Federal Regulations, 2004, p.79). The ECHO demonstration program was announced in the August 1993 Federal Register Vol. 58, No. 165, Notice of Funds Available (NOFA). The NOFA provided detailed information on the ECHO program guidelines for the HUD field offices involved in the proposed program (HUD regions II, IV, and VII). The NOFA contained comprehensive directives for sponsors that addressed the application process, including filing deadlines, and the selection process, including selection criteria, for the ECHO housing demonstration program. The NOFA addressed the uniqueness of the ECHO housing demonstration program as compared to other Section 202 programs. Durability of the structure, factors that influence sponsor success, and the degree to which those factors differ in the ECHO program from the traditional Section 202 program were noted. Potential sponsors and HUD staff were cautioned to avoid "screening out flexible, innovative approaches by eligible but

nontraditional Sponsors” (U.S. Department of Housing and Urban Development, 1993, p. 5384). The purpose of this directive was to encourage creativity in the formulation of the sponsor plan to administer this unique demonstration program.

ECHO Demonstration Awards. Applications for the ECHO demonstration were selected on a first-come, first-served basis up to the HUD regional allocation of 40 units (subject to transfer of excess units from other regions). Applications from Tennessee, New Jersey, Iowa, Kansas, and Missouri were selected to participate in the ECHO housing demonstration program. The initial allocation of ECHO housing units to these states was as follows: Tennessee, 20 units (1993); New Jersey, 20 units (1994); Iowa, 10 units (1996); and Kansas, 20 units (1994). Information on exactly when the ECHO program was initiated in Missouri was not available; however, the program was originally funded for 10 units. At the time of the evaluation of the program, the distribution of active units was; Tennessee, 2 units; New Jersey, 6 units; Iowa, 10 units; Kansas, 6 units; and Missouri, 10 units.

Post Award Implementation. Four groups are primarily involved in the ECHO program: HUD field staff, sponsors (also referred to as owners), hosts (also referred to as host families), and residents. The NOFA guidelines define each of these groups and their respective responsibilities. The HUD field officers were responsible for advising constituents of the availability of the program and supporting interested parties in completing the application process. In addition, HUD field officers were responsible for reviewing filings submitted by the selected sponsors as the program developed, and monitoring the progress of the program as a function of administering the appropriated funds.

Sponsors were responsible for completing the HUD application process for the grant, including a detailed plan for implementing the program in their area. Once the grant was awarded, the sponsor was responsible for selecting an appropriate design for the ECHO house; locating a manufacturer with the expertise required for constructing the house; advertising, researching, and selecting suitable host families and residents for the ECHO program; completing and filing required documentation of agreements between HUD, the host, and the resident; researching and approving appropriate site locations; securing the services of a qualified contractor to prepare the site; and monitoring the installation and occupancy of the ECHO houses. Once an ECHO house was occupied, sponsor responsibilities shifted from real-

estate-related tasks to those more closely aligned with property management. The sponsor collects rent, maintains the structure, and relocates the house when the host no longer needs it.

The “host family” is defined as “the family that owns the single family home site where the ECHO unit will be located”. The “single family home” is defined as “an existing one-to-four family dwelling” (U.S. Department of Housing and Urban Development, 1993, p. 45388). The host family is responsible for attending to the needs of the resident of the ECHO house. This is a loosely defined responsibility that was not formally monitored. The responsibilities are left to the host family and resident to determine.

The resident must meet the eligibility requirements of the program, but does not have other responsibilities under the program. The resident’s eligibility for the ECHO housing demonstration program is based on need. The resident must be elderly (62+), have low income (<80% of the area median family income), and a need for assistance that can feasibly be provided by the host family. Although other needs are referred to generally, the only stipulation of need clearly stated in the NOFA is close proximity between the homes of the host and the ECHO resident. Directives regarding verification of specific ECHO resident needs are not stated in the NOFA. Local sponsors began operating these demonstration programs between 1993 and 1996.

Evaluation. Although the end users, the residents and hosts of the ECHO houses, were very pleased with the advantages the ECHO program affords them, the ECHO program had problematic issues. These identified items must be resolved in order to continue the program (Koebel et al., 2003). Some of the prominent issues associated with the recent examination of ECHO housing that impact this study include design, construction, installation, maintenance, repair, relocation, program administration, and resident and caregiver support.

Design. Research indicates that the overwhelming preference of seniors is to remain in the home they have inhabited previously as they grow older (Pynoos, 2001). Those who chose or need to relocate prefer a small freestanding home (Lazarowich, 1991). Slightly more than 50% of elderly people in this category prefer a house that is either the same size or slightly smaller than the one they are leaving (Wylde, 2003). They require less square footage than in the past. This interpretation of the “granny flat”/ECHO concept addresses the growing concern for affordable housing for the aging population. Less square footage will cost less to construct than traditionally larger alternatives; thus the occupant may need to adapt the smaller square footage

to a variety of uses from time to time. Space must be designed for flexible usage which addresses another priority; maximum value in space for the financial investment in the structure. These details are compatible with the design of an ECHO house. The experts who recently evaluated the ECHO program for HUD noted that standardized designs need to be tested for performance and those units should be manufactured by companies that can assure unit quality, portability, and durability. Designs should fully incorporate UFAS requirements and meet the accessibility needs of the targeted population. Design criteria also need to address various geographic and climatic conditions (Koebel et al., 2003).

HUD defined the ECHO unit in the August 27, 1993 NOFA as follows "... a small, self-contained, barrier free, energy efficient and removable dwelling unit (ECHO unit)" (U.S. Department of Housing and Urban Development, 1993, p. 45384). Additional requirements described in the NOFA address such issues as durability, stating that the units must be constructed in such a way that permits "continued use over the life of a capital advance" defined as 40 years (U.S. Department of Housing and Urban Development, 1993, p. 45384). Construction standards stipulate that "ECHO units must be constructed in accordance with UFAS, and HUD's implementing regulations (24 CFR part 40), the statewide industrialized building code (if one exists) and any other relevant local building code" (U.S. Department of Housing and Urban Development, 1993, p. 45388). Adherence to the defined criteria resulted in four distinctly different architectural designs that were used in the ECHO demonstration housing program. Each design was a freestanding unit complete with electrical, plumbing, and heat/air conditioning systems that could be located near a "host" house. Each ECHO house contained a living room, kitchen, bedroom, and bathroom. With the exception of one bathroom item (tub/shower seats) UFAS guidelines were employed in the design of the kitchens and bathrooms.

Differing degrees of importance focus on the need for addressing the aesthetics of the basic design of ECHO house. A notable amount of research on the success of the program stresses regulatory issues instead of aesthetic ones. However, there is at least one line of thought that suggests that interest by the public would have an impact on the regulatory parameters. The theory suggests that aesthetics and appearance of the structure are related to the restrictive zoning regulations that have impeded the success of the ECHO program (Pynoos & Leibig, 1995). The curb appeal could be enhanced by addressing local cultural expectations through design to create a structure that is more congruent with the existing architecture of the neighborhood.

Construction. The five states involved in the current ECHO demonstration housing program chose manufactured housing (mobile homes) or modular construction techniques to provide ECHO units for their program. The mobile home design was used in Tennessee only. Modular homes were designed and built for New Jersey, Kansas, Iowa, and Missouri. The limited success of the program in Tennessee is associated with many factors, including the mobile-home format used for the ECHO houses. The modular design and construction technique proved to be more suitable for the construction of ECHO houses in the other states participating in the ECHO program.

The benefits of modular design and construction include factory-built efficiency of time and financial resources, consistent quality, and a more reliable labor pool. Although the same can be said of manufactured homes, good modular construction should be viable for as long as a similarly built site-built home (Wickel, n.d.). This is an important aspect of the ECHO program due to the stipulation requiring viability for the 40-years capital advance period.

The production of the ECHO units was problematic during the initial demonstration phase of the ECHO program for several reasons. One confounding area directly related to construction quality is variability of construction design. The guidelines for development of the ECHO program and the construction were stated in terms that could be interpreted by individual state programs as needed. Thus each state could customize its approach to meet the needs of its geographical characteristics and constituents. Therefore each state conducted independent research and developed a design that was unique.

Four distinctly different construction designs were used by the five states participating in the ECHO demonstration program. Missouri and Iowa used the same design, but Kansas, New Jersey, and Tennessee each used separate and unique construction designs. The units constructed for Iowa proved to be of good quality, functioned well, and have sustained relocation acceptably. The ECHO houses constructed for the Missouri program have not endured. Some issues were associated with original construction quality, and some to significant lapses in maintenance procedures. Some of the construction issues that have surfaced in the ECHO houses in Missouri involve roofing, single-pane windows, un-insulated crawl spaces, inadequate “skirting”, and plumbing and electrical problems. Additionally, the proximity to earthquake fault lines influenced the stability of the sites, and “settling” has occurred (B. Lakey, personal

communication, September 23, 2002) causing cracking in walls and ceilings. Kansas construction problems were related to the size and location of the water heater, insufficient and exposed crawl space, and relocation. The water heaters were too small to accommodate the needs of the occupants, and the structural design of the house located water heaters within sealed wall spaces, rendering them difficult, if not impossible, to service. The inappropriate and uninsulated crawl space led to plumbing problems that were inaccessible, and therefore could not be repaired. The design and construction of the ECHO houses in Kansas rendered them impossible to relocate (Koebel et al., 2003). The design of the New Jersey houses was similar to the one chosen for Iowa and Missouri, and they are serving the residents and caregivers admirably. The most serious problem reported in New Jersey was related to installation of the units. Tennessee's choice of a mobile home for the ECHO program reflected topographical issues. The mountainous terrain in the rural areas the program served required a unit design that could be moved in and out of locations that were challenging. A wheeled chassis provided the flexibility required. The mobile ECHO homes in Tennessee have not endured. The three that the researcher observed in Phase I of this research were in storage, had never been occupied, and were in disrepair. Siding material had separated from the body, windows were broken, and tires were flat. The interior, however did incorporate some universal design features. An open plan employed few doors in the living area, facilitating movement through the space. Single-lever door and water controls were installed, and the toe-kick in kitchen cabinetry was raised.

Installation. Proper installation of ECHO houses is not a simple matter. One aspect of the process involves requisite HUD procedures and approvals. Communication between the sponsor and the HUD field office is critical to the completion of work in a timely manner. Another phase of the installation process that is critical to the success of the program is preparation of the site. There are several phases of preparation, beginning with an on-site inspection of the proposed property to ascertain whether or not it possesses the required characteristics. Some of these characteristics include appropriate topography, proximity to the host house, and support connections (power, water, sewer, etc.). Another major consideration is the amount of time required to obtain local permitting and approvals. These issues have proven difficult in the past and are anticipated to continue to require attention in the future (Koebel et al., 2003). Another issue is the length of time required for the physical installation. Weather,

required inspections, and coordination of man-power and machinery can complicate and lengthen installation procedures (R. Maitland, personal communication, September 23, 2002).

Maintenance and Repair. Diligent attention to maintenance and repair is critical to the success of the ECHO housing program. It is the responsibility of the host or resident to notify the sponsor of any maintenance or repair requirements within a reasonable period of time. Because this process is dependent on clear communication of information, it is necessary to establish and maintain a good understanding of each party's responsibilities, and to set up procedures for notification of maintenance and repair issues early in the relationship. Proper administration of this aspect of the ECHO program was exemplified in the Iowa program, and is supported by the good condition of the ECHO units and the success of that program. A breakdown in the line of communication between the sponsor and the host and tenant results in either a substandard or a non-existent response to maintenance and repair needs. The Missouri and Kansas programs reported major problems with sponsor responsibilities and the resulting condition of the ECHO houses (B. Lakey, personal communication, September 23, 2002; J. Verbelli, personal communication, October 24, 2002). Structural integrity is seriously jeopardized when maintenance and repairs are not addressed in a timely manner.

Relocation. The ability to relocate the ECHO houses is a basic aspect of the program design. The structures must be capable of serving individuals at varying locations. The design of the ECHO units needs to accommodate relocation of the structure numerous times during the lifetime of the home. A design that does not address this issue appropriately contributes significantly to the cost of the program and potentially to the demise of the program. The only time this was a significant problem was in Kansas. The ECHO house design chosen by Kansas sponsors was adapted to various sites and has resulted in varying sizes and configurations of units. A lack of standardization has resulted in units that do not disassemble, relocate, and reassemble. The result is vacated units that remain on the original installation site with no one in residence, and no feasible means of removing the unit from the premises. Although Iowa reported requiring as little as six weeks to complete the relocation process (L. Hullinger, personal communication, October, 27, 2002), one host in New Jersey stated that a year and a half was required to complete the relocation and installation of her mother's ECHO home (Caregiver NJ4/7, personal communication, September 6, 2004).

Program administration. The experience of administering the ECHO program has varied from state to state, and many problems in the structure of the program have been identified. It is the nature and part of the purpose of small, demonstration, pilot programs to reveal aspects and issues of the program that require attention. In this regard the ECHO program has operated appropriately. Examination of each state's program revealed unique findings from which all the programs will benefit. Some of the variability related to the considerable difference in sponsor capacity and management style. The issue of sponsor capacity is multifaceted. The responsibilities include tasks that involve social and fiscal, as well as construction and maintenance skills. The Iowa program operates at an advanced level as compared to the other programs and is said to represent the "fulfillment of the program's potential" (Koebel et al., 2003, p. 55). Research indicates that one relevant factor is the sponsor's previous real-estate experience. The Iowa sponsor also had significant experience with other HUD Section 202 projects, and enjoyed a good relationship with the HUD field officers in Iowa. He was also a long-time resident of the community that the ECHO program served, and had good rapport with the local agencies and the elderly population in the service area. In contrast, two of the ECHO programs (New Jersey and Kansas) have experienced so many confounding problems with their ECHO programs they have decided to contract professional property management firms to manage the housing units in their ECHO program. Communication with the sponsor is a vital part of administration of the ECHO program. Detailed specifications for sponsors should be developed, along with criteria for host and tenant selection. Prospective sponsors should be required to document their experience and expertise in all aspects of the ECHO program, including construction contracting, site evaluation, and property management (Koebel et al., 2003).

Resident and Caregiver Support. Although there were challenges and frustrations, residents and caregiver/hosts were happy with the living arrangements and benefits provided by the ECHO housing program and the ECHO house. Family-based care for an older family member is currently popular, and the majority of assistance with ADLs and IADLs (80%) comes from family caregivers. The value of this care was calculated to be worth \$180 billion in 2002 (Summer & Ihara, 2004). It is important to acknowledge that these numbers do not reflect the priceless value of providing emotional support, or the critically important assistance with sensitive personal tasks such as health-care management.



Interviews with families and residents of ECHO housing programs reflect the benefits of the caregiving relationship. One caregiver referred to “a synergistic lifestyle that benefits all” (Amherst, n.d., p. 1). Caregivers also spoke of the benefits that the parents offer to the family, such as childcare and meal sharing (Koebel et al., 2003).

Caregiving is a personal act requiring both physical and emotional support. The design of ECHO housing has potential to facilitate efficient and effective use of both. The physical design of the ECHO house addresses both independent function and the potential need for human assistance with some activities. The proximity of the ECHO house to the host house facilitates both casual connections and the potential for quick response in an emergency situation. However, the most prevalent comment on the location of the ECHO house referenced “peace of mind” provided by having loved ones close (Koebel et al., 2003). Golant (1992) noted concern about the expediency of the ECHO units for family caregiving. Caregiving can be stressful and time-consuming. Depending on the degree of assistance that is required, the fact that the ECHO unit is not attached to the home may exacerbate caregiving activities. Advanced age and/or the need for enhanced support may render ECHO housing an unacceptable solution to current problems and may even be an impediment to appropriate care (Golant, 1992).

Overall Satisfaction. Despite the problematic areas of the ECHO program and the numerous challenges and frustrations encountered in the demonstration program, hosts and residents at each demonstration site were pleased overall to have their ECHO units. A sense of pride in ownership was expressed by most residents, and caregivers often mentioned their gratitude for the option of caring for their loved ones in an efficient and convenient manner.

### **Summary**

The popularity of the idea of aging in place considered in conjunction with the reality that existing housing stock does not meet the needs of the elderly calls to the attention of gerontologists and housing professionals alike the need to investigate strategies that will provide appropriate housing for the aging process. Universal design is a concept of interest to a number of disciplines including housing. Although the current trend is focused on the growing recognition that the concept is not limited to disability applications, but rather is of equal benefit to the able-bodied population, universal design has evolved from years of disability and barrier-free related regulatory information. It has been researched and promoted from a broad range of perspectives including academia, regulatory, industry, and advocacy. The potential of the seven

principles of universal design in housing for the frail and elderly population is supported on a theoretical basis, but little evidence is available from empirical sources.

ECHO housing, in general, and the HUD ECHO demonstration housing program in particular, present an appropriate setting for observing the experience of frail, elderly people who have experience living in universally designed environments. Residents and caregivers currently involved in the ECHO program provide a unique resource for a post-occupancy evaluation of the effectiveness of a critical list of universal design features in the performance of daily routines involving ADLs and IADLs in the kitchens and bathrooms of the ECHO houses.

As the lives of the elderly become more centered on and in their homes as they age, the impact of the supportive or unsupportive nature of the residential environments becomes a critical factor to their independence. The relationship between the demands of the often static environment and the often diminishing personal capacity of the occupant of the house to carry out tasks involved in personal maintenance is a critical one. The ability to optimize existing competencies and compensate for the loss of others in these matters of personal maintenance is a requirement of independence in late life. Housing choice becomes an issue affecting safety, efficiency, and ultimately independence.

The broader perspective of post-occupancy evaluation of universal design and ECHO housing addresses the burgeoning recognition by educators, researchers, industry leaders, advocacy groups, and policy makers that these concepts have potential to ameliorate problematic issues of housing and health care by joining the two. This perspective contradicts some long-held precepts and would benefit from supportive grounded research.

“Researchers conducting post-occupancy studies are capable of making a contribution to the theory, and actually testing the theory, under certain conditions. By planning the study to collect appropriate information and analyzing it statistically, the researcher performing design-oriented studies can provide insights into theoretical issues” (Beamish, 1983, p. 52).

**Chapter III**  
**METHODOLOGY**

The purpose of this research is to determine if universal design features in the kitchens and baths of ECHO housing are effective in meeting the needs of the residents.

The specific objective of the study is to identify universal design features of kitchens and bathrooms that are widely valued by researchers, designers, and other experts in the fields of housing and universal design. The research will additionally determine which of the identified kitchen and bath universal design features are present in ECHO demonstration houses, and evaluate reported effectiveness of the universal design features of kitchens and bathrooms for current residents and their caregivers in ECHO houses.

**Source of Data**

This research is a focused extension of a larger study commissioned by the U. S. Department of Housing and Urban Development (HUD) in 2003 to evaluate the 10-year-old HUD ECHO demonstration housing program. That larger work examined the ECHO program and houses from a broad perspective. It involved several tiers of research that included physical inspection and assessment, evaluation of financial viability, program design and implementation, and end-user post-occupancy evaluation. This research narrows the focus to determine the presence of universal design features in kitchens and bathrooms and to evaluate their effectiveness for the residents and caregivers associated with the ECHO houses currently occupied. This study is a post-occupancy evaluation involving several information-gathering techniques including structured interviews and visual observations by the researcher. This research was conducted in two phases. The researcher was a part of the team that constructed the Phase I interview guides (Appendix B and C) used in the original 2003 study. Additionally, the researcher administered the Phase I interviews through on-site and telephone interviews. The first phase was composed of on-site visits to caregivers and residents of sponsor-selected ECHO houses in New Jersey, Iowa, and Kansas, and phone interviews with caregivers and residents in Tennessee and Missouri in October and November of 2002. The same interview schedule was used for both in-home visits and phone interviews. The second phase, begun in 2004, consisted of information gathering and investigatory procedures designed to define important universal design features, and reveal the presence and benefits of those specified features in the ECHO house. Phase II also ascertains a health rating of the occupants and examines relationships

among the critical list of universal design features, occupants' health and independence with ADLs and IADLs, and the relationship between these components.

### **Phase I**

Data collected during Phase I was used to answer the broader questions that were part of the 2003 HUD ECHO demonstration evaluation. Primarily the interviews conducted with residents and their caregivers were used in this study to provide information about the ECHO houses, the health and abilities of the residents, and their feelings about their homes.

Architectural plans and elevations for three of the four models of units built in the demonstration program were obtained during Phase I. On-site and telephone interviews were conducted and photographs were taken of the houses visited. Additional photographs of some units not visited were provided by the HUD field offices.

Sample. The first phase of this research involved 34 occupied ECHO houses in use in five states. Participants in the ECHO program included residents of the ECHO houses and their hosts/caregivers.

Description of Instrument. One interview schedule was developed for residents (Appendix B), and one for caregivers (Appendix C). Phase I interview schedules were developed from current literature in ECHO housing, housing for older adults, and post-occupancy evaluation. The Phase I interview schedules were broad-based instruments that addressed the entire ECHO program, including housing unit design. The items from these questionnaires used in this research study are starred on the interview schedules in Appendix A and B.

Items. Questions that revealed information about the participants' routine, such as description of a typical day, provide important information (Appendix C, Question 1, Probe 1). Other questions covered in Phase I interview schedules were helpful. These questions addressed physical ability, mental/cognitive ability or alertness (Appendix B, Question 2, Probe 1, 2, and 3, p. 1), tasks that were carried out independently and those that required assistance (Appendix B, Question 3, Probe 1, 2, 3, and 4, p.1), experience with home-related services available through community-based agencies (Appendix B, Question 9a, p. 3; Appendix C, Question 7a, p. 3; and Appendix C, Question 1, Probe 1, 2, and 3, p. 1), and the length of time assistance had been required (Appendix B, Question 4, Probe 1, p. 1; and Appendix C, Question 2, Probe 1, p. 1). The information gathered was helpful in determining the presence of

universal design features and providing indicators of the residents' health status. Additional information provided by the Phase I interview schedule pertinent to this study involved questions that revealed the perceptions of the participant and caregivers regarding the disadvantage or benefit provided by characteristics of the ECHO house, such as the floor plan or room arrangement, lighting, finish materials, and the location of the house on the site. Questions that addressed the participants' satisfaction with the ECHO house and program in general, the impact that living in the house has had on the lives of the resident and caregiver, and recommendations they would make to improve the house contributed to issues of benefit and effectiveness that were evaluated in the 2003 study.

Procedures. Phase I involved Internal Review Board (IRB) approval for working with participants in the interviews that was also applied to Phase II work with ECHO sponsors, residents and caregivers (Appendix D).

On-site and phone interviews were conducted with residents and caregivers during the fall of 2003. The on-site interviews with residents, and caregivers were coordinated through the respective sponsors in each state, who selected the participants to be interviewed, notified them of the research, and scheduled interview visits. The on-site interviews with ECHO residents and caregivers were conducted in the host and ECHO houses. Residents and caregivers were interviewed separately or together according to their preference. If separately, the host was interviewed in the host house, and if together, both interviews took place in the ECHO house. An interview schedule provided structure for the inquiry, and participants were encouraged to augment the questions being asked whenever they felt it was appropriate to contribute additional information. Each interview lasted for approximately one hour. The participants not available for interview during the on-site visits were contacted by phone in the spring of 2003 using the original interview schedule. Phone interviews involved two stages. The first call was made to introduce the researcher, describe the research, and determine the residents' and caregivers' interest in participation in the research. A mutually convenient time for the researcher to call again to conduct the approximately one-hour- long interview was determined during the first call.

Information from Phase I interviews were reviewed by the researcher before the Phase II questionnaire was drafted. The review revealed gaps in information that were then used to compose questions that informed the Phase II study on the presence of the specified universal

design features, their importance to participants of the study, and the occupants' health status rating.

## **Phase II**

Phase II of this research involved an analysis of photographs and architectural plans of the ECHO units, and of the Phase I interviews with residents and caregivers in order to complete the ECHO Record. The ECHO Record is an instrument that was used to assimilate data on each case from Phase I and Phase II sources. Information was also obtained by follow-up interviews with residents and caregivers.

Phase II of this research included identification of important universal design features in the kitchens and bathrooms of ECHO houses, construction of evaluation instruments, an analysis of photographs and plans of the ECHO demonstration homes, and follow-up interviews with the residents and caregivers who participated in Phase I. These were then followed by an analysis of the relationships that occur among the factors revealed during the research.

Sample. The Phase II sample began with the same list that was used in Phase I, except for the two residents in Tennessee. Plans were not available for the Tennessee units, so these residents were interviewed as part of the pilot test of the instruments and procedures, but were not included in the final analysis. Several mitigating factors caused the distribution of residents and caregivers to change in Phase I from that of Phase II (Table 5). One confounding issue in Phase II was that one of the residents being interviewed with her caregivers present wandered in and out of the interview process. Therefore, some resident participation numbers are inconsistent. Sometimes responses indicate an  $n = 22$ , and for others  $n = 23$ .

Development of Instruments. Several new instruments were developed for Phase II by the researcher, and are included in the ECHO Record (Appendix E). The ECHO Record was composed of the following parts – a checklist of universal design features present in the ECHO house (Part 1 of Appendix E), an assessment of effectiveness of the universal design features in supporting health and completing ADLs and IADLs (Part 2 of Appendix E), and an assessment of the resident's health and functioning (Parts 3 and 4 of Appendix E). Some of the information required to complete the ECHO Record was available and had already been collected on the Phase I interview schedules and floor-plan drawings. This information was gleaned from the Phase I documentation and inserted onto the ECHO Record prior to conducting the Phase II interviews.

The checklist on the ECHO record is composed of the 20 items identified by conducting a content analysis of twelve universal design checklists during the literature review. These items were placed in a chart with a column for checking that the item was present (Part 1 of Appendix E). The checklist was completed by examining the plans, elevations, and photographs of the houses that were collected during Phase I. If there were any items that could not be assessed by these three sources, then the resident was asked about the items during the Phase II interview.

An assessment of the effectiveness of the universal design features was completed during the Phase II interview. The 20 items on the universal design checklist were incorporated into a form that was used to ask residents or caregivers to rate the effectiveness of the feature (Part 2 of Appendix E).

Finally, the general health and functioning assessments were determined from information gathered in Phase I and supplemented when required from the Phase II interview (Parts 3 and 4 of Appendix E). ADLs and IADLs that would typically occur in the kitchen or bathroom were used to assess function. Questions about eating, walking, bathing, toileting, transferring, and dressing determined how many ADLs required assistance (Part 3, Probe 4 of Appendix B, and Part 4 of Appendix E). Questions about preparation of meals and cleaning the kitchen and bathroom were used to determine the functional performance level of ADLs and IADLs (Part 3, Probes 2 and 3 of Appendix B, and Part 1, Probes 1, 2, and 4 of Appendix C). A variable based on this information was created for analysis. Some information regarding resident general health, and use of home-related services provided by community-based agencies was provided from Phase I data (Appendix B, Question 9a, p. 3 and Appendix C, Question 7a, p. 3) Information about health and function that was not available from Phase I data was obtained during Phase II interviews.

Items. The primary recording instrument for this research is the ECHO Record. The ECHO Record is composed of four parts. Part 1 is a checklist confirming the presence of the 20 items on the critical universal design checklist. These items are related to kitchens and bathrooms. They are presented in Tables 14 and 15. Part 2 of the ECHO Record contains a questionnaire designed to evaluate the effectiveness of the 20 critical-list universal design features. Part 3 questions are related to the health and dependency rating of the resident. The health section of Phase II ECHO Record reported the health scores. The health items scores

represent the level of self-reported health ratings. They ranged from 1-5 with “poor” = 1, “excellent” = 5. These scores were used to create another variable called health rating (Part 4).

Functional scores represented the ability exhibited in the performance of tasks that occur in kitchens and bathrooms. Scores were determined based on the level of independence in the performance of ADLs and on the frequency with which assistance was needed. The functional scores represent the level of assistance required in the performance of seven selected ADLs and IADLs. A response of “never” needing assistance received a score of 1, needing assistance “occasionally” = 2, and “always” = 3. These scores were used to create another variable called dependency. For instance, preparing food is an IADL. A person needing “occasional help” with preparation of food would receive a 2, and “always” needing help would receive a 3. For a bathing, a score of 1 would be given if help is never needed, and 2 was given if help is needed occasionally, and 3 if help was needed always in the performance of the ADL or IADL. In the kitchen these tasks include preparation of food and eating. Tasks that traditionally take place in the bathroom include bathing, toileting, and dressing. Cleaning occurs in both the kitchen and the bathroom. Information on these matters was gleaned from Phase I and II interviews. A score referencing whether or not the residents required assistance with ADLs and IADLs and a health score provided important information about the health and functioning of the subject. This information served as quantitative data for statistical analysis.

Effectiveness of the universal design features on the critical list was another important part of this research. The items researched for effectiveness were the items that were on the critical list of universal design features checklist. A Likert scale was used to measure the effectiveness as perceived by both the resident and the caregiver, with 5 being “very helpful” and 1 being “not at all helpful.” Separate scores were obtained for each feature from each resident and each caregiver.

Procedures. First, data about each ECHO resident and house was entered onto the ECHO Record, based on the information available from the Phase I plans, elevations, photographs, and interviews. Most of the universal design checklist items and ADL/IADL information were obtained from this review. However, some items on the checklist could not be completed without asking the residents or their caregivers. Some ADL/IADL information also required asking additional questions. Any information that could not be obtained from the review of Phase I data was incorporated into the Phase II interview schedule of the ECHO Record and



asked during the interview. Therefore, each Phase II interview schedule was customized for the individual resident and caregiver.

Arrangements for the phone interviews involved an initial introductory call to make arrangements to call back at a mutually convenient time to conduct the Phase II phone interviews. Each interview required approximately one half hour to conduct.

Pilot Test. Because of the unavailability of documentation important to the evaluation processes involved in this research (on-site inspection of occupied units in Phase I, architectural drawings, manufacturer information, etc.), Tennessee was not included in Phase II of this investigation beyond the pilot-test. For that reason, the Phase II phone survey form was pilot tested on the Tennessee participants. Minor changes were made to the interview schedule as a result of the pilot study. They consisted of rewording of some questions and clarification of terminology.

### **Qualitative Analysis**

A qualitative analysis was conducted using instruments from Phase I and Phase II of the research. The Phase II procedure included a review of the data gathered in Phase I including construction drawings, photographs, tape recordings of on-site interviews, and responses to interview schedules/questionnaires A and B. The questionnaires were particularly rich with annotations, quotes, and notes detailing the interview experience. The construction drawings provided structural details, and the notes and recordings helped to clarify the observations presented in the findings. The description is documented with plans and photographs and is supported by researcher observations and resident and caregiver comments.

### **Quantative Analysis**

Several ratings and items from Phase II questionnaires were scored and used to test the hypotheses.

### **Variables**

The independent variables are:

1. The universal design features identified as present in the three kitchens and three bathrooms of the ECHO house floor plans A, B, and C. This variable is determined by the critical list of universal design features that are present and unique to the individual plan A, B, or C.

2. The residents' perceptions of the effectiveness of the individual universal design features in the kitchens and bathrooms of the ECHO house. This variable is determined by the rating given to each feature on a scale of 1-5, with 1 being very ineffective and 5 being very effective.
3. The caregivers' perceptions of the effectiveness of the universal design features in the kitchens and bathrooms. This variable is determined by the rating given to each feature on a scale of 1-5, with 1 being very ineffective and 5 being very effective.

The dependent variables are:

1. The dependency score of the residents as determined by resident's self-reported level of assistance required to complete ADLs and selected IADLs. This rating was based on a 1-3 scale representing frequency of required assistance as "never", "occasionally", or "always".
2. The functioning score of the residents as determined by caregivers' perception of the level of assistance required by residents to complete ADLs and selected IADLs. This rating was based on a 1-3 scale representing frequency of required assistance as "never", "occasionally", and "always".
3. The resident health score was determined by the residents' self-reported general health status on a scale of 1-5 with 1 being "poor" and 5 being "very good" health.
4. The caregivers health score was determined by the caregivers perception of the residents' general health status on a scale of 1-5 with 1 being "poor" and 5 being "very good" health.

## **Hypotheses**

The null hypotheses examined in this study are:

1.  $H_0$  -No relationship exists between the residents' self-reported dependency and the presence of universal design features in ECHO kitchens and bathrooms.
2.  $H_0$  -No relationship exists between the caregivers' perception of dependency of residents and the presence of universal design features present in ECHO kitchens and bathrooms.
3.  $H_0$  -No relationship exists between the residents' self-reported general health rating and the presence of universal design features in ECHO kitchens and bathrooms.

4.  $H_0$  -No relationship exists between the caregivers' perception of general health rating of residents and the presence of universal design features present in ECHO kitchens and bathrooms.
5.  $H_0$  -No relationship exists between the residents' dependency rating and the residents' effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.
6.  $H_0$  -No relationship exists between the caregivers' perception of the residents' dependency and the caregivers' effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.

### **Statistical Analysis**

Information from the ECHO record was coded and entered into an SPSS data set. Frequencies were obtained and correlational tests, means, and standard deviation provided descriptive statistics. Paired T-tests were conducted on resident self-reported and caregiver global health ratings and individual performance of ADLs and IADLs. Bivariate correlations and one-way ANOVAs were conducted, and scatter plots were used to verify non-curvilinear relationships. Separate relationships between each ADL and IADL and specific universal design features were investigated. The statistical analysis, using a 5% level of statistical significance, supplemented the qualitative information obtained through Phase I and Phase II interviews and the analysis of plans and photographs of the houses.

## **Chapter IV**

### **RESULTS**

The purpose of this research is to determine if universal design features in the kitchens and baths of ECHO housing are effective in meeting the needs of the residents.

The specific objectives of the study are to identify universal design features of kitchens and bathrooms that are widely valued by researchers, designers and other experts in the field of housing. The research will additionally determine which of the identified kitchen and bath universal design features are present in ECHO demonstration houses, and evaluate reported effectiveness of the universal design features of kitchens and bathrooms for current residents and their caregivers in ECHO houses.

This chapter includes a description of the sample including: residents' demographic characteristics, relation of residents to the caregivers, residents' health characteristics, and the geographic location of the residences. The three architectural plans used for the ECHO houses are examined, and the presence of the critical universal design features in kitchens and bathrooms of the houses are reported. Other aspects of the description of the sample are associated with the residents' ability to perform ADLs and IADLs (also referred to as dependency score), and the relationship between that performance and residents' and caregivers' awareness of the presence of critical universal design features in kitchens and bathrooms. The relationship between residents' dependency scores and residents' and caregivers' effectiveness evaluation of critical universal design feature was also tested. Results of tests that involved 15 participants or more are reported.

#### **Description of Sample**

##### **Demographic Characteristics**

Phase I of this research involved contact with 34 families participating in Phase I of the ECHO program. At the time of the 2003 Phase I study, the distribution of active ECHO units used for interviews with residents and host families was: Tennessee, 2 units; New Jersey, 6 units; Iowa, 10 units; Kansas, 6 units; and Missouri, 10 units. This distribution varies from the number of units examined by the structural engineers who participated in the Phase I evaluation process. The engineers were interested only in structures, and therefore were unconcerned with occupancy. They examined more ECHO units than were occupied. The Phase II 2004 research

**Table 5 - Phase I Participation by State**

Item	States											
	TN		NJ		KS		IA		MO		Total	
ECHO Units Contacted	2		6		6		10		10			34
Occupied ECHO Units Inspected	0		2		4		10		0			16
Occupied units interviewed	2		4		5		10		8			29
Occupied units unavailable for interview	0		2		1		0		2			5
Resident and Caregiver Contacted	R	C	R	C	R	C	R	C	R	C	R	C
Occupied units interviewed	0	2	4	2	4	3	10	10	7	3	25	20
Occupied units unavailable for interview	2	0	2	4	2	3	0	0	3	7	9	14

**Table 6 - Phase II Participation by State**

Item	States											
	TN		NJ		KS		IA		MO		Total	
ECHO Units Contacted	0		6		6		10		10			32
Occupied ECHO Units Inspected	0		0		0		0		0			0
Occupied units interviewed	0		5		4		9		8			26
Occupied units unavailable for interview	0		1		2		1		2			6
Resident and Caregiver Contacted	R	C	R	C	R	C	R	C	R	C	R	C
Occupied units interviewed	0	0	5	4	2	4	8	9	7	5	22	22
Occupied units unavailable for interview	0	0	0	1	2	0	0	0	0	3	4	4
Died	0	0					1		1		2	0
Relocated	0	0			2	0		0			2	1
No information available	0	0	2	2	1	1	1	1	2	2	6	6

focused on resident and caregiver experiences, and was, therefore, interested only in occupied units. Phase I (Table 5) yielded 25 resident interviews (23 females, and 2 males) and 20 caregiver interviews. Due to a variety of occurrences, including death, relocation of residents, and divorce of caregivers, Phase II research yielded a slightly different distribution of responses. Table 6 describes the distribution of contacts and interviews conducted in Phase II.

Phase II research includes information from 22 ECHO house residents and 22 caregivers. Twenty-one residents were female and one was male; most were between 70 and 89 years old and had lived in their ECHO house for 4-6 years. Most caregivers were either the daughter (n=9), or son (n=7) of the resident. The demographic information addressing age of residents, length of occupancy in the ECHO house and relation to the caregiver are presented in Table 7.

**Table 7 - Demographic Characteristics of the Resident Respondents Characteristics**

<b>Characteristics</b>	<b>n</b>	<b>%</b>
<b>Gender</b>		
Male	1	5
Female	21	95
Total		100
<b>Age</b>		
60-69	1	5
70-79	10	45
80-89	10	45
90-99	1	5
Total	22	100
<b>Years in ECHO House</b>		
1-3	4	18
4-6	15	68
7-8	3	14
Total	22	100
<b>Caregiver Relationship to Resident</b>		
Daughter	9	31
Son	7	41
Son-in-Law	1	5
Sister	1	5
Friend	1	5
No Caregiver	3	13
Total	22	100

### **General Health**

A general health rating score was provided by resident and caregiver responses to one question on the interview schedule. The question asked for a general health score ranging from 1 to 5 with 1 being “poor health” and 5 being “excellent health”. Residents provided self-reported scores, and caregivers reported on their perception of the residents’ general health level. The mean (and standard deviation) of the resident health score was 2.95 (1.12). The mean (and standard deviation) of the caregiver’s health score for resident health was 3.41 (1.22), reflecting less than a full standard deviation difference. Means were compared using paired t-test to assess general agreement between resident responses and caregiver responses. The value of the test statistic is  $t = -1.065$  ( $p=.303$ ). Some of the chronic illnesses reported in Phase I and Phase II were heart disease (11), high blood pressure (4), diabetes (4), emphysema (2), arthritis (2),

cancer (2), asthma (2), and osteoporosis (2). Some of the conditions reported by residents were diminished hearing (2), vision (2), strength (1), and stamina. Obesity (1) and seizures (1) were also noted by residents. Mobility issues were the most prevalent problem; 16 residents acknowledged difficulty. Three residents reported using wheelchairs, seven used a cane, and four noted that they were not able to use stairs at all. Three residents had diminished cognitive capacity and two of these had family in a host house, and the other had no caregiver.

### **Dependency**

In order to determine how well the resident could function, a dependency score was created. The dependency score combined resident and caregiver responses to seven questions reflecting the amount of assistance required to complete defined ADLs and IADLs. The selected ADLs were eating, walking, bathing, toileting, and dressing. The selected IADLs were preparing food and house cleaning. The questions asked the frequency of the resident need for assistance with these activities. The responses were 1-“never”, 2-“occasionally”, and 3-“always”. The higher the score, the more dependent the resident was on assistance in order to perform of routine tasks. The seven scores obtained from the residents and the seven scores from the caregivers were summed separately to create a resident dependency total score and caregiver dependency total score with a possible range of 7 - 21. The mean (and standard deviation) for the resident dependency total score was 8.86 (1.52). The mean (and standard deviation) for the caregiver dependency total score was 9.77 (1.82) reflecting a 66% increase from the resident dependency total score. A reliability analysis was run on each of the dependency scores. For the resident total dependency score, the coefficient alpha was .149, and for the caregiver total dependency score, the coefficient alpha was .472. Because of the low reliability of the total scores, it was determined that the individual ADL and IADL items would be used in analysis in addition to the total scores.

Four residents of Phase II of this research, ranging in age from 71 to 91, reported having no caregiver in a host house to assist them when needed. Although they reported receiving sporadic and unscheduled assistance with meals and cleaning, they were functioning, for all practical purposes, independently. Their health and dependency scores (Table 8) are notable in light of their lack of dependable assistance. The fact that more than half the ADLs and IADLs never required assistance is also noteworthy (Table 9).

**Table 8 – Residents Without Caregivers Health and Dependency Scores**

<b>Item</b>	<b>Resident 1</b>	<b>Resident 2</b>	<b>Resident 3</b>	<b>Resident 4</b>
Age	91	71	84	71
Health Score	Average	Slightly Above Poor	Excellent	Poor
Dependency Score	14	10	9	10

**Table 9 – Residents Without Caregivers Assistance With Selected ADLs & IADLs**

<b>Item</b>	<b>Resident 1</b>	<b>Resident 2</b>	<b>Resident 3</b>	<b>Resident 4</b>
Age	91	71	84	71
Preparation of food	<b>Always</b>	<b>Occasionally</b>	<b>Always</b>	<b>Never</b>
House cleaning	Always	Occasionally	Never	Occasionally
Eating	Never	Never	Never	Never
Walking	Occasionally	Occasionally	Never	Never
Bathing	Always	Always	Never	Occasionally
Dressing	Never	Never	Never	Occasionally
Toileting	Never	Never	Never	Never

Dependency scores were examined using a plan classification, which would identify trends by state program as well as provide insight into the abilities of residents of the plan. Each plan was unique in the presence of 1 or 2 universal design features. Plan A was the only plan to have rocker light switches. Plan B was the only plan to have front-mounted range controls. Plan C was the only plan to have variable height work centers and clear knee space under the sink in the kitchen. Several residents needed help with food preparation, cleaning, and walking. This information is presented in Tables 10, 11, and 12.

Dependency information was obtained from Appendices B and C, and was also used to evaluate changes that had occurred between Phase I and Phase II of the research. Comparing questionnaires from Phase I and Phase II provided indicators of changes in the year between the two interviews. Although Phase I data were not available for all the selected ADLs and IADLs examined in Phase II, the information that was available indicated more improvement than decline (Table 13).



**Table 10 – Plan A Dependency Tasks, Means, and Standard Deviations**

Item	Frequency							
	Never		Occasionally		Always		Means (SD)	
Plan A	R	C	R	C	R	C	R	C
ADL/IADL	R	C	R	C	R	C	R	C
Preparation of food	3	2		2	2		1.80 (.110)	1.50 (.577)
House cleaning	2	1	3	2		1	1.60 (.548)	2.00 (.817)
Eating	5	4					1.00 (.000)	1.00 (.000)
Walking	2	2	1		2	2	2.00 (1.00)	2.00 (1.15)
Bathing	5	4					1.00 (.000)	1.00 (.000)
Dressing	4	2	1	2			1.20 (.447)	1.50 (.577)
Toileting	5	4					1.00 (.000)	1.00 (.000)

**Table 11 – Plan B Dependency Tasks, Means and Standard Deviations**

Item	Frequency							
	Never		Occasionally		Always		Means (SD)	
Plan B	R	C	R	C	R	C	R	C
ADL/IADL	R	C	R	C	R	C	R	C
Preparation of food			1	3	1	1	2.50 (.711)	2.25 (.500)
House cleaning		2			2	2	3.00 (.000)	2.50 (.577)
Eating	2	3		1			1.00 (.000)	1.25 (.500)
Walking	2	1		3			1.00 (.000)	1.75 (.500)
Bathing	2	2		1		1	1.00 (.000)	1.75 (.957)
Dressing	2	4					1.00 (.000)	1.00 (.000)
Toileting	2	4					1.00 (.000)	1.00 (.000)

**Table 12 – Plan C Dependency Tasks, Means and Standard Deviations**

Item	Frequency							
	Never		Occasionally		Always		Means (SD)	
Plan C	R	C	R	C	R	C	R	C
ADL/IADL	R	C	R	C	R	C	R	C
Preparation of food	8	7	6	5	1	2	1.53 (.789)	1.64 (.745)
House cleaning	6	4	4	8	5	2	1.93 (.844)	1.86 (.663)
Eating	15	14					1.00 (.000)	1.00 (.000)
Walking	10	9	1	4	4	1	1.60 (.910)	1.43 (.646)
Bathing	14	11	1	3			1.06 (.258)	1.21 (.426)
Dressing	13	13	2				1.13 (.352)	1.07 (.267)
Toileting	15	14					1.00 (.000)	1.00 (.000)

**Table 13 – Change in Dependency Between Phase I and Phase II**

<b>ADL/IADL</b>	<b>Improvement</b>	<b>Decline</b>
Preparation of food	5	3
Cleaning	4	2
Walking	3	0
Dressing	1	0

### **Description of ECHO Units**

Three floor plans were used for the four ECHO demonstration programs. The floor plans are designated A (Figure 5), B (Figure 6), and C (Figure 7) for comparison purposes. Floor plan A was used only in New Jersey. Floor plan B was used only in Kansas. Floor plan C was used by the Missouri and Iowa ECHO programs exclusively. Tennessee was not examined in the Phase II of the study. The ECHO houses built with floor plan A were the largest, with 624 square feet of interior space. Floor plan B contained 437 square feet, and floor plan C had 576 square feet.

The houses were manufactured of traditional vinyl siding that resembled wooden clap-board construction with shutters. They had a central front door flanked by a window on each side. All the house plans had front entry doors that entered into the living room. Some approaches had stairs, and others had ramps. Some had both. Most were detached from the host house, but one was connected through the master bedroom closet of the host house to the living room of the ECHO house. Two plans (A and C) were supported by piers with skirting concealing the crawl space. One plan (B) was built on a slab. This made this model difficult or impossible to relocate. ECHO houses arrived with the customary infrastructure of plumbing, electrical, and heating systems. The flooring in all the houses was sheet vinyl in the kitchens and bathrooms.

Square footage of kitchens was generally proportionate to the size of the house. Floor plans A and C had the largest kitchens, with 168 square feet and 163 square feet respectively. The kitchen of floor plan B was approximately half the size of kitchens A and C, with 86.26 square feet. However; the kitchen of plan B has the most “open plan” of the three examined. There is no wall separating the kitchen from the 132-square foot living room. Square footage of bathrooms did not follow the same format. Floor Plan A had the largest bathroom (72.18 square

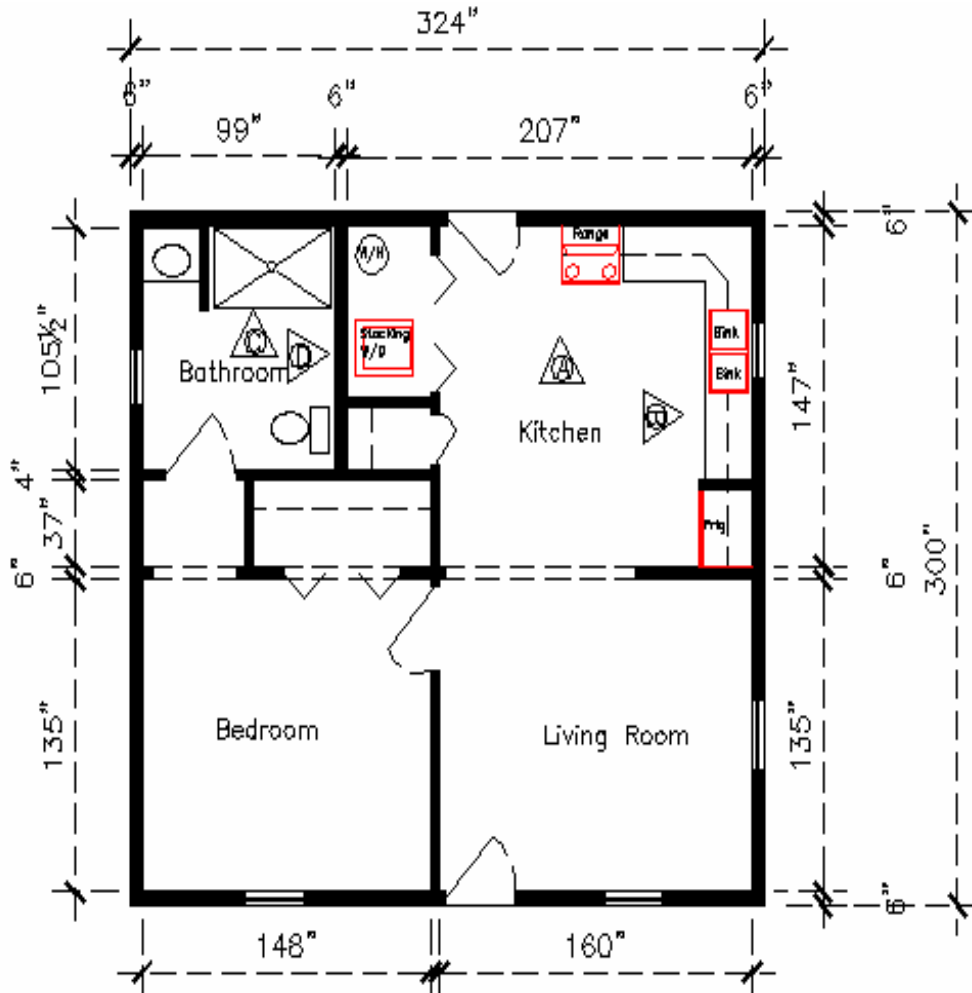
feet); floor plan B had the next largest (55.5 square feet); and floor plan C had the smallest (49 square feet).

Two house plans (B and C) had no doors in the kitchen. House plan A had one door that led to the outside from the kitchen. Plan C had a secondary entrance/exit from the bedroom. All passage doors provided a minimum of 32" of clearance and were supplied with single-lever handles. The space plan allowed for minimal furniture and a clear path through the house; however, in some instances resident choice in furnishings overwhelmed the space and compromised the clear path.

The ECHO houses were furnished with traditional kitchen appliances including a range, range hood, refrigerator, and sink. Faucets at sinks and lavatories had single-lever water controls, and in the bathroom anti-scald temperature and pressure valves provided a level of safety. The ranges in plan B had controls located on the back of the range, and plan A houses had rocker switches at the light switches in the kitchen. A stackable washer/dryer was also provided and installed in the kitchen closet of two of the units (A and C). House plan B did not include a washing machine or a dryer.

A standard grade of cabinets was provided for the kitchens and the bathrooms. House plan C kitchen cabinetry was particularly attentive to universal design features and the needs of the elderly population; it had a pull-out work surface approximately 34" above the finished floor and clear knee space under the sink. Plans B and C also provided clear knee space at the lavatories in the bathrooms. Plans A had large roll-in or walk-in curbless showers, and plan B had a large shower. Plan C had a bathtub/shower combination. Grab bars were installed at most toilets and in shower and tub areas.

Several residents spoke of enjoying their kitchens and their beautiful, big bathrooms. The large showers with grab bars were the universal design feature most appreciated. They spoke of bragging about this feature to their friends. The bright kitchens with modern appliances were another feature spoken of with pride. Some residents occasionally prepared entire meals for the host families or a dish to contribute to a family meal shared with the younger family. One resident, who moved to her ECHO house from a house that had been condemned for years, spoke of never having lived in a house with indoor plumbing and running water before. She was awed by all the modern conveniences in her ECHO house.



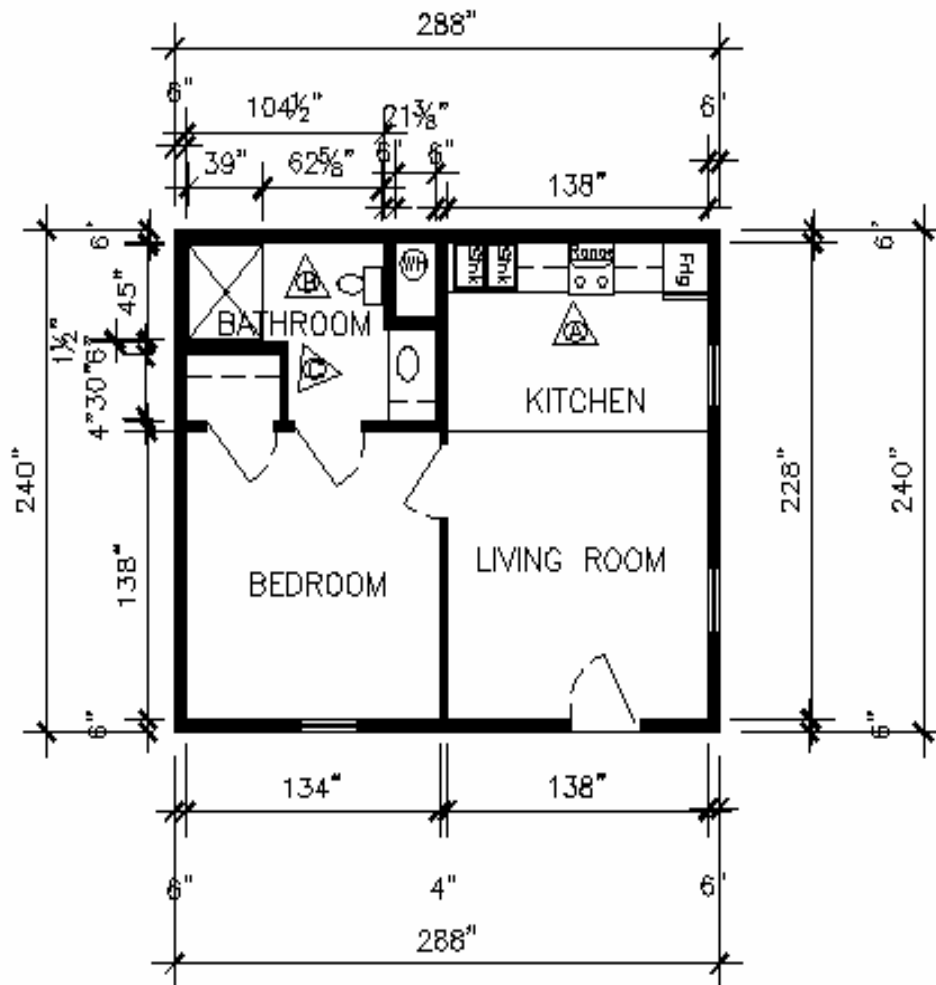
**Figure 5 - House Plan A Dimensioned**

### Universal Design Features

Several universal design features are mandated through UFAS for ECHO homes according to the NOFA that initiated the program. With the exception of seats for showers, and tubs, the UFAS requirements are being met in the construction of the ECHO houses.

### Presence of Critical Universal Design Features in Plans A, B, and C

Each of the floor plans included fourteen critical universal design features that were common to all three plans. In the kitchen these features were 32 inch door clearances, single-lever door controls, single-lever water controls, outlets located between 18 inch and 22 inch above the finished floor, wall switches mounted between 42 inch and 48 inch above the finished floor, non-slip



**Figure 6 – House Plan B Dimensioned**

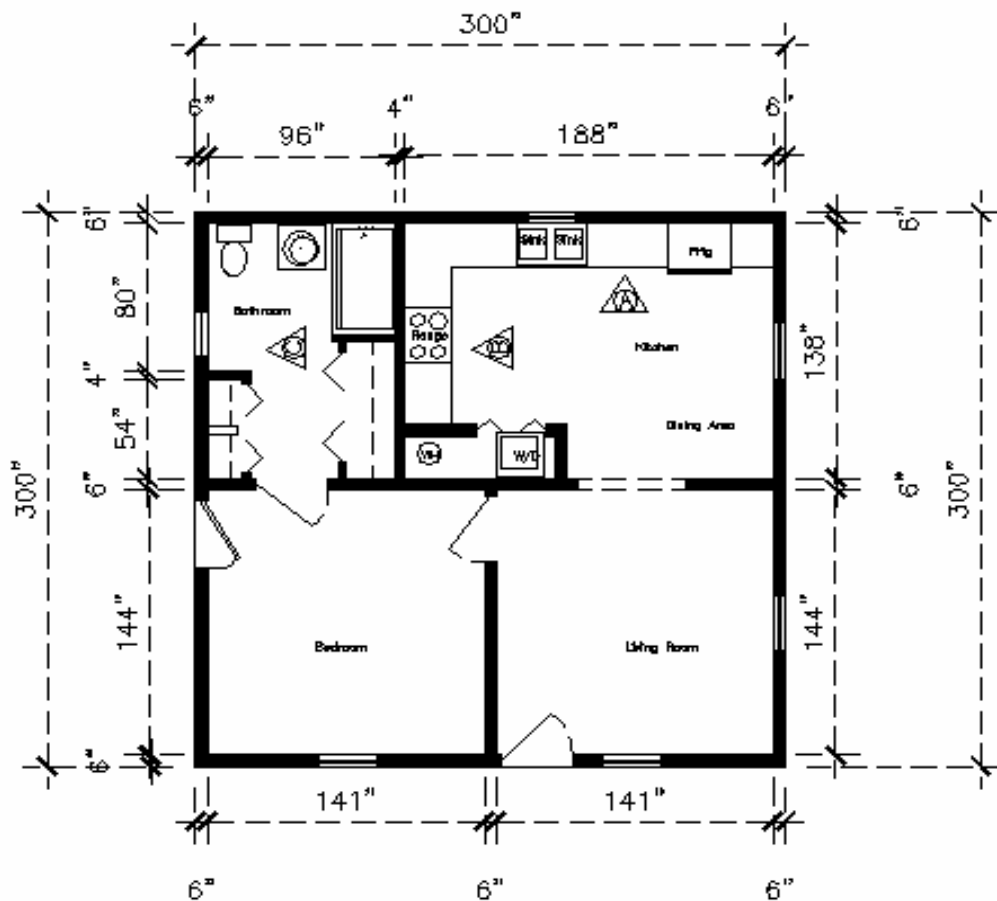
flooring, and a minimum circulation clearance of 40" in task areas. In the bathroom the common items were 32" door clearances, board blocking in walls around the toilet and tub/shower areas, single lever-door controls, single-lever water controls, anti-scald valves that control water pressure and temperature, and toilet seat heights between 17" and 19" above the finished floor. Four critical list features were found in floor plans A, B, or C, but not in any two floor plans. Rocker light switches were present in Floor plan A only. Front-mounted range controls were present in Floor plan B only. Variable height work centers and clear knees space under the sink were present in Floor plan C only. Tables 14 and 15 depict this information graphically.

**Table 14 - Checklist of Critical Universal Design Features Found in Plans A, B, & C Kitchens**

Plan A	Plan B	Plan C	Feature
*	*	*	Minimum circulation clearance of 40"
*	*	*	Wall switches mounted between 42" and 48" above the finished floor
*	*	*	Single-lever water controls at all faucets
*	*	*	32" door clearance
*	*	*	Outlets located between 18" and 22" above the finished floor
*	*	*	Non-slip flooring
*	*	*	Single-lever controls at all doors
		*	Clear knee space under sink
		*	Adjustable or variable work center heights ranging between 28" and 45" high
*			Rocker switchplates
	*		Front-mounted controls on appliances
			Dishwasher elevated 6" above the finished floor
			Side by side refrigerator
<b>8</b>	<b>8</b>	<b>9</b>	Sub Totals

**Table 15 - Checklist of Critical Universal Design Features Found in Plans A, B, & C Bathrooms**

Plan A	Plan B	Plan C	Feature
*	*	*	Blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars
*	*	*	Single-lever water controls at all plumbing fixtures and faucets
*	*	*	Mix valve with pressure balancing and hot water limiter
*	*	*	Entry door 32" clearance
			Tub/Shower seat
*	*	*	Toilet bowl height between 17" and 19" high.
*	*	*	Single-lever controls at all doors
<b>6</b>	<b>6</b>	<b>6</b>	Sub Totals
<b>14</b>	<b>14</b>	<b>15</b>	Totals



**Figure 7 – House Plan C Dimensioned**

### **Effectiveness of Critical Universal Design Features in Plans A, B, and C**

Ascertaining the effectiveness of each critical list universal design feature in the kitchen and bathrooms of ECHO houses was accomplished by asking each resident and caregiver to rate each feature on a scale of 1 to 5, with 1 being “no help at all” and 5 being “very helpful”. The higher the score, the more helpful, or effective, the feature was considered to be by the resident or caregiver. Detailed information on resident and caregiver perceptions of effectiveness of the universal design features available in their kitchens and bathrooms is presented in Table 16.

The effectiveness means for “grab bars at toilet “ and “grab bars at tub/shower” correspond to the critical universal design feature “blocking in walls around toilet and tub/shower areas for future placement and relocation of grab bars. For the most part the ECHO houses had grab bars installed, although they more frequently had grab bars in the tub/shower

**Table 16 - Resident and Caregiver Universal Design Feature Effectiveness Scores**

<b>Design Feature</b>	<b>Resident</b>			<b>Caregiver</b>
	<b>n</b>	<b>Effectiveness Mean (SD)</b>	<b>n</b>	<b>Effectiveness Mean (SD)</b>
<b>Kitchen</b>				
40” Clear Floor Space	21	4.90 (.300)	16	4.75 (.447)
Wall Switches Between 42”-48”	22	4.82 (.501)	22	4.64 (.954)
Single-Lever Water Controls	19	4.74 (.934)	18	4.44 (.985)
32” Door Clearance	23	4.70 (.926)	22	4.73 (.6311)
Outlets Between 18”– 22” AFF	20	4.70 (.657)	15	4.20 (1.21)
Non-slip Flooring	22	4.65 (1.06)	22	5.00 (.000)
Single-Lever Door Controls	22	4.41 (.796)	16	4.50 (1.10)
<b>Bathroom</b>				
Grab Bar at Toilet	19	5.00 (.000)	20	5.00 (.000)
Grab Bar at tub/Shower	19	5.00 (.000)	21	5.00 (.000)
Single-Lever Water Controls	21	4.76 (.625)	18	4.67 (.686)
Pressure and Temperature Valve	22	4.64 (1.18)	20	4.95 (.224)
32” Door Clearance	21	4.52 (1.03)	22	5.00 (.000)
Tub/Shower Seat	15	4.40 (1.40)	14	4.64 (.745)
Toilet Seat Height 17” – 19” AFF	12	4.33 (1.37)	15	4.53 (1.06)
Single-Lever Door Controls	20	4.10 (1.65)	19	.468 (.671)

than at the toilet, which was why the effectiveness measure was split for this feature? Also, even though the tub/shower seat was not built into the ECHO houses, most residents had purchased and used an after-market product and were able to give an effectiveness rating, even though the units appear to not have the feature on Table 15.

Three critical universal design features were not found in any of the plans. Two of the missing features were in the kitchen, and one was in the bathroom. The kitchen items were dishwashers elevated 6” above the finished floor, and side-by-side refrigerators. The bathroom item was a seat in the shower, but most had installed one, so an effectiveness score was available. When asked if these features would be helpful, the responses of residents and caregivers sometimes differed (Table17). The caregivers rated helpfulness of absent features more highly than did residents.



**Table 17 – Projected Effectiveness Score of Universal Design Items Not Present in Any of the ECHO Kitchens and Baths**

Features	Floor Plan A, B, & C	
	% Helpful	
	Resident	Caregiver
<b>Kitchen</b>		
Side by side refrigerator	33.33	59
Raised Dishwasher	32	55

A bathroom feature that was not on either the critical universal design feature list or the secondary universal design feature list warrants mention. A hand-held water source was noted in both the large showers and the bathtub of the ECHO houses. This accessory works well with the tub/shower seat especially when the control of the water is on the hand-held piece. When the flow of water can be controlled from the hand-held component, it is not necessary to stand periodically while bathing to make adjustments. This feature makes bathing safer, more convenient, and more pleasant for the resident.

**Kitchen Universal Design Features**

There were thirteen universal design kitchen features identified on the critical list. The following is a discussion of these critical universal design features, resident and caregiver perceptions, and some details about how the feature impacted their lives.

Minimum circulation clearance of 40”. One resident and six caregivers reported not having a minimum circulation clearance of 40” in the kitchen. All the residents and 4 of the caregivers who did not have a minimum circulation clearance of 40” in the kitchen thought it would be helpful. Ninety percent (19) of residents and 69% (11) of the caregivers who reported having this universal design feature gave it the highest possible effectiveness score of 5 or “very helpful”. However, some residents compromised or negated the benefit of functioning with clear circulation space by placing furniture and accessory items in this space. Examples of this practice can be seen in Figures 23 and 25. Figure 23 shows a microwave cart, and Figure 25 shows how the resident has added shelving and is storing items on the floor just in front of the sink.

One aspect of circulation clearance is the provision of space for anticipated furniture pieces as well as medical equipment that may be needed during the resident’s occupancy of the



**Figure 8 – Bedside Medical Equipment**

ECHO house (Figure 8). Medical equipment that addresses mobility, heart disease, and other prominent diseases and conditions should be considered when space planning is being done. It is important to make appropriate space allocations in order to maintain clear circulation spaces. The second highest mean effectiveness score reported for a universal design feature in the kitchen by residents was for a 40” clearance space at task areas (4.90). It was the third highest effectiveness mean for caregivers (4.75).

Wall switches mounted between 15” and 48” AFF. Every resident and caregiver interviewed confirmed that their wall switches were mounted at a comfortable height for access (between 15” and 48” above the finished floor). Nineteen residents and eighteen caregivers gave it the highest possible effectiveness score of “very helpful”. With the exception of one caregiver who gave this feature the lowest possible score of “no help at all”, the remainder of the resident and caregiver effectiveness scores ranged between “somewhat helpful” and “very helpful”. The caregiver who gave this feature a “no help at all” score may have been speaking of his own experience since there was no resident in this ECHO house. The resident effectiveness mean was 4.82, and the caregiver effectiveness mean was 4.64.

Single-lever water controls at all faucets. Two residents reported not having single-lever water controls at all kitchen faucets. Another did not know whether or not he had a single-lever water control at the kitchen sink. Four caregivers report no single-lever water controls. Two of these contradict resident data, one confirms resident data, and one has no resident in the ECHO

house. Eighteen residents and nineteen caregivers reported that it was a helpful feature. All residents and one (of the four) caregivers who reported not having the feature also reported that it would be helpful to have a single-lever water control at all faucets in the kitchen. The resident effectiveness mean was 4.74. The caregiver effectiveness mean was 4.44.

Minimum 32” Door Clearance. There was one kitchen door on one floor plan only. In plan A a door leads to the outside. This door was 36” wide. Every resident and caregiver of plan A agreed that kitchen doors had a minimum of 32” clearances, and only one resident reported that the feature was “no help at all”. All other respondents found the minimum 32” door clearance to be helpful, and the overwhelming majority (residents 20, and caregivers 17) reported a score of “very helpful”. The resident and caregiver effectiveness mean scores for this feature were 4.70 and 4.73 respectively.

Outlets. Twenty residents and fifteen caregivers reported that electrical outlets were installed at a comfortable level (between 18” and 22” above the finished floor) in their ECHO houses. Two residents gave this feature a score of “somewhat helpful”, two rated it “more than somewhat helpful”, and 16 found outlets installed between 18” and 22” above the finished floor to be “very helpful”. The one resident and four of the caregivers who reported not having electrical outlets installed between 18” and 22” above the finished floor noted that it would be helpful to have electrical outlets installed at a higher level. Two of the caregivers did not think it would be helpful. The resident and caregiver effectiveness mean scores for this feature were 4.70 and 4.20 respectively.

Non-slip flooring. Seventeen residents and caregivers reported the presence of non-slip flooring in their ECHO house kitchen. Five residents and caregivers had slippery floors. The responses were not necessarily paired. One resident who had a slippery floor did not think that a non-slip floor would be helpful. The other respondents (residents and caregivers) agreed that a non-slip floor would be helpful. When those with slippery floors were asked what they had done to prevent falling in their kitchens the responses included “nothing”, “waxed the floors”, “throw rugs”, “rubber mats”, and “wear shoes”. The effectiveness scores from residents and caregivers were overwhelmingly “very helpful”. The highest mean effectiveness score reported for a universal design feature in the kitchen by caregivers was for non-slip floors (5.00).

Single-lever Door Controls. Single-lever door controls were used throughout the houses. All residents reported that single-lever door controls were helpful, and the resident effectiveness

mean was 4.41. Seventeen of the 18 residents interviewed also reported having single-lever door controls, although only five of these residents had doors in their kitchens. The one 78 year-old resident who reported not having single-lever door controls in her kitchen lived in one of the house plans that had no doors in the kitchen. Her health was the poorest reported (1), and her dependency score (10) was more than one full standard of deviation of the total dependency mean (8.86), indicating that she was more dependent than the average. She may have misunderstood the question, and may have been thinking about doors throughout the house. Caregiver responses were a little more diverse. One caregiver did not know if there were single-lever controls at the kitchen doors. Five caregivers reported not having single-lever controls in the ECHO house. Three thought they would be helpful, and two did not. The caregiver effectiveness mean was 4.50.

Clear Knee Space Under Sink. Sixteen houses built with floor plan C had clear knee space under the sink. However, only three residents and two caregivers of plan C houses reported having this feature in their ECHO house, and only one of the residents had both a poor health score (1) and a higher than average dependency score may have made him more aware of the features that were provided for him. One resident and the coordinating caregiver of a plan A house also reported a clear knee space under the sink, although this feature was not indicated on architectural drawings. It is possible that the ECHO unit could have been customized to accommodate the resident's needs. She had a pacemaker and her dependency score of 12 was considerably above the mean. The remaining residents and caregivers of plan C houses reported that they did not have a clear knee space under their sink. This claim was contradicted by architectural drawings, photographs, and researcher observations in ten of the Plan C houses that were observed during on-site interviews. Researcher observation and photographs suggest that one reason residents and caregivers of plan C houses did not report clear knee space under the sink is because they were not using the space in the way it was designed to be used. Instead the clear space was being used for storage. In the kitchen large items are being stored in the open area under the sink (Figure 38). This may have influenced the relatively low effectiveness mean of residents (2.75) and caregivers (3.00).

Adjustable or variable work center heights ranging between 28" and 45" AFF.  
Adjustable or variable work center heights ranging between 28" and 45" above the finished floor was another universal design feature that caused some confusion among the residents and

caregivers. It may have been because this is a relatively recent development in supportive environments for the elderly. Whatever the case, the sixteen houses built with floor plan C had adjustable or variable work center heights ranging between 28” and 45” above the finished floor. However, only four residents and two caregivers of plan C houses reported having this feature in their ECHO house. This result could have been caused by a wording problem. The concept seemed to be hard for residents and caregivers to grasp. The health range of the residents ran the gamut of lowest health scores with high dependency scores to highest health scores with low dependency, a result that does not explain why these residents might have been more aware of this particular feature. Two residents of floor plans A and B noted having adjustable or variable work center heights in their kitchens. This claim was corroborated by caregivers, but not by architectural drawings, photographs, or researcher observation. Three of the four residents gave the adjustable or variable work center heights ranging between 28” and 45” above the finished floor feature the lowest possible effectiveness score of “no help at all”. One resident and all 3 caregivers who acknowledged the presence of the feature gave it the highest effectiveness score possible of “very helpful”. The resident effectiveness mean was 2.00, and the caregiver effectiveness mean was 5.00.

Rocker Light Switches. Rocker light switches were present in Plan A only. Each resident and caregiver associated with floor plan A reported the presence of rocker light switches in their kitchens. All the residents gave this feature an effectiveness score of 5 or “very helpful”, and 80% of caregivers gave it a 4 or “somewhat helpful”. Some residents made reference to the assistance this feature lent to their arthritic hands. Another resident mentioned that she could turn the lights on with her elbow. Three residents noted that the light switch is back-lit so that it glows in the dark, making it easy to find at night.

Front mounted controls on appliances. Six residents and five caregivers report the presence of a range with front-mounted controls. Four of these residents are distributed throughout floor plans B and C. Their responses are not corroborated by their caregivers, and are suspect. Two of the residents’ and four of the caregivers’ affirmative responses referred to floor plan B. Two residents from floor plan B were unavailable. Photographs and observation confirm that all the floor plan B units have ranges with front-mounted controls. The residents of floor plan B receive assistance with the preparation of food and cleaning occasionally or always. Although their health scores ranged between “slightly above poor” to “good health”, their

dependency scores (10-14) identified them as some of the most dependent subjects studied. All caregivers and one resident gave front-mounted range controls the highest effectiveness score of “very helpful”. The remaining resident, who receives assistance with food preparation occasionally, gave it an effectiveness score of “somewhat helpful”. Both effectiveness means are high, and reflect small cell sizes (6 residents and 5 caregivers). The resident effectiveness mean is 4.00, and the caregiver effectiveness mean is 5.00.

Dishwasher elevated 6” AFF. Positioning of the dishwasher was irrelevant, since there were no dishwashers in any of the ECHO houses. Residents’ responses indicated that they preferred not to have a dishwasher, raised or otherwise, by more than two to one (7 of 22 preferred no dishwasher). Caregiver responses indicated a reverse trend, however in less dramatic proportions (13 of 22 preferred no dishwasher). There are several possible options for explaining why dishwashers are not considered an important feature by residents. Some residents and caregivers commented that they would rather have the storage that the cabinetry provided than the dishwasher that would fill the same space. One resident commented that she “enjoyed doing dishes”, and made references to “never” having had a dishwasher. Her caregiver said he would be surprised if she used it (even if she had one). Several residents responded to each question about missing features with a comment about liking the house “just the way it is”. The only man interviewed noted that the warm water he washed his dishes in felt good to his arthritic hands. Dishwashers did not receive an effectiveness score because no one had experienced using them in the ECHO houses.

Side-by-side refrigerator. No side-by-side refrigerators were found in any of the floor plans, although the researcher was told that it had been an option in the Kansas ECHO houses. Conversation with residents and caregivers suggest that the option was declined by each resident and caregiver primarily because of the increased cost involved. Six of the 22 residents and 12 of the 22 caregivers reported that having a side-by-side refrigerator would be helpful. The majority of existing refrigerators were traditional top-mounted freezer versions. One ECHO house, with an 84-year-old resident who was the least dependent resident examined, had a bottom-mounted freezer model. Another resident commented that her house did not have enough space for a side-by-side refrigerator. This indicated her perception that side-by-side refrigerators were larger than her top-mounted freezer. An Iowa caregiver, whose mother had a garden, noted that he had put a small deep freeze in the utility area of the ECHO house. It served his mother’s needs well,

but made it difficult for him to access the hot water heater for maintenance purposes. No mean scores are available because no ECHO resident or caregiver had experience with this feature.

### **Bathroom Universal Design Features**

There were seven universal design bathroom features on the critical list. The following is a discussion of these universal design features, resident and caregiver perceptions and some details about how those features impacted their lives.

Blocking in Walls Around Toilet, Tub, and Shower for Future Placement and Relocation of Grab Bars. Nineteen residents and 20 caregivers report currently having grab bars at the toilet. All residents and 21 caregivers report currently having grab bars at the tub/shower areas. One caregiver reports not knowing whether or not his mother has a grab bar in the tub/shower area. All residents and half the caregivers who reported not having grab bars at the toilet thought they would be helpful. All residents who did not have grab bars at the tub/shower area reported thinking they would be helpful. Grab bars had the highest mean effectiveness score by both residents and caregivers. Every person interviewed gave grab bars at the toilet and tub/shower areas the highest possible effectiveness score of 5 or “very helpful”. The importance of grab bars in shower and tub use is emphasized by the large number of residents and caregivers who rate them highly in effectiveness scores. The resident and caregiver effectiveness means for this feature are 5.00. This represents the highest effectiveness mean recorded, and it was reported by both residents and caregivers.

Single-lever Water Controls at All Plumbing Fixtures and Faucets. Twenty-one residents and eighteen caregivers confirmed that single-lever water controls are present in their ECHO bathrooms. One caregiver did not know whether or not the ECHO bathroom had a single-lever water controller. None of the residents or caregivers who reported not having single-lever water controllers in the bathroom thought they would be helpful. Eighteen of the twenty-one residents who reported having single-lever water controllers gave them an effectiveness score of 5 or “very helpful”. The remaining two resident effectiveness scores were “somewhat helpful” and “more than somewhat helpful”. Fourteen caregivers’ effectiveness scores were 5 or “very helpful”, two were “more than somewhat helpful”, and 1 was “somewhat helpful”. Resident and caregiver effectiveness mean scores were 4.76, and 5.00 respectively.

Mix Valve with Pressure Balancing and Hot Water Limiter. Because this item caused considerable confusion during the pilot test, the original phrasing was altered to facilitate clear

communication to residents and caregivers. Participants were asked if the temperature of the water had ever burned or scalded them. No one reported ever having been burned or scalded by water in their bathrooms. In light of that unanimous comment the dichotomous responses were interesting. Two residents gave the mix valve with pressure balancing and hot water limiter an effectiveness score of 1 or “not at all helpful”. The balance reported 5 or “very helpful”. One caregiver gave this feature an effectiveness score of 4 or “more than somewhat helpful”, and the balance 5 or “very helpful”. The resident effectiveness mean for this feature was 4.64, and the caregiver effectiveness mean was 4.95.

Minimum 32” door clearance. One door led from the bedroom into the bathroom in each ECHO house. Sixteen residents and fifteen caregivers reported that the bathroom door was a minimum of 32” wide. One resident did not know how wide his bathroom door was. One resident and three caregivers reported that the bathroom door was not a minimum of 32” wide.

Tub/Shower Seats. Built-in tub/shower seats were not observed in any of the houses. Seven residents and eight caregivers report that their ECHO houses do not have tub/shower seats. Only one resident and three caregiver (who did not have tub/shower seats) reported that they did not think it would be helpful because the resident was not in a wheelchair. After-market shower and tub seats have been acquired by 15 residents in the program. Examples of resident and caregiver choices for tub/shower seats can be seen in Figures 9, 10, and 11. Twelve residents and eleven caregivers gave tub/shower seats an effectiveness score of 5 or “very helpful”. The resident effectiveness mean was 4.40, and the caregiver effectiveness mean for this feature was 4.64.

Toilet Bowl Height Between 17” and 19” High. Twelve residents and fifteen caregivers report that the toilet bowl height is between 17” and 19” in their ECHO bathroom. Three residents and three caregivers indicated that they did not believe toilet seats that comply with this universal design criterion would be helpful. Ten residents and ten caregivers gave this feature an effectiveness score of 5 or “very helpful”. The remaining caregiver scores were all 4 or “More than somewhat helpful”. The remaining resident scores ranged between 1 - “no help at all”, 2- Minimally helpful, 3 – “Somewhat helpful”, and 4 or “More than somewhat helpful”. Resident and caregiver effectiveness scores for this feature are 4.33 and 4.53 respectively.

Single-lever Controls at All Doors. Twenty residents and nineteen caregivers confirmed that single-lever door controls are present in their ECHO bathrooms. One resident did not know



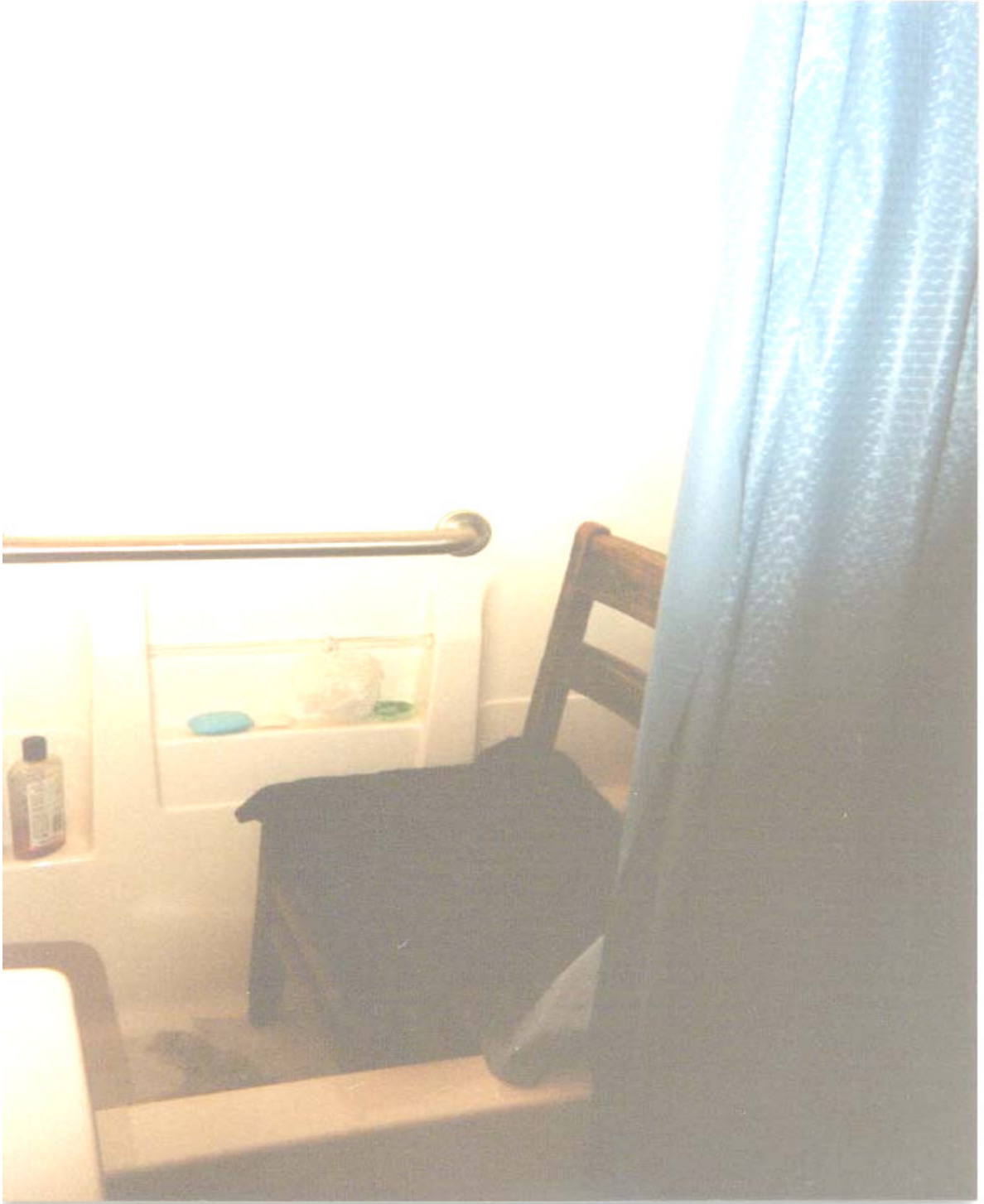
whether or not his bathroom had a single-lever door control. One resident and one caregiver who reported not having this feature thought that a single-lever door control would be helpful for the resident, and three caregivers reported that it would not be helpful. Fifteen residents and fourteen caregivers gave single-lever door controls in the bathroom an effectiveness score of “very helpful”. One resident rated it “more than somewhat helpful” and two caregivers rated it “somewhat helpful”. Five residents gave single-lever door controllers the lowest possible effectiveness score of “no help at all”.

### **ECHO Kitchen and Bath Analysis**

The NKBA published a list of 40-item guidelines for kitchen planning checklist, and a 41-item guide for a bathroom planning in 1996 and 1997, respectively. They were the most current available guidelines at the time of this research. Ten items have been chosen from the kitchen checklists for evaluation of the ECHO house kitchens, and eight items have been chosen from the critical universal design features bathroom checklist. For the kitchen, the items are 1) No traffic pattern through the work triangle; 2) Work triangle should total no more than 26’ with no single leg shorter than 4’; 3) Wall cabinet frontage of 186”; 4) Base cabinet frontage of 192”; 5) Landing space beside the range 9” and 15”; 6) Landing space beside the refrigerator 15 “; 7) Clear floor space of 30” X 48” at sink, range and refrigerator; 8) Sink located between range, and refrigerator; 9) 36” work centers adjacent to water source; 10) Sink with 24” of counter task area on one side and 18” on the other at same level. The bathroom items are: 1) Clear floor space of 48” X 48” in front of the toilet; 2) Clear floor space 30” X 48” at the lavatory; 3) Clear floor space 30” X 60” at the bathtub; 4) Minimum center-line from sink to side-wall of 15”; 5) Tub/Shower controls accessible from inside and outside the fixture; 6) Minimum center-line from toilet to obstruction of 16”; 7) Minimum shower interior dimension 34” X 34”; 8) Clear floor space of 36” X width of shower + 12” (Cheever, 1997). Not all of the eight bathroom items are appropriate for each bathroom. When this is the case, the inappropriate item has been removed from the evaluation checklist. The checklists are presented and discussed individually at each kitchen and bathroom floor plan. The NKBA evaluation checklists are combined in Appendix E.



**Figure 9 – Vinyl Chair Shower Seat**



**Figure 10 – Wooden Chair Shower Seat**



**Figure 11- Vinyl Chair/Transfer Bench Shower Seat**



**Table 18 - Plan A Kitchen Guidelines Checklist**

<b>ECHO Kitchen Planning Guidelines</b>	<b>Y</b>	<b>N</b>
No major traffic pattern through work triangle	X	
Work triangle total no more than 26' with no single leg shorter than 4'		X
Wall cabinet frontage of 186"		X
Base cabinet frontage of 192"	X	
Landing space beside the range 12" & 15 "		X
Landing space beside the refrigerator 15 "	X	
Clear floor space of 30" X 48" at sink, range & refrigerator	X	
Sink located between range and refrigerator	X	
36" work centers adjacent to water source	X	
Sink with 24" on one side and 18" on the other at same level	X	

**Table 19 – Plan A Kitchen Universal Design Features**

<b>Critical Universal Design Kitchen Features</b>	<b>Y</b>	<b>N</b>
32" door clearance	X	
Single-lever door controls at all doors	X	
Single-lever water controls at all faucets	X	
Clear knee space under the sink		X
Adjustable or variable work center heights between 28" & 45" AFF		X
Rocker switchplates	X	
Outlets located between 18" and 22" above finished floor	X	
Wall switches mounted between 42" and 48" above finished floor	X	
Dishwasher elevated 6" above the finished floor		X
Front-mounted appliance controls		X
Non-slip flooring	X	
40" Minimum circulation clearance	X	
Side-by-side refrigerator		X

The plan A kitchen was the only kitchen in the study that had a door. The door accessed the outside of the house, and was 36" wide. The other unique feature of the plan A kitchen was the rocker style light switches on the wall. Residents of house plan A prepared their meals independently unless a temporary medical condition made it impossible. In that case, caregivers assisted until the medical condition improved. Caregivers reported that the ECHO resident prepared meals for the caregiver occasionally, and frequently prepared and shared small meals or snacks with grandchildren who lived nearby in the host house.



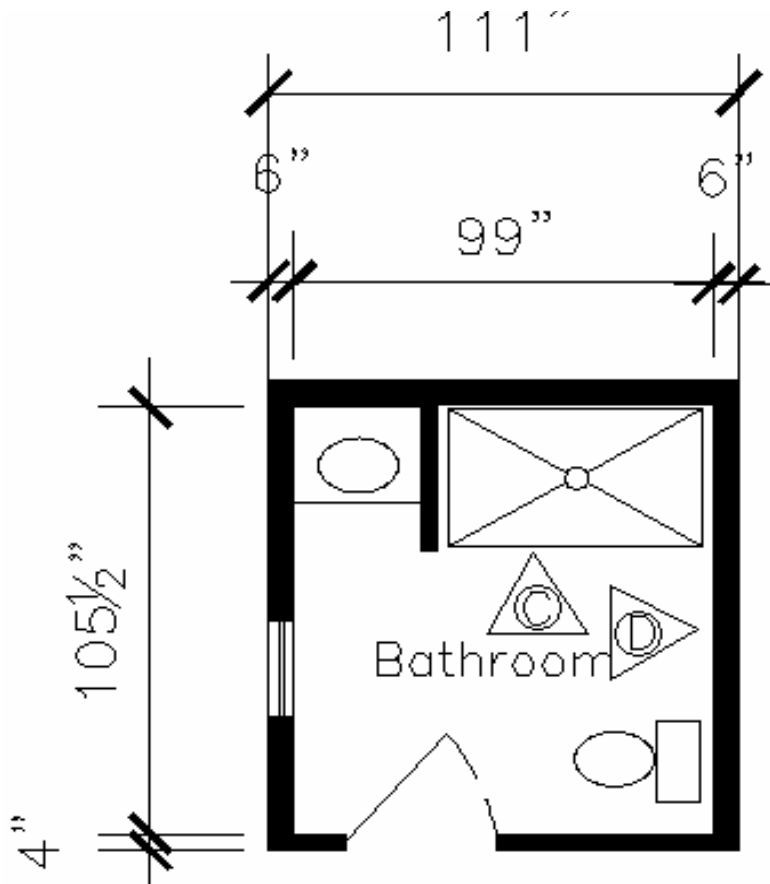
**Figure 15- Plan A Kitchen Photograph**

The kitchen was spacious and provided ample space for dining furniture. Most of the residents and caregivers commented on the comfortable nature of the kitchen, and one caregiver noted that the kitchen was where her mother spent most of her time. One caregiver made note of the fact that the modern technology used in the range was difficult for her mother to understand, and that she relied on her toaster-oven and microwave for most of her cooking needs. Another resident and her caregiver both commented how important it is to have the washer and dryer conveniently located in the kitchen area. Although most agreed that their floors had a non-slip finish, one resident said that she used “throw rugs” because it was warmer for her feet. The residents and caregivers were generally happy with the ECHO house plan A kitchens.



**Floor Plan A Bathroom Analysis**

Bathroom A (Figures 16 – 21) was in compliance with 100% of the 7-point bathroom checklist (Table 20), and 86% of the 7-item critical universal design features list (Table 21). The one universal design bath feature not present was a tub/shower seat. Although task space at the lavatory was limited, there is ample space at the toilet for mechanical or human support should it be needed. Efficient use of space and careful selection and placement of fixtures produced a bathroom that responded to resident and caregiver needs by using universal design principles and the NKBA guidelines. With only one exception, the residents of house plan A were completely independent in bathroom-related ADLs (bathing, toileting, and dressing). The exception involved one resident’s need for occasional assistance with bathing. Residents’ mean dependency score was 10.5, more than a full standard deviation above the total dependency mean score of 8.86 (1.52). Caregivers’ mean dependency score for residents of plan A houses



**Figure 16 - Plan A Bathroom Floor Plan Dimensioned**



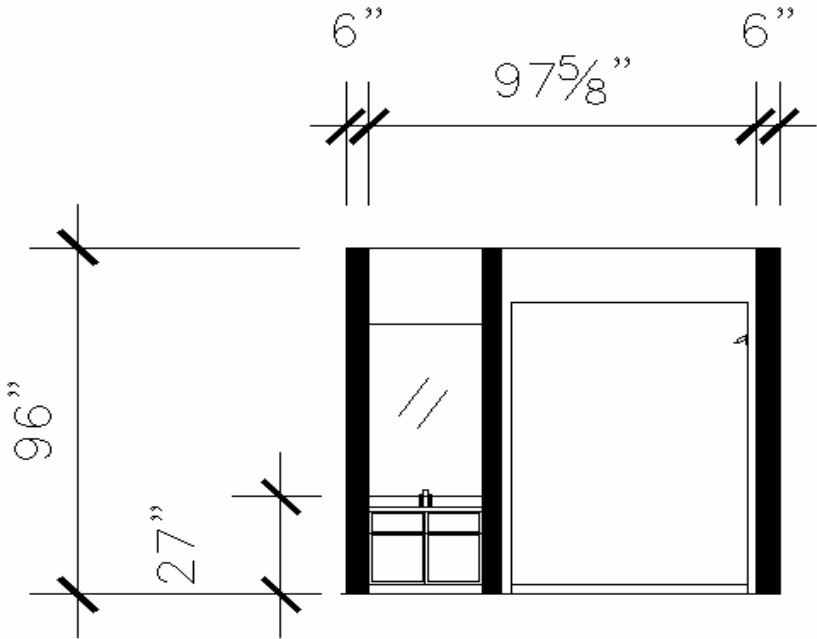


Figure 17 - Plan A Bathroom Section C Dimensioned

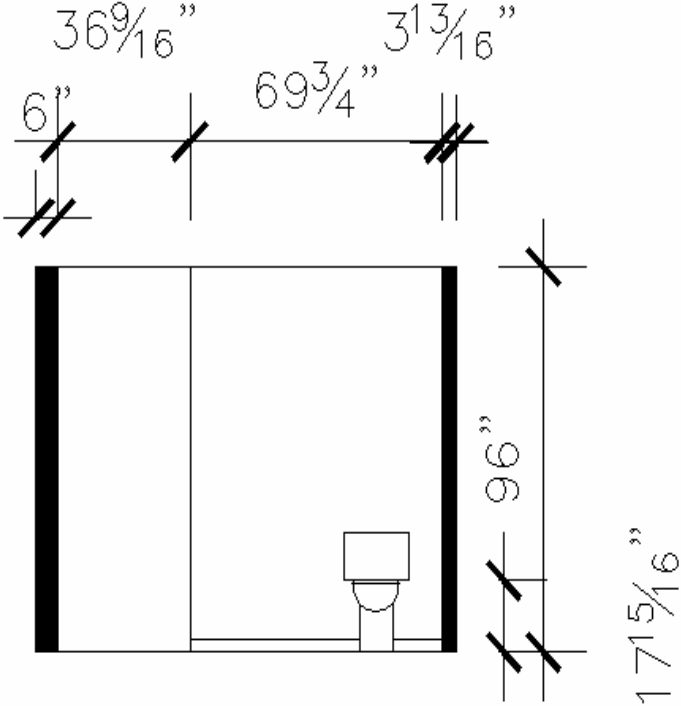


Figure 18 - Plan A Bathroom Section D Dimensioned

**Table 20 - Plan A Bathroom Guidelines Checklist**

<b>ECHO Bathroom Planning Guidelines</b>	<b>Y</b>	<b>N</b>
Clear floor space of 48”X48” in front of the toilet	X	
Clear floor space of 30”X48” at the lavatory	X	
Clear floor space of 36”X width of shower + 12”	X	
Minimum center-line from sink to side-wall 15”	X	
Minimum shower interior dimensions 34”X 34”	X	
Tub/Shower controls accessible from inside and outside the fixture	X	
Minimum center-line from toilet to obstruction 16”	X	

**Table 21 - Plan A Bathroom Universal Design Features**

<b>Critical Universal Design Features Bathroom</b>	<b>Y</b>	<b>N</b>
32” clearance at entry door	X	
Single-lever controls at all doors	X	
Blocking in walls around tub, toilet, and shower for grab bars	X	
Single-lever water controls at all fixtures and faucets	X	
Mix valve with pressure balancing and hot water limiter	X	
Tub/shower seat		X
Toilet bowl height between 17” and 19” above finished floor	X	

was 13.75, more than two full standard deviations above the total dependency mean score of 9.77 (1.82). These results indicate caregivers’ perception of an increased level of dependence than that reported by the average resident. It is interesting to note that the health of this group is reported by both residents and caregivers to range from “slightly above poor health” to “good health”.

One problematic issue noted by residents and caregivers was the “over-spray” of the shower. This appeared to be a serious concern, and was being addressed in a variety of ways. The example shown in the photograph (Figure 19) is one of the more problematic choices. A tension-mounted shower curtain pole has been installed at the bottom of the shower entrance in an attempt to contain the water from the shower by restricting the movement of the bottom of the shower curtain away from the shower surround, and into the bathroom. This solution introduces a “trip hazard” upon entry or exit from the shower, and does not effectively resolve the problem of containing the water from the shower. Another resident addressed the problem by rolling

towels and placing them along the floor at the entrance to the shower surround requiring her to step over them at entry and again at exit. The resident reported that the rolled towels were effective in limiting (but not restricting completely) the flow of water onto the bathroom floor. However, the wet towels were a problem to be dealt with after each shower.

A second issue with bathing involved a shower seat. Each resident acquired an after-market shower seat that allowed them to sit while bathing. With the exception of one caregiver who rated the shower seat “somewhat helpful”, every other resident and caregiver gave the shower seat the highest possible rating of “very helpful”. Overall, the plan A bathroom was effective in meeting the needs of residents and caregivers.



**Figure 19 - Plan A Shower  
Grab Bars and Two Shower Rods**



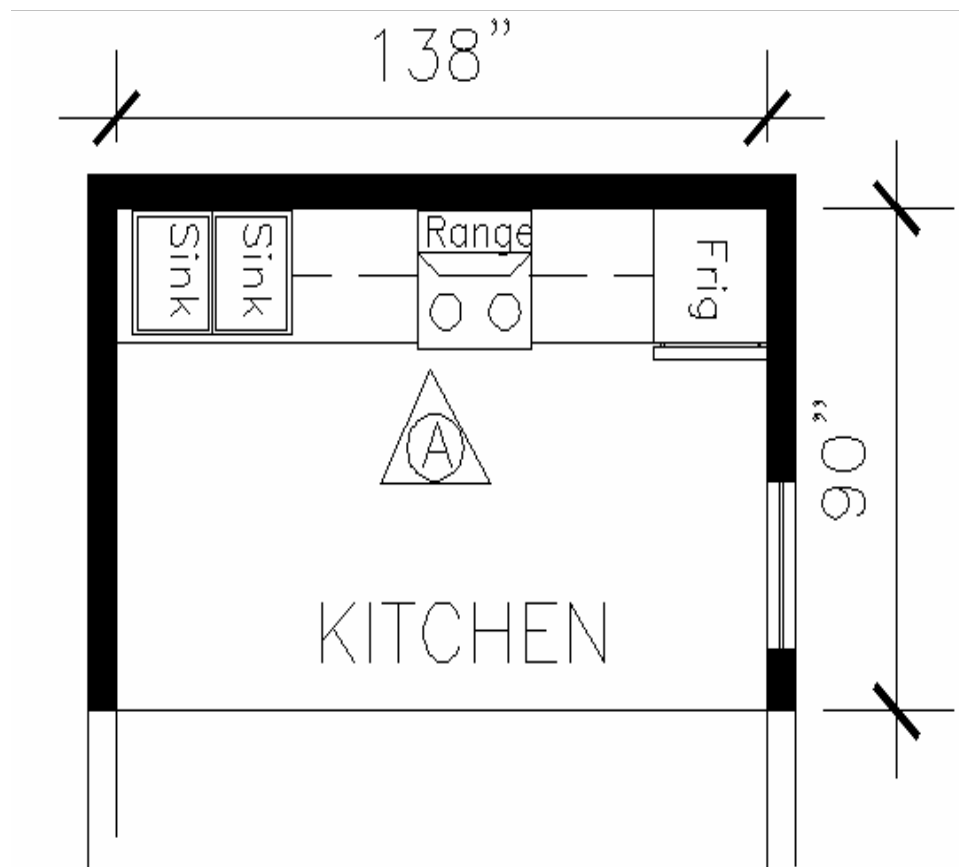
**Figure 20- Plan A Bathroom Vanity  
No Clear Knee Space**



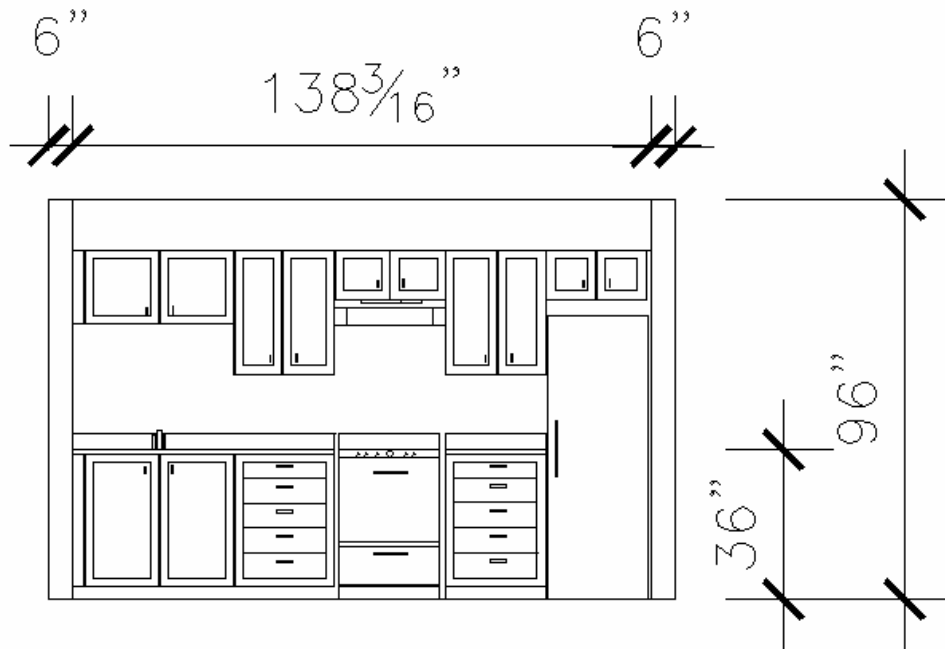
**Figure 21 - Plan A Toilet  
Clear Space and Grab Bars**

### Floor Plan B Kitchen Analysis

Kitchen B (Figures 22-25) was in compliance with 50% of the ten point checklist (Table 22). The amount of wall storage totaled less than 144", and base cabinet totaled less than 156". The sink was not located between the range and the refrigerator. There was only one work center adjacent to the water source and it was 26" wide instead of the 36" recommended. Wall storage varied from house to house, but even the largest capacity (Figure 23) provided only 48" of storage, and did not meet the minimum NKBA guidelines. The sink is positioned at the end of the counter against the wall with work space on one side only. The plan B kitchen meets 62% of the critical universal design feature list (Table 23). The feature that was unique to the house was front-mounted range controls.



**Figure 22 - Plan B Kitchen Floor Plan Dimensioned**



**Figure 23 - Plan B Kitchen Section A Dimensioned**

**Table 22 - Plan B Kitchen Guidelines Checklist**

<b>ECHO Kitchen Planning Guidelines</b>	<b>Y</b>	<b>N</b>
No major traffic pattern through work triangle	X	
Work triangle total no more than 26' with no single leg shorter than 4'	X	
Wall cabinet frontage of 144"		X
Base cabinet frontage of 156"		X
Landing space beside the range 12" & 15"	X	
Landing space beside the refrigerator 15"	X	
Clear floor space of 30" X 48" at sink, range & refrigerator	X	
Sink located between range and refrigerator		X
36" work centers adjacent to water source		X
Sink with 24" on one side and 18" on the other at same level		X

**Table 23 - Plan B Kitchen Universal Design Features**

<b>Critical Kitchen Universal Design Features</b>	<b>Y</b>	<b>Y</b>
32" door clearance	X	
Single-lever door controls at all doors	X	
Single-lever water controls at all faucets	X	
Clear knee space under the sink		X
Adjustable or variable work center heights between 28" & 45" AFF		X
Rocker switchplates		X
Outlets located between 18" and 22" above finished floor	X	
Wall switches mounted between 42" and 48" above finished floor	X	
Dishwasher elevated 6" above the finished floor		X
Front-mounted appliance controls	X	
Non-slip flooring	X	
40" Minimum circulation clearance	X	
Side-by-side refrigerator		X

One resident of house plan B prepared full meals on a regular basis, and all her meals were prepared independently. The balance of the residents (3) prepared smaller meals and required assistance occasionally. For one, this meant weekends only, for another it meant the evening meal each day, and for the third it meant assistance was required when she did not feel like preparing a meal.

The plan B kitchen was the only one that exhibited variations in wall-mounted cabinetry from one installation to another (Figures 24 and 25), and was the smallest of the three kitchens examined. However, the open plan of the B kitchen flows into the living area seamlessly, making both spaces appear ample. The B kitchen has less storage space and counter frontage than the other two kitchens, but a bank of base cabinet drawers was provided in this kitchen that was not available in plans A and C. The wall cabinets were hung higher than the standard 18" above the counter top and most of the storage space was outside the comfort zone. One resident said that she does not use the upper shelves because she can not reach them, another noted using a "reacher" to access items on high shelves, and a third commented that the kitchen does not provide enough storage. Several residents have brought in free-standing storage pieces for the kitchen, such as a microwave cart (Figure 24), and shelving (Figure 26). One caregiver perceived the counter tops to be higher than the standard 36", although that comment was contradicted by architectural drawings, researcher observation, and photographs. A unique





**Figure 24 - Plan B Kitchen - Maximum Cabinetry**

feature of the plan B kitchen is the front-mounted controls on the range. Residents and caregivers agreed that the plan B kitchen met their needs.



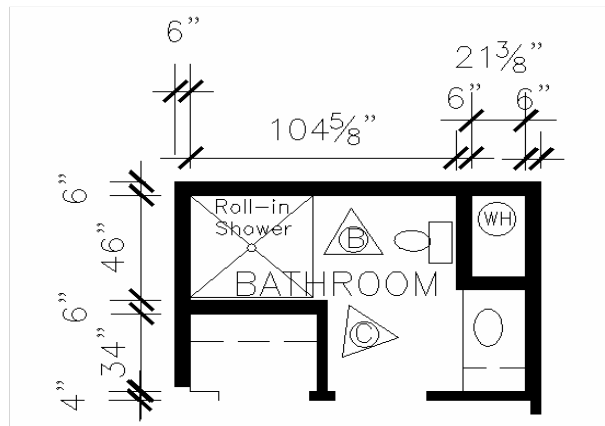
**Figure 25 - Plan B Kitchen - Minimum Cabinetry**



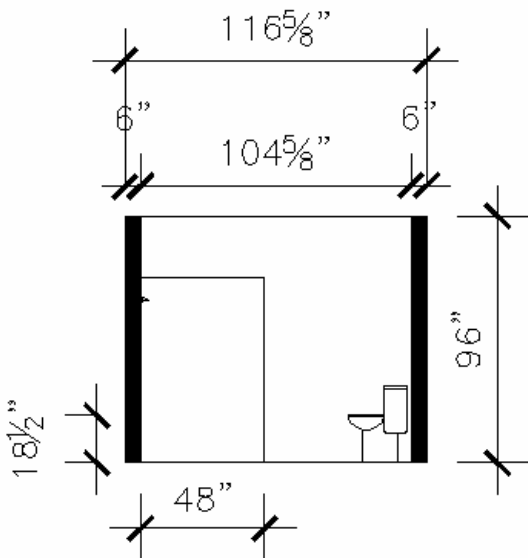
**Figure 26 – No Clear Circulation Space in Task area of Kitchen**

**Floor Plan B Bathroom Analysis**

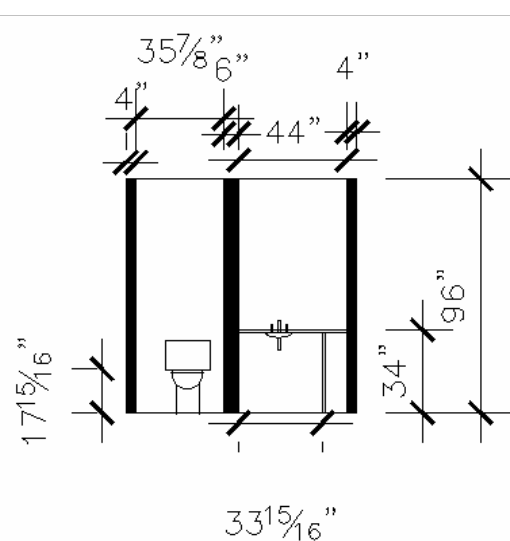
Bathroom B (Figures 27 – 34) was in compliance with 86% of the 7-point checklist appropriate for this design (Table 24). The two features that did not comply were; 48” X 48” clear floor space at the toilet and tub/shower controls accessible from inside and outside the fixture. Eighty-eight percent of universal design features (Table 25) were present in the Plan B bathroom. The one missing item was a tub/shower seat. In some bathrooms the clear space under the sink of house Plan B is used for storing bath linens and toiletries (Figure 32), and the space in front of the shower entrance and the toilet has been filled with furniture and accessories (Figure 33). The choice to use this space for storage compromises the intended purpose of providing comfortable seating at the lavatory. Such use is likely connected to the low effectiveness scores associated with some universal design feature.



**Figure 27 – Plan B Bathroom Floor Plan Dimensioned**



**Figure 28- Plan B Section B Dimensioned**



**Figure 29 - Plan B Section C Dimensioned**



**Table 24 - Plan B Bathroom Guidelines Checklist**

<b>ECHO Bathroom Planning Guidelines</b>	<b>Y</b>	<b>N</b>
Clear floor space of 48”X48” in front of the toilet	X	X
Clear floor space of 30”X48” at the lavatory	X	
Clear floor space of 36”X width of shower + 12”	X	
Minimum center-line from sink to side-wall 15”	X	
Minimum shower interior dimensions 34”X 34”	X	
Tub/shower controls accessible from inside and outside the fixture		X
Minimum center-line from toilet to obstruction 16”	X	

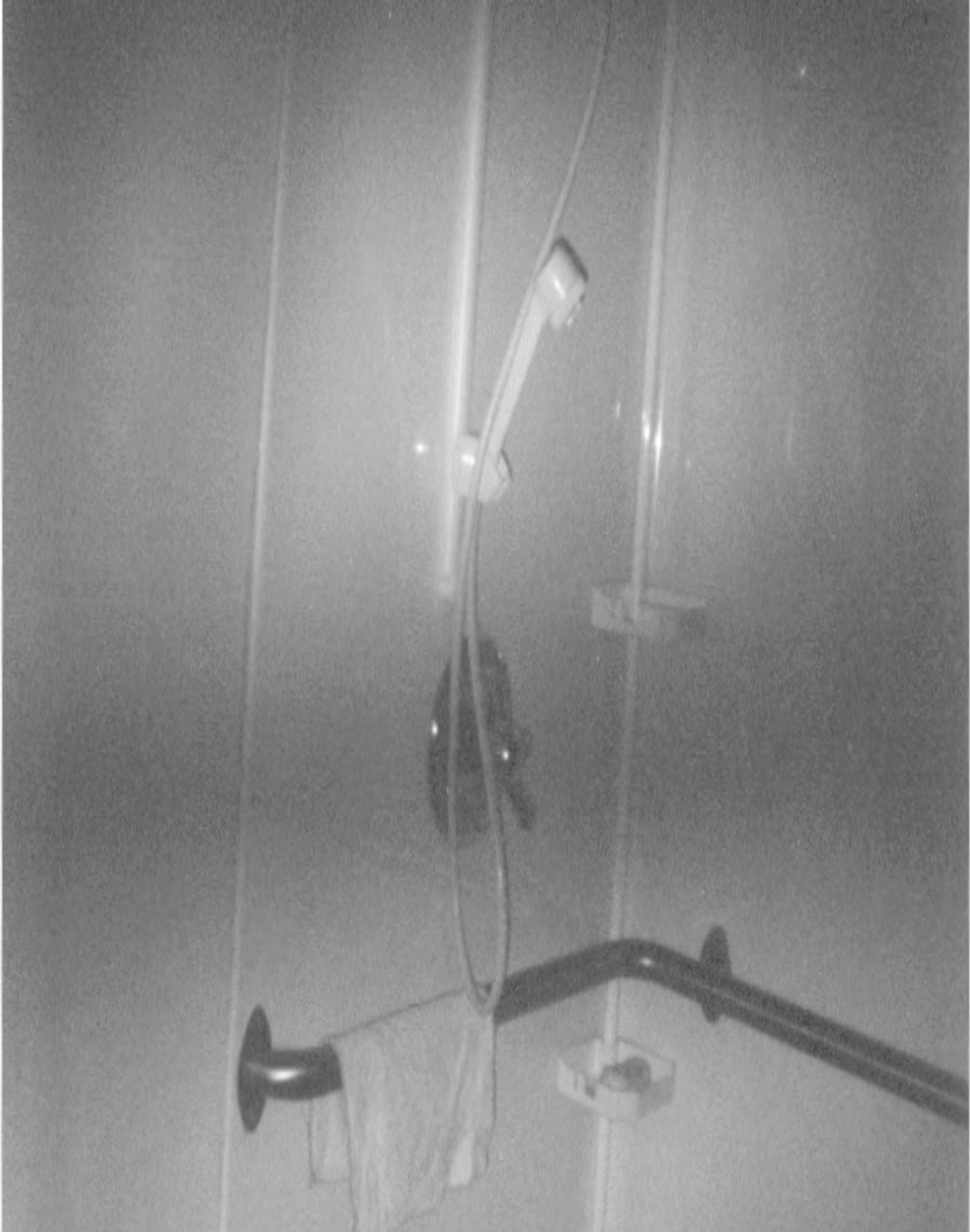
**Table 25 Plan B-Bathroom Universal Design Features**

<b>Critical Universal Design Features Plan B Bathroom</b>	<b>Y</b>	<b>N</b>
32” clearance at entry door	X	
Single-lever controls at all doors	X	
Blocking in walls around tub, toilet, and shower for grab bars	X	
Single-lever water controls at all fixtures and faucets	X	
Mix valve with pressure balancing and hot water limiter	X	
Tub/shower seat		X
Toilet bowl height between 17” and 19” above finished floor	X	

Residents and caregivers described the bathroom in positive terms, noting the wide doors and the walk-in showers (Figure 31). Although the piping was not insulated, the lavatory provided a knee space below (Figure 30). Each resident had procured an after-market seat for the shower that allowed them to sit while bathing. Although only one resident required assistance with dressing occasionally, and no one reported requiring assistance with toileting or bathing, the dependency scores reported by residents and caregivers were above the mean, indicating a higher-than-average level of dependency. The health scores reported were below the mean 75% of the time for residents and 50% of the time for caregivers. Residents and caregivers appeared to be happy with universal design features such as clear knee space under the lavatory.



**Figure 30 - Plan B Bathroom Vanity Clear Knee Space at Lavatory**



**Figure 31 - Plan B Bathroom Shower-Hand-Held Water Supply**



**Figure 32 – Plan B Vanity - No Clear Knee Space Under Lavatory**





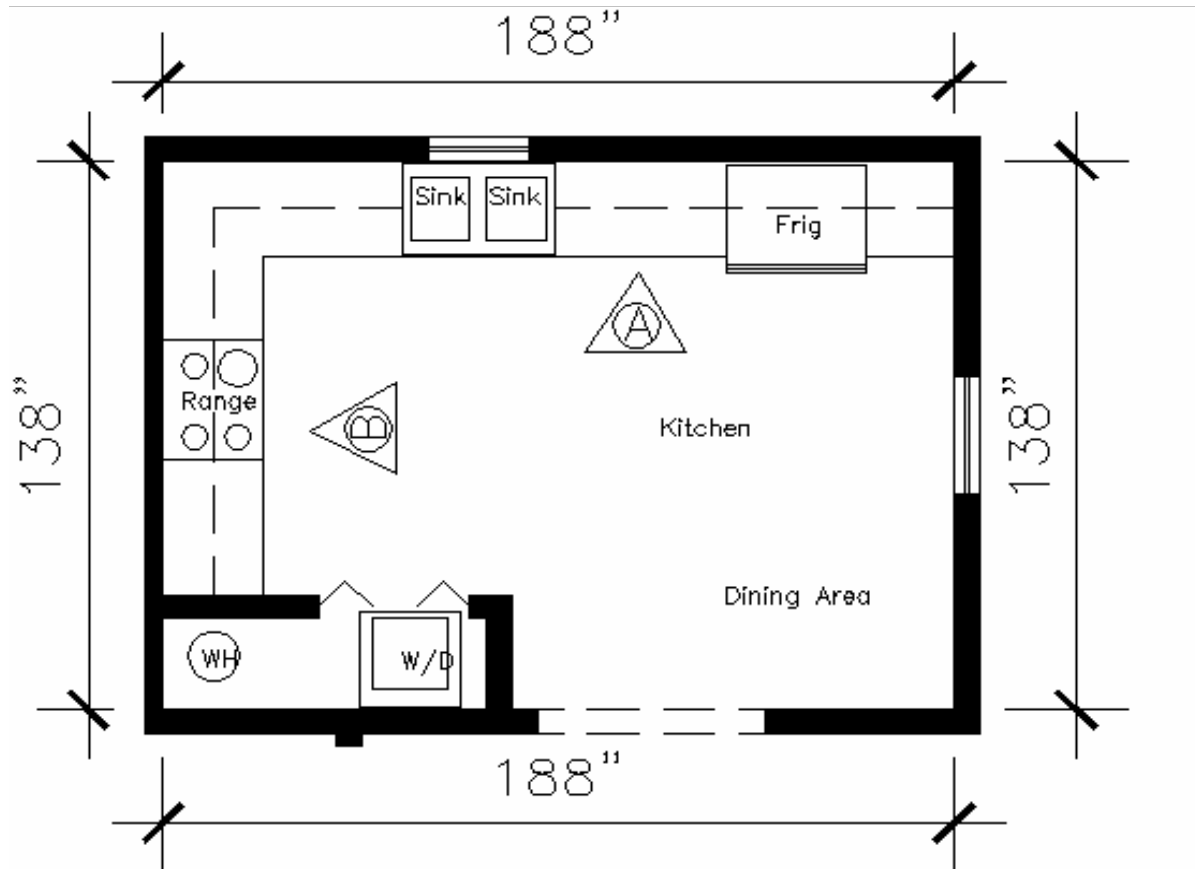
**Figure 33 – Plan B Bathroom - No Clear Approach to Toilet**



**Figure 34 - Plan B Bathroom Toilet - Grab Bars**

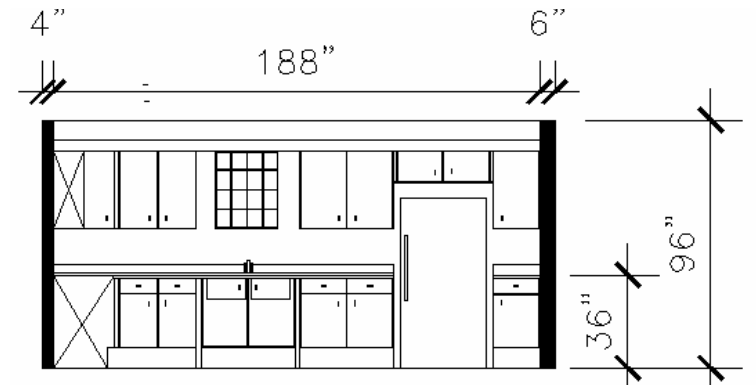
### Floor Plan C Kitchen Analysis

Kitchen C (Figures 35 – 39) was in compliance with 70% of the ten-point kitchen checklist (Table 26). The three features that were not in compliance were the amount of wall storage totaled less than 186”, the base cabinet totaled less than 192”, and one leg of the traffic pattern exceeded 9’. Kitchen C met 69% of the critical universal design feature list (Table 27).

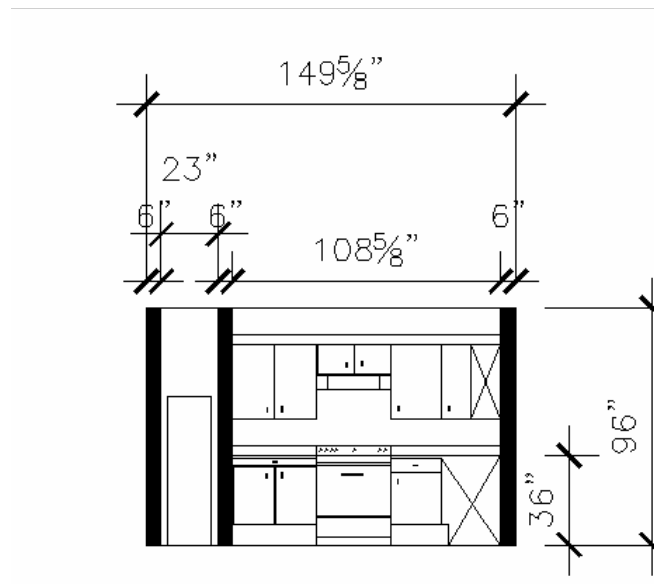


**Figure 35 - Plan C Kitchen Floor Plan Dimensioned**

The plan C kitchen is unique in several ways. Each individual base cabinet and counter top was constructed in separate modules. The base cabinetry to the left of the range contains what appears to be a top drawer, but is actually a pull-out work surface that is approximately 2” lower than the standard 36” counter height (Figure 38). The wall cabinets are taller than average, and are hung at approximately 12” above the counter top. Some features in the kitchen were



**Figure 36 - Plan C Kitchen Section A**



**Figure 37 - Plan C Kitchen Section B Dimensioned**

particularly helpful for people in wheelchair. Eight-inch toe space height was incorporated into the base cabinetry design, and an outlet has been placed on the front, vertical surface of base-mounted cabinetry (Figure 39). The space under the sink has been left free of built-in cabinetry (although there are cabinet doors) to allow for knee space while sitting at the sink (Figure 39). These features address wheelchair use in the ECHO kitchen. The space planning allows for a dining table and chairs in the kitchen without interference in either the work triangle or the clear floor space at the appliances.

**Table 26 - Plan C Kitchen Guidelines Checklist**

<b>ECHO Kitchen Planning Guidelines</b>	<b>Y</b>	<b>N</b>
No major traffic pattern through work triangle	X	
Work triangle total no more than 26' with no single leg shorter than 4'		X
Wall cabinet frontage of 186"		X
Base cabinet frontage of 192"		X
Landing space beside the range 12" & 15 "	X	
Landing space beside the refrigerator 15 "	X	
Clear floor space of 30" X 48" at sink, range & refrigerator	X	
Sink located between range and refrigerator	X	
36" work centers adjacent to water source	X	
Sink with 24" on one side and 18" on the other at same level	X	

**Table 27 - Plan C Kitchen Universal Design Features**

<b>Critical Kitchen Universal Design Features</b>	<b>Y</b>	<b>N</b>
32" door clearance	X	
Single-lever door controls at all doors	X	
Single-lever water controls at all faucets	X	
Clear knee space under the sink	X	
Adjustable or variable work center heights between 28" & 45" AFF	X	
Rocker switchplates		X
Outlets located between 18" and 22" above finished floor	X	
Wall switches mounted between 42" and 48" above finished floor	X	
Dishwasher elevated 6" above the finished floor		X
Front-mounted appliance controls		X
40" Minimum circulation clearance	X	
Side-by-side refrigerator		X
Non-slip flooring	X	

Residents and caregivers responded enthusiastically when asked about their kitchens. Most used terms like “love it”, “...nothing I would change”, and “excellent”. One resident spoke of visitors to her home wishing they had a “nice kitchen like hers”. Another resident commented on the large size of the kitchen, and referenced the lower work-center height when she spoke about enjoying the “bread board”. Although it was included in each of the 17 plan C kitchens, the lowered work-surface feature was acknowledged as present by only two of the residents and

one of the caregivers associated with house plan C. The universal-design feature clear knee space under the sink was similarly unacknowledged by the majority in the 17 ECHO homes that offered it. Some had filled the space by using it for storage of large items (Figure 39) and, in doing so, negated the intended use of the feature. Two residents and one caregiver with plan C kitchens confirmed that this feature was present in their kitchens when asked during the interview.

Residents of house plan C prepared at least one meal each day in their kitchens independently, and some prepared food for their caregivers. The two residents who reported that all their meals were prepared by others also commented that they liked their kitchens. There were mixed evaluations on the lazy-susan in the corner base cabinet. Some found it very helpful, but one resident referred to it as “useless”. Effectiveness appeared to be related to the physical capabilities of the resident. Other negative remarks were associated with not having enough storage, the back door located in the bedroom instead of the kitchen, and a venting system that recycles the cooking fumes back into the kitchen as opposed to the outside. The storage issue had been addressed by some residents as it had been with residents of plan B kitchens. Free standing furniture pieces were placed in the kitchen to provide additional storage. The size and design of the kitchen did not allow for furniture placement beyond customary dining furniture, and the addition of storage pieces compromised the 40” clearance space provided for safe and comfortable movement in the task area (Figures 24 and 26). Although some areas for improvement in the plan C kitchens were identified, most residents and their caregivers found that the ECHO kitchens met their needs sufficiently.



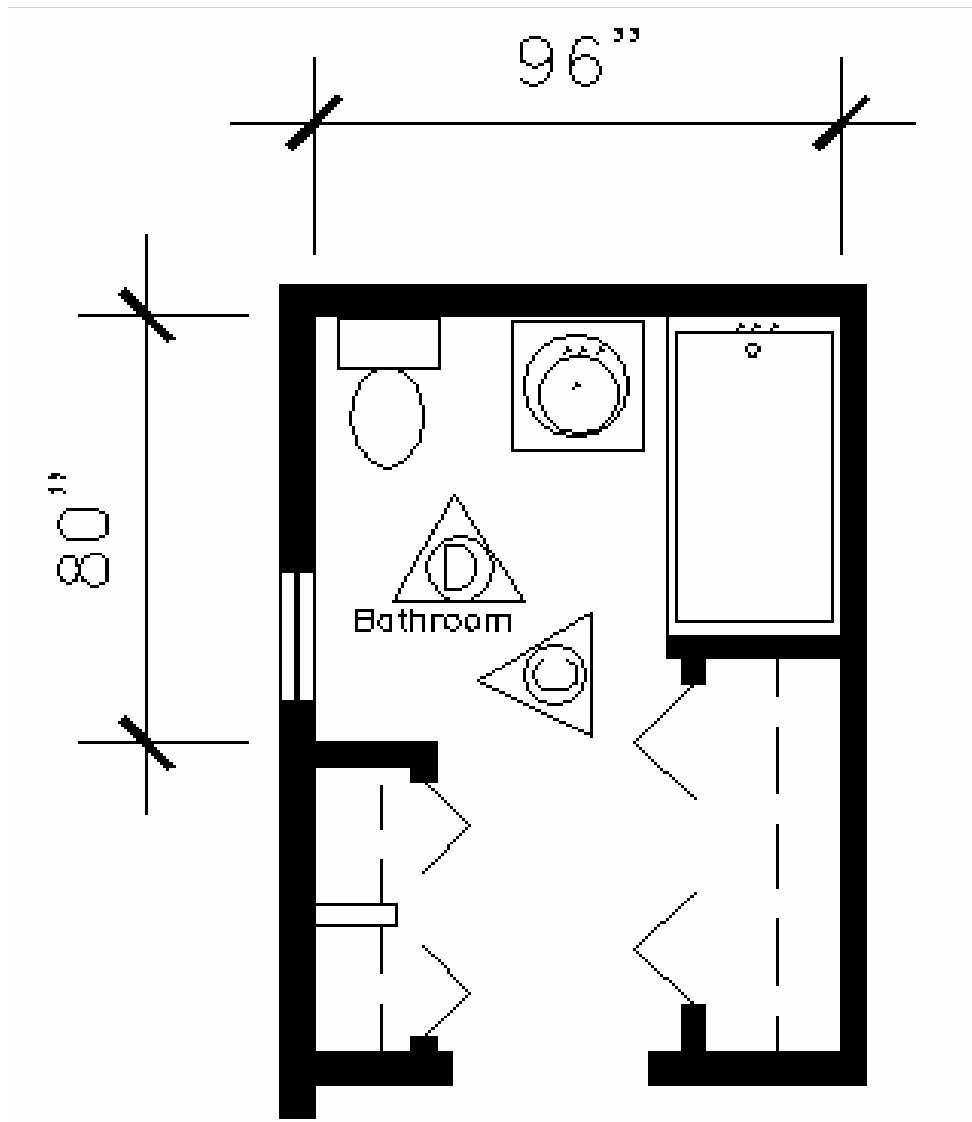
**Figure 38 - Plan C Kitchen Electrical Outlet on Front of Base Cabinetry & Variable Height Work Center**





**Figure 39 - Plan C Kitchen No Clear Knee Space Under Sink**

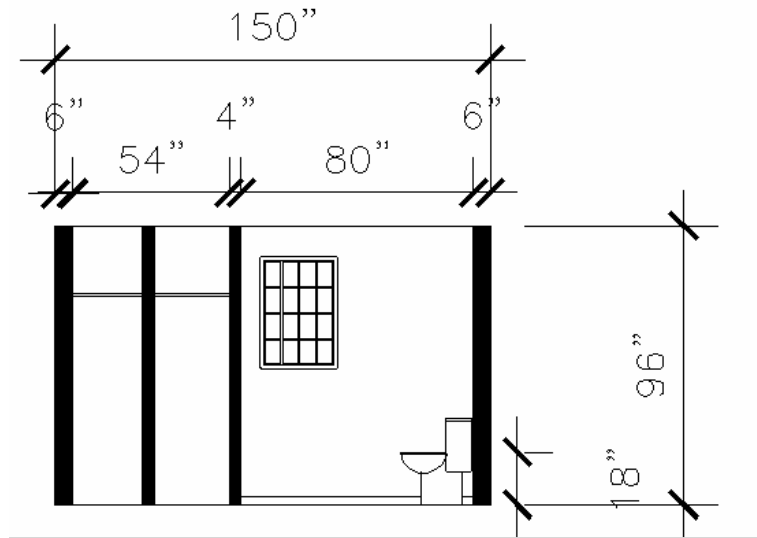




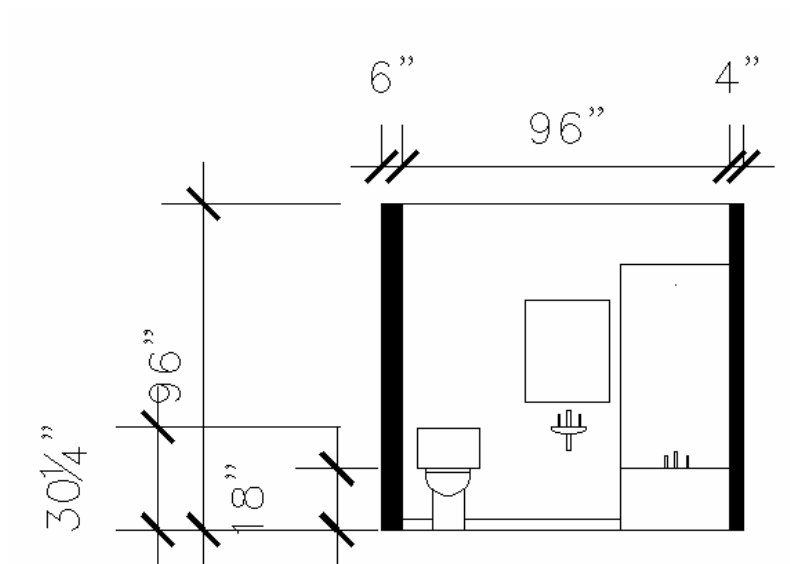
**Figure 40 - Plan C Bathroom Dimensioned**

### **Floor Plan C Bathroom Analysis**

Bathroom C (Figures 40 – 44) was in compliance with 83% of the 6-point guideline checklist and critical universal design checklist. The one feature that did not comply was a 30” X 60” clear floor space at the bathtub. The placement of the sink infringed on the open space beside the bathtub. A bathroom design guidelines checklist can be seen in Table 28, and the critical universal design features checklist can be seen in Table 29.



**Figure 41 - Plan C Bathroom Section C Dimensioned**



**Figure 42 - Plan C Bathroom Section D Dimensioned**

**Table 28 - Plan C Bathroom Guidelines Checklist**

<b>ECHO Bathroom Planning Guidelines</b>	<b>Y</b>	<b>N</b>
Clear floor space of 48”X48” in front of the toilet	X	
Clear floor space of 30”X48” at the lavatory	X	
Clear floor space of 30”X60” at the bathtub		X
Minimum center-line from sink to side-wall 15”	X	
Tub/shower controls accessible from inside and outside the fixture	X	
Minimum center-line from toilet to obstruction 16”	X	

**Table 29 - Plan C Bathroom Universal Design Features**

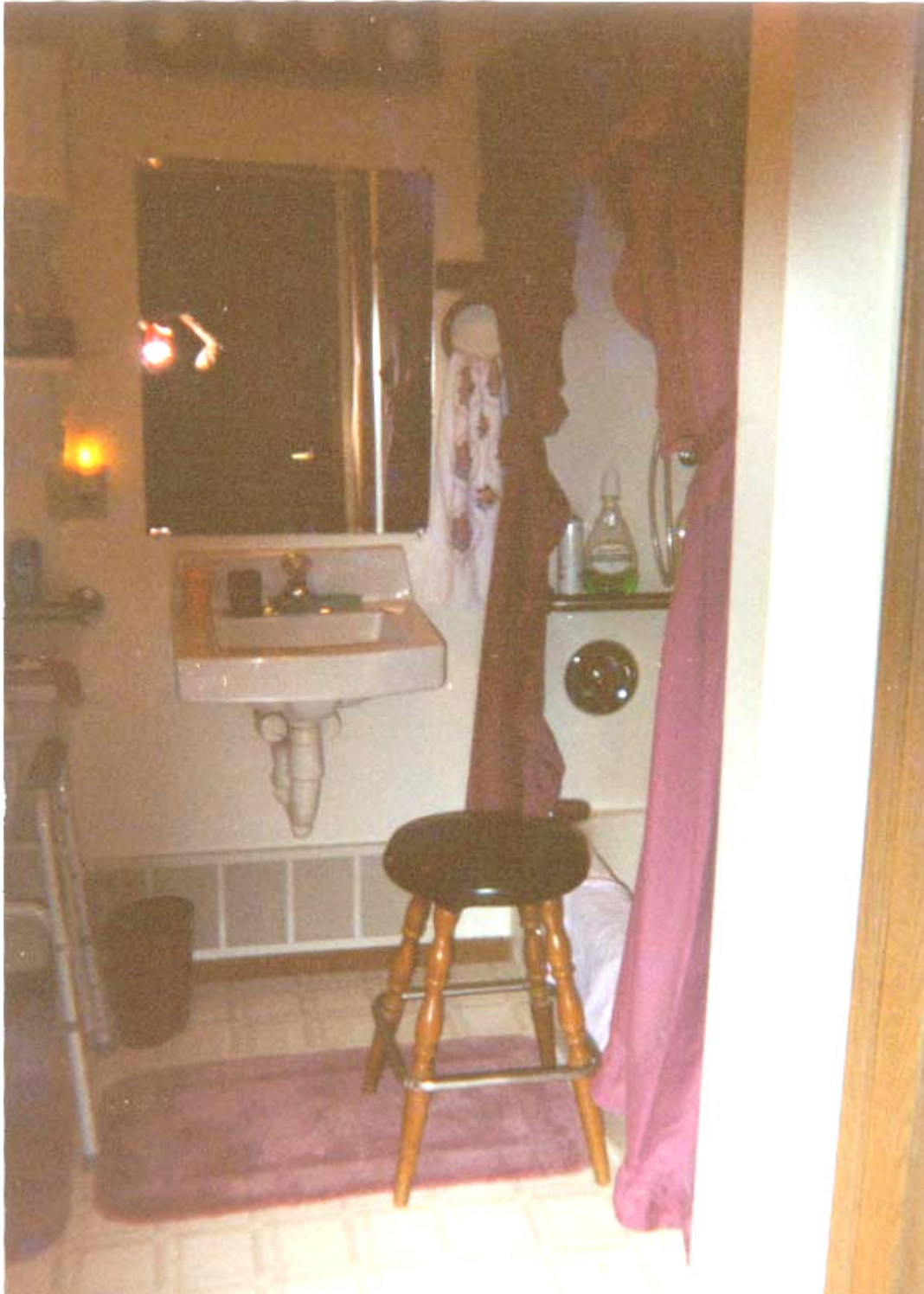
<b>Critical Bathroom Universal Design Features</b>	<b>Y</b>	<b>N</b>
32” clearance at entry door	X	
Single-lever controls at all doors	X	
Blocking in walls around tub, toilet, and shower for grab bars	X	
Single-lever water controls at all fixtures and faucets	X	
Mix valve with pressure balancing and hot water limiter	X	
Tub/shower seat		X
Toilet bowl height between 17” and 19” above finished floor	X	

House plan C was used by the largest number of participants in this research (17). No resident reported requiring assistance with toileting. One resident reported requiring assistance occasionally with bathing. Two other residents reported requiring assistance occasionally with dressing.

The plan C bathroom is the only bathroom that has a bathtub/shower combination (Figure 43). Some residents reported a preference for a walk-in shower early in their residency, but have since adjusted to using a bathtub and currently have few complaints. Not all residents are able to rise from a sitting position on the floor of the bathtub safely and independently. Two thirds of residents have placed a seat in their tub. Residents and caregivers gave the shower seat the highest effectiveness rating of “very helpful”. One resident who neither had nor wanted a seat in her tub commented that she has no problem sitting in or exiting her bathtub. Overall, residents and caregivers of plan C houses are supported in their efforts to remain independently housed by the universal design features found in their bathrooms.



**Figure 43 - Plan C Bathroom Bathtub/Shower  
Clear Access, Hand-held Water Supply**



**Figure 44 - Plan C Bathroom Sink - Clear Knee Space Under Lavatory**

**Hypothesis Testing**

The specific objectives of this research include the evaluation of the effectiveness of the universal design features of the kitchens and bathrooms of ECHO houses. To examine this relationship, effectiveness scores of identified critical universal design features and general health scores were tested with the dependency scores. In order to address these objectives and purposes of this research, six hypotheses were tested.

1.  $H_0$  -No relationship exists between the residents’ self-reported dependency and the presence of universal design features in ECHO kitchens and bathrooms.

This hypothesis addressed the residents’ perceptions of the relationship between the independent variable, presence of critical universal design features and the dependent variable, resident level of dependence in the performance of ADLs and selected IADLs. The issue of presence of critical-list universal design features was determined by referencing floor plans A, B, and C. Floor plans A and B both had scores of 14, and floor plan C had a score of 15. The presence of specific features in each of these floor plans was presented in Tables 14 and 15. To test this hypothesis, means for the three floor plans were computed using a one-way ANOVA. A separate analysis was run on the resident total dependency score, and on each individual ADL and IADL item. A follow-up power analysis was also done. No relationship was found, and the null hypothesis was accepted. The results of these tests are provided in Table 30.

**Table 30 - Resident Dependency and Floor Plans A, B, and C**

<b>Function/Dependency</b>	<b>Floor Plan A</b>	<b>Floor Plan B</b>	<b>Floor Plan C</b>	<b>F</b>	<b>p</b>	<b>Power</b>
<b>Required Assistance w/</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>			
Food Preparation	1.80(1.10)	2.50(.707)	1.53(.640)	1.50	.250	.279
House Cleaning	1.60(.548)	3.00(.000)	1.93(.844)	2.21	.137	.394
Walking	2.00(1.00)	1.00(.000)	1.60(.910)	.908	.420	.183
Bathing	1.00(.000)	1.00(.000)	1.07(.258)	.216	.808	.079
Dressing	1.20(.447)	1.00(.000)	1.13(.352)	.216	.808	.079
Resident Function	8.60(1.34)	10.50(.707)	8.73(1.58)	1.33	.289	.251

2.  $H_0$  -No relationship exists between the caregivers’ perception of dependency of residents and the presence of universal design features present in ECHO kitchens and bathrooms.

This hypothesis addressed the caregivers’ perceptions of the relationship between the independent variable, presence of critical universal design features, and the dependent variable, residents’ level of dependency in the performance of ADLs and selected IADLs. This hypothesis mirrored hypothesis 1, but analyzed caregiver responses rather than residents’ responses. To test this hypothesis, means for the three floor plans were computed using a one-way ANOVA. A separate analysis was run on the resident total dependency score, and on each individual ADL and IADL item. No relationship was found, and the null hypothesis was accepted. The results of these tests are presented in Table 31.

**Table 31 - Caregiver Dependency and Floor Plan A, B, and C**

<b>Function/Dependency</b>	<b>Floor Plan A</b>	<b>Floor Plan B</b>	<b>Floor Plan C</b>	<b>F</b>	<b>p</b>	<b>Power</b>
<b>Required Assistance w/</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>			
Food Preparation	1.50(.577)	2.25(.500)	1.64(.7025)	1.50	.249	.279
House Cleaning	2.00(.817)	2.50(.577)	1.86(.663)	1.40	.271	.264
Eating	1.00(.000)	1.25(.500)	1.00(.000)	2.59	.101	.453
Walking	2.00(1.15)	1.75(.500)	1.43(.646)	1.06	.365	.208
Bathing	1.00(.000)	1.75(.957)	1.21(.426)	2.34	.124	.415
Dressing	1.50(.577)	1.00(.000)	1.07(.267)	3.26	.061	.550
Resident Function	10.00(1.83)	11.50(1.91)	9.21(1.58)	2.94	.077	.505

3.  $H_0$  -No relationship exists between the residents’ self-reported general health rating and the presence of universal design features in ECHO kitchens and bathrooms.

This hypothesis addresses the relationship between the dependent variable, resident self-reported general health rating, and the independent variable, the critical universal design features present in floor plans A, B, and C. A one-way univariate ANOVA was used to compare the general health means for the three floor plan groups. No relationship was found, and the null hypothesis was accepted. Results are shown in Table 32.

**Table 32 - Resident General Health and Floor Plan A, B, and C**

<b>Residents' Self-Reported General Health</b>					
<b>Floor Plan A</b>	<b>Floor Plan B</b>	<b>Floor Plan C</b>	<b>F</b>	<b>p</b>	<b>Power</b>
<b>Mean(SD)</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>			
2.75 (1.50)	3.50 (.707)	2.93 (1.10)	.286	.754	.088

4.  $H_0$  -No relationship exists between the caregivers' perception of general health rating of residents and the presence of universal design features present in ECHO kitchens and bathrooms.

This hypothesis addresses the relationship between caregivers' perceptions of residents' general health rating and the critical universal design features as defined by floor plans A, B, and C. The health status means for caregivers assisting residents living in floor plans A, B, and C contain information relative to this research. Univariate ANOVA test was used to test this hypothesis. No relationship was found, and the null hypothesis was accepted. The result of the means and univariate ANOVA tests that provided this information is presented in Table 33.

**Table 33 - Caregiver General Health and Floor Plan A, B, and C**

<b>Caregiver Perception of Residents' General Health</b>					
<b>Floor Plan A</b>	<b>Floor Plan B</b>	<b>Floor Plan C</b>	<b>F</b>	<b>p</b>	<b>Power</b>
<b>Mean(SD)</b>	<b>Mean(SD)</b>	<b>Mean(SD)</b>			
2.50 (1.29)	3.00 (.817)	3.79 (1.18)	2.23	.135	.398

5.  $H_0$  -No relationship exists between the residents' dependency rating and the residents' effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.

To test this hypothesis, scatter plots visually assessed statistical findings using the Pearson correlation coefficient. This test examined the relationship between the independent variable, residents' effectiveness rating of the universal design features, and the dependent variable,



residents' level of dependency. No relationship was found, and the null hypothesis was accepted. The result of the correlation is presented in Table 34.

**Table 34 - Resident Dependency and Effectiveness of Universal Design**

<b>Features</b>			
<b>Universal Design Feature</b>	<b>n</b>	<b>Correlation Coefficient r</b>	<b>p</b>
<b>Kitchen</b>			
Light switches 42"-48"	22	-.346	.114
32" Door Clearance	23	-.197	.379
Single-lever Door Control	22	-.084	.717
Single-lever Water Control	19	-.288	.231
40" Clear floor space	20	-.157	.508
Outlets 18"- 22" AFF	20	-.131	.581
Non-slip flooring	17	.073	.781
<b>Bathroom</b>			
Tub/Shower Seat	15	.292	.291
Single-lever door control	20	.084	.723
Anti-scald valve	22	-.029	.898
Single-lever water control	21	-.206	.371
32" Door clearance	21	-.344	.126

**Table 35 - Caregiver Dependency and Effectiveness of Universal Design Features**

<b>Universal Design Feature</b>	<b>n</b>	<b>Correlation Coefficient r</b>	<b>p</b>
<b>Kitchen</b>			
Single-lever door control	16	.429	.097
Single-lever water control	19	.071	.774
32" Door clearance	21	.024	.919
Light switches 42"-48"	22	.005	.982
Outlets 18"- 22" AFF	15	-.053	.850
40" Clear floor space	15	-.061	.829
Rocker Light Switches	15	-.197	.482
<b>Bathroom</b>			
Single-lever door control	18	.442	.066
32" Door clearance	22	.087	.702
Anti-scald valve	20	.065	.786
Single-lever water control	18	.031	.902

6.  $H_0$  -No relationship exists between the caregivers’ perception of the residents’ dependency and the caregivers’ effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.

This test mirrors Hypothesis 5, and the same test was used to test this hypothesis. Scatter plots visually assessed statistical findings using the Pearson correlation coefficient. No relationship was found, and the null hypothesis was accepted. The result of the correlation analysis is presented in Table 35.

**Additional Questions**

A summary of the statistical tests revealed that cell sizes were small (15-22), the power of the tests was low (.079 - .550), no significance was found at the 5% level, and no relationships between the variables were found. All null hypotheses were accepted. These results led the researcher to ask additional questions. Age was examined as a variable related to the effectiveness of universal design features and dependency. The relationship between universal design features that are present in the kitchen were tested with ADLs and IADLs that typically occur in the kitchen, and features that are present in the bathroom were tested with ADLs and IADLs that typically occur in the bathroom.

**Table 36 - Correlation Between Residents’ Age and Resident and Caregiver Universal Design Feature Effectiveness Scores**

Feature	Resident		Caregiver	
	r	n	r	n
<b>Kitchen</b>				
Single-lever water controls	.345	19	-.033	19
Light switches between 42” – 48”	-.008	22	-.153	22
40” clear floor space in task areas	-.026	20	-.043	22
32” Door Clearance	-.072	23	-.198	21
Outlets between 18”-22” AFF	-.117	20	.041	15
Single-lever door controls	-.358	22	-.117	16
<b>Bathroom</b>				
Toilet seat between 17” – 19” AFF	.315	14	-.097	13
Single-lever water controls	.297	21	.344	18
Tub/shower seat	.138	15	.277	14
Anti-scald valve	.102	22	.221	20
32” Door Clearance	-.062	22	.030	22
Single-lever door controls	-.397	21	-.094	18

**Age and Effectiveness**

The question was: Is there a relationship between the independent variable resident age, and the dependent variables, residents’ and caregivers’ effectiveness scores of universal design features? To test this question, a mean for residents’ age was computed, and this was compared to residents’ and caregivers’ individual effectiveness scores for critical universal design features. A separate analysis was run on each effectiveness score for each universal design item. A surprising number of negative correlations (9) were found. All correlation coefficients were low, and no significance was found.

The data revealed a surprising trend in the responses; a high number of negative correlations were found between age and the effectiveness of universal design features. Of the 24 comparisons, 10 were positive and 14 were negative. The majority of caregivers and residents appeared to be saying that the older a resident, the less effective the universal design feature was considered. This result was contrary to anticipated thought on the subject, and therefore surprising. The results of these tests are provided in Table 36.

**Table 37 - Correlation Between Residents’ Age and Resident and Caregiver Individual Dependency Scores**

Dependency Issue	Resident		Caregiver	
	r	n	r	n
Walking	.133	22	-.046	22
Dressing	.114	22	-.152	22
Cleaning	-.121	22	-.042	22
Bathing	-.170	22	-.088	22
Preparation of Food	-.343	22	-.014	22

**Age and Dependency**

The question was: Is there a relationship between the independent variable, resident age, and the dependent variable, residents’ and caregivers’ dependency rating? To answer this question, correlations between age and dependency for residents were computed. A separate analysis was run on each of the seven dependency items. A surprising number of negative correlations (9) were found. All correlations were low and no significance was found. The correlation coefficient differences for age and each of the ADLs and IADLs was noteworthy

(preparation of food R -.343 and C -.014, cleaning R -.121 and C -.042, walking R.133 and C -.046, bathing R -.170 and C -.088, and dressing .114 and -.152). All five caregiver and three of the five resident comparisons yielded a negative correlation. The data seem to indicate that for the most part (2 positive, 9 negative) caregivers and residents agree that the older the resident, the less dependent with regard to the specific ADLs and IADLs tested. Although it is true that advanced age does not categorically equal dependency, a negative correlation between age and dependency is surprising. The results of these tests are provided in Table 37.

**Kitchen Universal Design Features Effectiveness and Kitchen ADLs and IADLs**

The question was: Is there a relationship between the effectiveness scores of the kitchen-related universal design features present in the kitchens of ECHO houses, and the resident and caregiver assessment of ADLs and IADLs customarily performed in the kitchen? Five kitchen related universal design features were used. They were 32” door clearance, Single-lever door controls, outlets 18” – 22” above finished floor, wall light switch 42” – 48” AFF, and 40” clear

**Table 38 – Kitchen-Related Universal Design Features Effectiveness and Kitchen-Related ADLs & IADLs/Dependency Scores**

Feature	Dependency Issue	Resident		Caregiver	
		r	n	r	n
Outlets 18” – 22” above finished floor	Walking	.327	20	.257	15
Single-lever door controls	Preparation of food	.279	21	.423	16
Wall light switch 42” – 48” above finished floor	Walking	.268	22	.254	22
32” Door clearance	Cleaning	.220	22	.110	21
Single-lever door controls	Walking	.175	22	.393	16
40” Clear floor space in task areas	Preparation of food	.085	20	.139	15
40” Clear floor space in task areas	Walking	.039	20	.152	15
Outlets 18” – 22” above finished floor	Preparation of food	.020	20	-.607*	15
Single-lever door controls	Cleaning	-.159	22	.434	16
Outlets 18” – 22” above finished floor	Cleaning	-.223	20	.078	15
Wall light switch 42” – 48” above finished floor	Preparation of food	-.277	22	-.297	22
Single-lever water controls	Cleaning	-.299	19	.202	19
Single-lever water controls	Preparation of food	-.364	19	-.089	19
32” Door clearance	Preparation of food	-.467*	19	.139	21
Wall light switch 42” – 48” above finished floor	Cleaning	-.471*	22	.217	22
32” Door clearance	Walking	-.477*	22	.075	21

\*Correlation is significant at the 0.05 level (2-tailed)

floor space in task areas. The ADLs and IADLs that typically take place in the kitchen were food preparation, cleaning, eating, and walking. A separate correlation test was run for each combination. The 32 comparisons yielded 11 negative results, and 21 positive results. Four correlation coefficients were statistically significant at the 5% level. All were negative. Among these were: 32” door clearance with resident rating of preparation of food ( $r = -.467^*$ ), and walking ( $r = -.477^*$ ); and resident rating of wall light switches between 42” and 48” above the finished floor and cleaning ( $r = -.471^*$ ). There were also statistically significant correlations preparation of food ( $r = -.607^*$ ). This information is seen in Table 38.

### **Bathroom Universal Design Features Effectiveness and Bathroom ADLs and IADLs**

This analysis was a mirror of the previous comparison. The question was: Is there a relationship between bathroom related universal design features present in the kitchens of ECHO houses and the ADLs and IADLs customarily performed in the bathroom? There were seven bathroom related universal design features. The bathroom-related ADLs and IADLs were cleaning, bathing, walking, and dressing. This analysis yielded 50 correlations. Thirty were positive, and 20 were negative. One of the resident coefficients ( $r = -.550^{**}$  for 32” door clearance and cleaning) was statistically significant at the 1% level with  $n = 22$ . One caregiver coefficient ( $r = .500^*$  for single-lever door controls with cleaning) was statistically significant at the 5% level with  $n = 18$ , and one ( $r = -.606^{**}$  for single-lever door controls with dressing) was statically significant at the 1% level with  $n = 18$ . This information is listed in Table 39.

### **Summary**

Although three house plans were used, the houses appeared similar to each other from the exterior. The ECHO houses were small, rectangular houses with between 437 and 624 square feet of interior space. The small size was a feature that was noted by several residents and caregivers in favorable terms. Residents and caregivers agreed that a small house was manageable for the residents. The small size also contributed to the ability to locate the ECHO house near family and/or friends. That was a benefit expressed by residents and caregivers frequently.

**Description of the Residents and Caregivers**

The people who lived in the ECHO houses were a diverse group. Most were women; all were elderly and in need of assistance, but not necessarily medical attention. It was primarily health and dependency issues that diversified the group. Some were relatively high functioning and independent, and others were in the poorest health and required assistance with most tasks. Some were physically challenged, others had cognitive impairment, and some had both. Most had access to a family member or friend living in the host house who agreed to assist the elderly person and attend to their needs. However, four residents had no caregiver in a host house, and in some cases there was no host house. Where a caregiver was available, the arrangement appeared to be beneficial to all parties involved. When there was no caregiver, the residents appeared to be resourceful maintaining themselves sufficiently, and acquiring assistance when it was needed.

**Table 39 – Bathroom-Related Universal Design Features Effectiveness and Bathroom-Related ADLs & IADLs/Dependency Scores**

Feature	Dependency Issue	Resident		Caregiver	
		r	n	r	n
Tub/shower seat	Cleaning	.307	15	.241	14
Toilet seat 17” – 19” high	Walking	.228	14	.019	13
32” Door clearance	Cleaning	.220	22	.198	18
Toilet seat 17” – 19” high	Bathing	.159	14	.247	13
Single-lever door controls	Bathing	.138	21	.100	18
Anti-scald valve	Dressing	.126	22	-.546*	20
Tub/shower seat	Walking	.097	15	.440	14
Single-lever water controls	Bathing	.087	21	.209	18
32” Door clearance	Bathing	.075	22	.287	22
Anti-scald valve	Bathing	.069	22	-.546*	20
Tub/shower seat	Dressing	.029	15	.203	14
Single-lever water controls	Walking	-.013	21	-.041	18
Anti-scald valve	Cleaning	-.017	22	-.017	20
Single-lever water controls	Cleaning	-.027	21	.079	18
32” Door clearance	Walking	-.046	22	.110	21
Single-lever door controls	Dressing	-.068	21	-.606**	18
Single-lever door controls	Walking	-.113	22	.406	18
Anti-scald valve	Walking	-.130	22	.187	20
Single-lever door controls	Cleaning	-.159	21	.500*	18
Toilet seat 17” – 19” high	Dressing	-.213	14	.234	13
Single-lever water controls	Dressing	-.287	21	.121	18
32” Door clearance	Dressing	-.550**	22	.019	22

\*Correlation is significant at the 0.05 level \*\* Correlation is significant at the 0.01 level

There appeared to be a great deal of pride in ownership of the ECHO house. Residents seemed pleased with being able to maintain a level of independence, and residents and caregivers appeared appreciative of the availability of a rapid response should there be need for assistance. The close proximity to family had many advantages for the elderly person as well as younger family members. Residents and caregivers spoke of grandchildren routinely spending time with the grandmother in her ECHO house. Some residents babysat for their grandchildren once in a while. One caregiver expressed relief at being able to spend the night at her mother's home occasionally when the mother's medication had to be changed. The ECHO house and its nearness to the host house made such situations less stressful both on the host and the resident.

Some residents had gardens, and some had customized their houses with wallpaper and wall décor that reflected their personal style. All had brought furniture in from their previous residence, which provided a level of comfort and familiarity immediately. Residents appeared comfortable and proud to refer to the ECHO as their home.

### **Summary of Kitchen and Bath Features**

The kitchen and bath universal design features chosen for and examined in this research are for the most part successful in meeting the needs of the older adults who live in them, and their caregivers. Most of the critical universal design features are included in ECHO house specifications. Seven of 13 universal design features were present in all kitchens. Each of the three plans had one or two additional features for a total of 8 or 9 features. In the bathroom, six of seven features were present in each plan. These features support residents and caregivers in their efforts to maintain as much independence as is feasible for residents.

### **Residents and Caregiver Responses to Universal Design Features**

Many of the responses to specific questions about effectiveness of the features were met with enthusiasm and high scores. Questions regarding features that were not present in the home also prompted responses that indicated that many residents and caregivers found the idea of having those features desirable. The few features that drew ambivalent or negative responses were relatively recent concepts (raised dishwashers, full-extension base cabinet shelving, etc.) and may have simply been unfamiliar to the residents. This could have caused hesitation or rejection on their part.

The universal design features that make up the critical list address some of the most prevalent diseases and conditions often associated with advanced age. In addition they support the changing requirements and limitations of the healthy aging process. Resident and caregiver responses to questions about the effectiveness of these features indicate that most of the critical universal design features examined in this research have been successful in addressing symptoms of prevalent conditions. The research also reveals that some features are not as important to the residents of ECHO houses and caregivers as they were thought to have been by professionals in the field of aging and housing. Responses suggested that ECHO residents and their caregivers may benefit from training in maximizing the potential of some of the critical universal design features. Overall the critical universal design list appears to be a cost effective, efficient, and practical way of providing environmental support for the aging process.

The information gleaned from the statistical analysis in this research provides subtle but interesting findings. Small cell sizes were consistent throughout the research, and led to a lack of statistically significant findings in the initial testing. However, the small cell sizes are a function of size of the ECHO demonstration housing program. The people contacted reflected the entire population of the ECHO demonstration housing program participants. Tests of the hypotheses failed to provide statistical significance at the 5% level, with strong power and reliability. Additional research that compared resident age with universal design feature effectiveness and dependency scores were investigated. The results yielded statistically significant correlations at both the 5% and the 1% level. Some of the findings were confounding contradictions between resident and caregiver responses. Confusing negative relationships were also revealed. The design of the research is likely the reason for the perplexing findings.



## **Chapter V**

### **SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS**

This chapter contains a brief summary of the research conducted. This is followed by conclusions and implications regarding the hypothesis tested. Recommendations for future research are also provided.

#### **Summary**

This research is a focused extension of a broader study, Evaluation of the HUD Elder Cottage Housing Opportunity (ECHO) Program that was conducted in 2003. That study is referred to in this research as Phase I. It consisted of a HUD-sponsored multi-level evaluation of the ECHO demonstration housing program in the United States reported in this study. This research concentrated on an examination of the effectiveness of the universal design features in the kitchen and bathrooms of ECHO houses.

The purpose of this research was to determine if universal design features in the kitchens and baths of the ECHO housing were effective in meeting the needs of the residents and caregivers. First, the universal design features of kitchens and bathrooms that were widely valued by researchers, designers, and other experts in the field of housing had to be identified. The research then determined which of the identified kitchen and bath universal design features were present in ECHO demonstration houses. Resident dependency was evaluated, as was the effectiveness of the universal design features of kitchens and bathrooms for current residents of ECHO houses and their caregivers.

The sample in Phase I of the study involved contact with thirty-two families. Twenty-six contacts responded, and 22 residents and 22 caregivers participated in the research. They were not necessarily matched pairs. Although most interviews were conducted with the resident and the caregiver from one house, some interview contacts yielded an interview with either a resident or a caregiver, but not both.

The 44 respondents were located in four states; New Jersey, Kansas, Missouri, and Iowa. Twenty-one residents were females ranging in age from 66 to 91. Most were between 70 and 89. One male resident, age 82, participated in the research. The mean age of resident respondents was 77. The ECHO homes in this study had been occupied between one and eight years. Most residents had been in their homes between four and six years. Nine caregivers were daughters,

seven were sons, one was a sister, one was a son-in-law, and one was a friend. Four residents had no caregiver in a host house.

The survey instrument used in this study is called the ECHO Record (Appendix E). The ECHO Record was generated employing several resources: researcher experience, consultation with housing educators and other housing professionals, and review of existing universal design research. The ECHO Record was composed of four parts. Part 1 confirmed the presence of the critical list universal design features in the houses, and contains a 20-item checklist of universal design features. Part 2 evaluated the effectiveness of the critical universal design features present in the ECHO homes using a 63-item questionnaire. Part 3 involved health, and is made up of one question regarding general health. Part 4 covers dependency. Part 4 is composed of seven questions about frequency of assistance required in the performance of selected ADLs and IADLs.

### **Descriptive Summary**

Health scores were determined from resident and caregiver responses to one question on the interview schedule. The resident mean health score was 2.95 out of a possible 5. The caregivers mean was 3.41, indicating that their evaluation of the residents' general health was higher than the residents perceived their health to be.

Dependency was determined from seven questions related to the assistance required to perform selected ADLs and IADLs. Dependency scores for resident and caregivers were summed separately. Potential total dependency scores ranged from seven to 21. Residents self-reported dependency scores had a mean of 8.86. Caregivers' resident dependency score mean was 9.77, indicating that caregivers considered residents to be more dependent than the residents considered themselves to be.

Effectiveness scores on each of the universal design features in the kitchens and bathrooms of each ECHO house were reported by residents and caregivers. With the exception of two features (variable work center heights and clear knee space under the sink), the means of the resident effectiveness scores for each feature ranged between 4 (somewhat helpful) and 5 (very helpful) with the majority in the 4.70 and above area.

### **Presence of Critical Universal Design Features in Kitchens and Bathrooms**

Many of the critical universal design features were present in most of the ECHO housing plans (e. g. 32" door clearances in the kitchen and bath, single-lever door handles in the kitchen

and bath, single-lever water controls in the kitchen and bath, outlets located between 18” – 22” above the finished floor, wall light switches located between 18” and 45” above the finished floor. Each plan had at least one feature that was unique to that plan. Only plan A had rocker light switches in the kitchen. Only plan B had front-mounted appliance controls on the ranges, and only plan C had variable height work centers and clear knee space under the sink.

### **Effectiveness of Universal Design Kitchens and Bathrooms Features**

More than half of the critical universal design kitchen features (7 out of 13) were rated “helpful” to “very helpful” by residents. In order of the effectiveness means scores, they were: minimum circulation clearance of 40” in task area, wall switches mounted between 42” and 48” above the finished floor, single-lever water controls, non-slip floors, 32” door clearance, outlets between 18” and 22” above the finished floor, non-slip floors, and single-lever controls at kitchen doors. Caregivers rated the same features with the same range of scores, but in a slightly different priority. They are: minimum circulation clearance of 40” in task area, 32” door clearance, wall switches mounted between 42” and 48” above the finished floor, single-lever controls at kitchen doors, single-lever water controls, and outlets between 18” and 22” above the finished floor.

All universal design bathroom features were rated as effective by residents and caregivers. In order of resident ratings (according to effectiveness means) they were: blocking in walls around toilet, tub/shower for future placement, and relocation of grab bars; single-lever water controls; mix valve with pressure balancing and hot water limiter; 32” door clearance; tub/shower seats; toilet bowl height between 17” and 19” above the finished floor; and single-lever controls at all doors. All of these features, except the shower seat, are built into the ECHO houses. The order of caregivers effectiveness scores were: blocking in walls around toilet, tub/shower for future placement, and relocation of grab bars, single-lever water controls, mix valve with pressure balancing and hot water limiter, 32” door clearance, tub/shower seats, toilet bowl height between 17” and 19” above the finished floor, and single-lever controls at all doors. The tub/shower seat had not been a built-in feature of the ECHO houses, but most had added an after-market product and rated it as highly effective

Residents and caregivers were asked to report on the possible helpfulness of critical universal design features that were recommended by housing experts but not present in their homes. The responses indicated that, in general, caregivers rated the effectiveness of the absent

features more highly than did the residents. The features were side-by-side refrigerators, raised dishwashers, and tub/shower seats.

Although there were no side-by-side refrigerators in any of the ECHO houses 6 out of 22 residents reported that they would be helpful. Twelve of the twenty-two caregivers agreed. One resident commented that the kitchen was not big enough for a side-by-side refrigerator implying that (in her perception) a side-by-side would require more space than her current refrigerator.

Overall, kitchens and bathrooms of ECHO houses rank high in compliance with the critical list of universal design features. The presence, and high rate of effectiveness of more than half the kitchen features, and the entire bathroom features means that ECHO houses are of high quality in respect to meeting the needs of the elderly population they cater to.

### **Quantitative Summary**

Six hypotheses were tested using data from the ECHO Record. The Record was completed by the researcher from information gathered in Phase I and Phase II.

1.  $H_0$  -No relationship exists between the residents' self-reported level of independent functioning and presence of the universal design features present in ECHO kitchens and bathrooms.
2.  $H_0$  -No relationship exists between the caregivers' perception of level of independent functioning of residents and the presence of the universal design features present in ECHO kitchens and bathrooms.
3.  $H_0$  -No relationship exists between the residents' self-reported general health rating and presence of universal design features in ECHO kitchens and bathrooms.
4.  $H_0$  -No relationship exists between the caregivers' perception of general health rating of residents and the presence of the universal design features present in ECHO kitchens and bathrooms.
5.  $H_0$  -No relationship exists between residents' level of independent functioning and the residents' effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.
6.  $H_0$  -No relationship exists between the caregivers' perception of the residents' level of independent functioning and the caregivers' effectiveness rating of the universal design features present in ECHO kitchens and bathrooms.

No significance was found in the analysis, and these null hypotheses were accepted.

### Additional Questions Raised

The original hypotheses provided minimal information, but generated alternative thought processes that inspired additional queries. Several questions were asked.

1. Is there a relationship between resident age and resident and caregiver effectiveness scores?
2. Is there a relationship between resident age and resident and caregiver total dependency scores?
3. Is there a relationship between the effectiveness scores of the universal features present in the kitchens of ECHO houses and resident and caregiver assessment of selected ADLs and IADLs that typically occur in the kitchen?
4. Is there a relationship between the effectiveness scores of the universal features present in the bathrooms of the ECHO houses and resident and caregiver assessment of selected ADLs and IADLs that typically occur in the bathroom?

When the relationships between resident age and the effectiveness of universal design features present in the kitchens and bathrooms of ECHO houses and resident age and dependency scores were tested (Questions 1-2), correlation coefficients were not statistically significant at the 5% level, and the majority of them were negative.

Five kitchen-related critical list universal design features were tested with each of three selected kitchen-related ADLs and IADL tasks (Question 3). Although significance was found with the correlation coefficients between five features and tasks, all of the significant correlations were unexplainably negative. Four of these were from resident data, and one was from caregiver data. In no case were the resident and caregiver data statistically significant on the same feature and task.

Seven bathroom-related critical list universal design features were tested with each of selected bathroom-related ADLs and IADLs (Question 4). Significance was found with the correlation coefficients between five features and tasks. One of the statistically significant findings was from resident data, and four were from caregiver data. In no case were the resident and caregiver data statistically significant on the same feature and task. All resident and three of the four caregiver correlation coefficients were negative. One caregiver (n = 18) feature and task was positive and statistically significant at the 5% level: The relationship was between the 32" door clearance feature and cleaning (.500\*). These findings are perplexing. Negative

relationships were not anticipated, and the connection between the feature and the task involved in the one positive correlation coefficient is not apparent.

The findings presented in this research addressed the degree to which the needs of the elderly population were being met with regard to the universal design features in the kitchens and bathrooms of ECHO homes. A statistical analysis of the data gathered during this research suggests that although tendencies and trends have been identified, the statistically significant data present some confounding findings. Unanticipated, statistically significant correlation coefficients were found between variables, and anticipated relationships were either nonexistent or negative, indicating an inverse relationship. These results are likely due to issues of the research design. Non-existent or inverse relationships where strong positive relations are a reasonable expectation suggest extraneous variables outside the scope of this research. For instance, it is reasonable to anticipate a positive relationship between a tub/shower seat and bathing. When statistical analysis indicates that the relationship does not exist (which was the case in this study) or that the two variables are inversely related, it gives the researcher pause.

### **Conclusions**

Overall, the ECHO program is meeting the requirements of the target population of elderly, frail people in need of affordable housing that meets their physical challenges, and, to some degree, their psychological ones. Several aspects of these findings affirm Lawton and Nahemow's theory of environmental press. The design of the ECHO house, and the inclusion of critical universal design features provide the environmental support that Lawton and Nahemow theorized would maintain a healthy balance between physical ability and environmental demand. The firm and exuberant declarations of contentment with the ECHO house expressed by residents and caregivers can also be interpreted as a confirmation that, to some extent, the universal design features recommended by experts in the field of housing and aging (including Lawton and Nahemow) have accomplished the goal of meeting the needs of the frail, elderly population. This result supports Lawton and Nahemow's theory that a well-designed and appointed environment (e.g., kitchen and bathroom) is conducive to independence. The desire of older adults to mature in as independent a manner as is possible, with privacy, dignity, and safety is supported by Lawton and Nahemow's theory and this research.

The full capacity for effectiveness of some universal design features recommended by experts consulted is not being realized by residents and caregivers. The presence of variable

work height centers and clear knee spaces under kitchen sinks and bath lavatories in some of the ECHO houses (where those features exist) was not being acknowledged by some residents and caregivers. This is a considerable miscalculation on the part of designers. Much time, energy, and money are appropriated for the purpose of providing the most-needed features for the aging population. If the purpose of the features is not clear or, is not desired by the end users, the entire process has essentially been an exercise in futility. The effectiveness of the universal design features is a foundational issue in the ECHO demonstration housing program.

Measurement of the effectiveness of a universal design feature is compromised when users are either not aware that the feature is available to them, or when they misinterpret the purpose of the feature and use it in some unintended way.

Effectiveness of innovations such as universal design features plays a part in Baltes' theory of selective optimization with compensation. A basic premise of the concept is the availability of new options. This research has drawn attention to the possibility that provision of the universal design feature may be stopping short of the goal. Some innovations may be so novel as to make them unapproachable to the end user without introduction.

Residents and caregivers reported that some features recommended by experts, but not included in ECHO house design, are highly desirable. These features are full-extension base cabinet shelving and shower seats. They also reported that there are some universal design features currently being recommended by housing and aging experts, about which residents and/or caregivers appear to be ambivalent or resistant. These items are side-by-side refrigerators and dishwashers. The recommendation is that the dishwashers be elevated 6" above the finished floor. The height of the dishwasher installation was irrelevant in this study because residents are resistant to the idea of dishwashers at any level. This attitude is surprising considering the prevalence of health conditions sometimes experienced in late life. Blood-pressure symptoms impact circulation. Spine, leg, and feet problems are frequently experienced by older people in connection with high or low blood-pressure. It follows that they would benefit from a dishwasher that negated the necessity of standing at a kitchen sink. The size of the dishwasher may impact the preferences reported by some residents and caregivers. The appliance industry provides a wide range of options for the consumer market. Small capacity dishwashers are available in a variety of configurations. History could also be a factor. It is likely that the current elderly population grew up without a dishwasher in their homes. Resistance to the idea

of having a dishwasher in their home could be a cultural issue for them. But future generations will likely have never lived in a home without a dishwasher and this recommendation may still be suitable for a younger age cohort.

### **Health and Dependency**

The residents' total health mean scores from residents and caregivers was low (2.95 and 3.41 respectively). The indication was that residents perceived themselves slightly below average health, and caregivers considered the residents to be comfortably into the average health category. The overall residents' dependency mean scores from residents and caregivers were 8.86, and 9.77, respectively. This result places the average resident more than one full standard of deviation above the lowest dependency score possible (7), and indicates that the residents of the ECHO program are high functioning, and relatively independent in their successful performance of selected ADLs and IADLs. The residents who lived in houses built with floor plan A experienced the least dependency (Resident mean = 8.60, Caregiver mean = 10.5), and the best health (Resident mean = 2.75, Caregiver mean = 2.5) of all the residents investigated. These data could be interpreted to imply that there appears to be a health and dependency advantage related to living in a house built with floor plan A. Because it is unlikely that the floor plan is in any way causal, the more likely probability is that factors not investigated in this research are influential in the relationship between health, dependency, and the residents of plan A houses. Some of those factors could be related to the sponsors' choices of applicants' for the ECHO program, the length of time they have resided in the ECHO house, the availability of medical care, and attentiveness of host family to resident deeds. The geographical location may be influential as well.

### **Relationships Between Variable**

The research suggests that some of the highest correlation coefficients, although not statistically significant, are associated with inverse relationships between variables. According to current expert recommendations, it would be surprising to learn that the presence or effectiveness of universal design features is either negatively or not at all related to dependence; that age is not related to dependence or perceptions of effectiveness of universal design features; and that age and dependence are either negatively or not at all related to health. These conclusions would suggest that many long-standing research findings being currently recommended are not helpful to the aging populations, and that some may be detrimental. It is



more likely that there are extraneous variables beyond the scope of this research that have produced this anomaly. Some of these variables could include awareness and appropriate use of the universal design feature. Interview responses, photographs, and interviewer observations indicated that residents could have been unaware of features and/or not maximizing their potential. Figures 32 and 39 present examples of how open spaces under some sinks are being used for storage in both the bathroom and the kitchen. This use compromises the maximum potential of these features to provide seating in task areas. This is also the case for the adjustable or variable work center heights universal design feature. The majority of people who had this feature in their ECHO kitchen did not acknowledge it. If awareness is low, effectiveness will be similarly impacted. Specific dependency issues could also be considered as viable variables. Symptoms exhibited by illnesses such as arthritis, Parkinson's disease, late-stage heart disease, and Alzheimer's disease can affect performance of ADLs and IADLs in a variety of ways. The ability of a particular universal design feature to address these differences is likely to influence the effectiveness of the feature.

Falletti's human factors model of person-environment transaction provides an appropriate approach for this sort of anomaly. While this research attempted to examine resident abilities by using ADL and IADL variables, more specific information may be needed. Breaking down the confounding factors to tasks, and analyzing the human factors that are required to accomplish the task have potential for providing answers to what is behind the residents' attraction to one universal feature and aversion to another. A dissection of pertinent tasks, according to Falletti's model, provides the focus that is sometimes required to reveal details that are not available from a more general approach. The detailed analysis of components of a task provides impetus for creating strategies that can ameliorate the original problem. For instance, resident and caregiver data on dishwashers is conflicting. A breakdown of the tasks involved in using a dishwasher has potential for revealing what it is about dishwashers that cause them to be attractive to one person and resisted by another. The factors that might be relevant are whether the attitude is an informed one, a personal one with grounding in physical issues, a fear of technology, or something known only to the individual who is being interviewed. Once this information is revealed, it is possible to address the issue efficiently and from the point where the problem emanates. Falletti's model is a time intensive proposition, but one with good potential for answering questions that may not be available with alternative approaches.

According to current expert recommendations, it is neither expensive nor labor-intensive to provide most frail, elderly people with the features identified on the 20-item critical universal design features list. Five of the 13 kitchen features identified (32" door clearance, clear knee space under sink, outlets located between 18" and 22" above the finished floor, wall switches mounted between 15" and 48" above the finished floor, and adjustable or variable work center heights ranging between 28" and 45" above the finished floor) require skilled labor to accomplish. The remainder of the kitchen universal design features (single-lever controls at all doors, single-lever water controls at all faucets, front-mounted controls on appliances, rocker light switches, dishwasher elevated 6" above the finished floor, non-slip flooring, minimum circulation clearance of 40", and side-by-side refrigerator) do not require skilled labor so much as they require purchasing power. The materials are available at home improvement centers at a reasonable cost, and unskilled labor can accomplish most of the tasks involved in acquiring the features. The preference of an overwhelming majority of elderly people is to age in place. It is good news, to the large portion of the elderly population and their families that a safe and comfortable environment in the home that they prefer to age in is within the reach of many of them. This is a home that encourages activity and engagement in life, including life-sustaining activities. The information provided by this research is also inspiring to those who choose to build a new home. It is important in undertaking the construction of a home intended to support the late-life aging process to know that the information needed to confirm that they are building a home that will support them as they age is available and supported by research.

### **Implications**

#### **Policy Implications and Recommendations**

HUD and Section 202 policy governs the ECHO demonstration program. The control on the design of the ECHO houses was defined by Section 202 and UFAS. These guidelines dictate the majority of design decisions that have been implemented in current ECHO house designs. It is the same policy that guides the construction of all Section 202 housing. The findings revealed in this study indicate that a review of this aspect of ECHO policy may be appropriate. The ECHO concept is unique and would benefit from a policy development that originates from that position. The challenge is to address pertinent issues through a lens that reflects the unique nature of the ECHO concept, its potential as well as its complexity.

1. A review of UFAS recommendations may be in order. Findings from this research suggest that some UFAS recommendations may not be meeting the needs of ECHO program participants. The recommendation for including tub/shower seats has not been implemented, and the side-by-side refrigerators, full-extension base cabinet shelves, and dishwashers appear to be unimportant to most residents and caregivers. Policy that provides and guides future research in the effectiveness of ECHO houses and the guidelines that govern their construction appears to be appropriate.
2. A review of established policy for related programs could also be beneficial to the ECHO program. A comparison of aspects of the ECHO program to the policy of other programs such as visitability, assistive housing, and assisted living could prompt pertinent connections. It could encourage investigation of the successes, and the paths taken to achieve them, as well as examination of disappointments and barriers to the success of various programs.
3. Caregivers and residents commented favorably on the majority of ECHO house design features. The comment heard most often during both phases of the research was how “grateful” caregivers were to have the option of housing their loved one in a safe and convenient location. “Peace of mind” was the benefit expressed most frequently from residents and caregivers. Policy design that emphasized the aspects of the ECHO program that benefits residents and caregivers the most would be appropriate. Perhaps specifications that include health alert systems or communication technology would enhance the existing level of “peace of mind”.
4. One of the issues involved in policy that was tested in this research is the relationship between age and dependency. Although advanced age does bring with it a higher risk of loss of independence, the idea that dependence is an accepted consequence of aging is a myth. It is possible to be young, and in poor health, just as it is possible to be old and independent. One of the caregivers interviewed was a double amputee. He was the caregiver for his 77-year-old mother. He made a comment about housing in reference to his physical challenges. He said that although he and his mother were very grateful for the ECHO house she occupies, he also would benefit from a home that was constructed with consideration for his physical condition. He wished the government would provide him with a home that addressed his needs as well as the ECHO house addressed his

mother's needs. This comment, and the frequent mistake of assuming that advanced age means decline in independence, suggests that the age and dependency issues could be revisited with regard to the assumption that they move in a linear progression. This revisiting might involve investigating the need for houses for older adults that encourage a safe level of activity and challenge for the active, mature adult who would benefit from a defined level of physical and mental activity.

5. Some responses indicate a lack of resident and caregiver awareness of some universal design features that are known to be present in some of the ECHO houses. This result is confirmed by findings from Phase I of this research (Koebel et al., 2003) as well as a conversation between the researcher and a HUD ECHO specialist (Tolliver, personal communication, September 6, 2003). There is evidence that training on maximum utilization of universal design features could improve effectiveness for caregivers and residents. A policy that includes resident and caregiver training is recommended.
6. The absence of hosts and the assistance they provide is a matter of concern. Training for families that are chosen for the ECHO program has potential to reduce the serious family problems that can result in a resident being without a caregiver. Families that are trained in the management of caring for an elderly person in the ECHO house also has potential for reducing the frequency of relocations of units, and thereby supporting the structural integrity of the ECHO unit. The recommendation is for initial training, as well as the availability of support throughout the residents' occupancy of the ECHO unit.
7. Phase I data indicated that the capacity of home-related services to support community-dwelling elderly people was not being utilized by the majority of residents and caregivers. Training that provides information for residents and caregivers on the availability of home-based services such as home-health, cleaning services, meal delivery, basic companionship, and other life-sustaining services is also recommended.
8. The ECHO concept is not static. The dynamics of the program will change periodically with changing assistive technology, economics, and population demographics. Policy that includes periodic post-occupancy evaluations is recommended to remain cognizant of industry advances and user needs. Questions that test the effectiveness of universal design features can direct designers in their attempt to address the most problematic issues in the most efficient way. Questions that test existing construction requirements

can confirm or contest the appropriateness of UFAS as the appropriate guide for addressing ECHO housing occupant and caregiver needs. Periodic review of the survey instrument also serves the need to address timely issues such as advances in technology for the home, medical treatment, and home health services. Survey instrument adjustments can provide information regarding level of awareness of recent advances in products and services, as well as the degree to which they are being utilized by residents and caregivers, and why. A re-evaluation of the interview technique that addresses intimidation and provides an acceptable level of comfort and security for the researcher, sponsor, host, and resident is indicated. Refinement of the survey instrument is recommended to perfect wording of questions that are not easily understood by any and all of the parties involved. This procedure will enhance preservation of the integrity of the program.

### **Design Implications and Recommendations**

Although residents and caregivers spoke admirably of the ECHO houses, some design issues would benefit from review. Some design features are unique to the ECHO concept, and would benefit from being addressed as such. Design, just as policy, would benefit from acknowledging and addressing the ECHO program as the unique concept it is. The following are design implications and recommendations based on the findings of this study. Because ECHO is an affordable housing concept, the cost of each of the following recommendations is understood to be an important consideration. It should be noted that although findings are based on research, the strength of the statistical significance is weak, and implications and recommendations should be considered with this condition in mind.

1. The absence of tub/shower seats in ECHO houses is confounding and problematic. Tub/shower seats are required by UFAS in tubs and showers with a minimum interior space of 34" X 34". Bathtubs and showers in house plans B and C fall into this category. UFAS guides the construction mandates of ECHO houses. Research regarding how the existing houses were accepted by sponsors without having tub/shower seats, how to retrofit existing ECHO units, and how to enforce their inclusion in future construction is important. Integrated tub/shower-seats are recommended for all bathrooms. The importance of this feature to residents and caregivers is apparent from the data. Fifteen of the twenty-two residents interviewed

- had obtained a tub/shower seat. It is important to safety, comfort, and convenience in self-maintenance.
2. Although the features were not acknowledged to be present in the majority of homes where it was an integral part of the cabinetry design, the recommendation is that variable work center heights and clear knee space at the sink be made more visually prominent in kitchen design. This practice could facilitate resident and caregiver awareness and maximum potential benefit of these universal design features.
  3. The residents' and caregivers' responses suggest that they find most of the critical universal design features in their ECHO houses to be effective in meeting their needs. Periodic monitoring of resident and caregiver needs is recommended to affirm that the researchers' perceptions are in sync with user experience with universal design features. Space planning, with particular attention to: reasonable and probable furnishings that will be brought into the ECHO house from the resident's previous home, likely medical equipment, and storage needs of the typical resident. The monitoring could also determine why end-users preferences are in conflict with those of experts and what universal design features might be made available as an option, etc.
  4. Several residents and caregivers mentioned a hand-held water source that is controlled from the hand-held unit. It enhances safety, comfort, and efficiency during the bathing process. This tub/shower accessory is recommended to be part of tub/shower specifications.

### **Recommended Future Research**

Future research in policy and design is needed for the growth of the ECHO concept. Recommended research is guided by the findings in this research.

### **Policy Research**

The ECHO program, the universal design concept, and the general aging population will benefit from research that investigates strategies for housing frail, elderly people in environments that provide safety, convenience, and comfort. The ECHO program is positioned for recommendations and revisions. Policy that supports the advancement of the ECHO program has potential to positively impact the aging experience of millions of Americans.

1. Longitudinal research that follows the experience of residents and caregivers in their ECHO houses could inform housing professionals in efficiently addressing their needs.
2. Policy that makes it easier to place ECHO houses in community settings has potential for familiarizing the general public with the advantages of the universal concept. Although the design of the ECHO house targets the elderly population, younger generations will be exposed to universal design features through visitation and observation. This exposure has potential for de-mystifying, and experiencing first hand the positive impact universal design and ECHO housing can make on the lives of older adults as well as the general population.
3. Policy research pertaining to variations in caregiver-relationship will benefit HUD, sponsors, and residents. Research that determines the absence of daughters-in-law as caregivers in this research is recommended to clarify this anomaly. Is responsibility for caregiving impacted when mothers of sons are conveniently housed? What are other mitigating factors that have influenced the relatively large number of male caregivers in this research? Is the data realistic? How is “caregiver” defined by the men interviewed, and who performs these tasks?
4. Consultation with home-health professionals to determine what their home-related needs are in the performance of their duties is recommended. Appropriate space and infrastructure for the medical requirements that are needed by the occupants of ECHO houses is an important space-planning consideration.

### **Design Research**

1. Design research that focuses on the day-to-day functional needs of frail, elderly people is needed. Building products that support diminishing physical and cognitive capacity can make ECHO houses comforting and productive environments for the aging occupant.
2. Research that addresses the reason older people do not want dishwashers would be helpful. Circulation and stamina problems are common for older people. Appliances that have potential to impact the need to stand in one place for extended periods of time should be investigated.

3. It would be beneficial for future design research to narrow the focus and obtain more detailed information on fewer variables. This research could have produced more definitive information had it been limited to an exhaustive examination of the effectiveness of fewer universal design features, fewer dependency tasks, and a closer look at the health of resident participants.
4. This research has indicated no relationship between general health and dependency, contrary to expert understanding. Additional research is recommended targeted at resolving this counter-intuitive finding. A more detailed health and dependency history could yield information germane to this issue.
5. In this study, cleaning is positively related to the effectiveness of a 32” door clearance by residents and caregivers. Additional research is recommended to determine what specific tasks associated with cleaning intersect with a 32” door clearance. Door clearance could be a factor that relates to other ECHO house mobility issues, such as clear access minimums and clearance minimums in task areas. Targeted research that explores a positive relationship has potential to resolve issues that are not initially apparent to researchers.
6. The negative relationships between kitchen-and-bath-related universal design features and kitchen-and-bath-related ADLs and IADLs are perplexing. Recommendations to solve this mystery include more extensive information gathering regarding the performance of specific ADL and IADL routines. Breaking them down into component tasks and approaching them from the Falletti theory model is recommended. Detailed questions regarding problematic issues with self maintenance may enhance the body of knowledge that allows designers to more efficiently solve problems.
7. Further scientific research regarding what features residents and prospective residents would find helpful, and why, is recommended. Such research will provide authentic, point-of-use information to direct designers in addressing the needs of the occupants effectively.
8. Consultation with home-health professionals to determine what their home-related needs are in the performance of their duties is recommended. Appropriate space



and infrastructure for the medical requirements that are needed by the occupants of ECHO houses is an important space planning consideration.

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## Appendix A

### Referenced Standards for Universal Design Features

#### Kitchens

##### Single-lever controls at all doors

ANSI A117.1, item 404.2.7 – Door Hardware. Handles, pulls, latches, locks, and other operable parts on accessible doors shall have a shape that is easy to grasp with one hand and does not require tight grasping, pinching or twisting of the wrist to operate. Such hardware shall be 34 inches (865mm) minimum and 48 inches (1220mm) maximum above the floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides.

##### Single-lever water controls at all faucets

ANSI 309.4 Operation. Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds (22.2N) maximum.

##### 32” door clearance

ANSI A117.1, item 404.2.3 – Clear Width. Doorways shall have a clear opening of 32 inches (815 mm) minimum. Clear opening of doorways with swinging doors shall minimum. There shall be no projections into the clear opening width lower than 34 inches (865 mm) above the floor or ground. Projections into the minimum clear opening width more than 34 inches (865mm) and up to 80 inches (220mm) above the floor or ground are permitted but shall not exceed 4 inches (102mm).

##### Clear knee space under sink

###### ANSI A117.1, items 306.1, 2, & 3

306.1 General. Space under an element between 9 inches (230 mm) and 27 inches (685 mm) above the floor or ground shall be knee clearance and shall comply with Section 306.3.

306.2 Maximum Depth. Knee clearance shall be permitted to extend 25 inches (635 mm) maximum under an element at 9 inches (230 mm) above the floor or ground.

306.3 Minimum Depth. Where knee clearance is required beneath an element as part of a clear floor or ground space, the knee clearance shall be 11 inches (280 mm) deep minimum at 9 inches (205 mm) deep minimum at 27 inches (685 mm) above the floor or ground. be measured between the face of door and stop, with the door open 90 degrees. Openings more than 24 inches (610mm) deep shall provide a clear opening of 36 inches (915 mm)

##### Front-mounted controls on appliances

ANSI A117.1, item 404.3.5 Control Switches. Control switches shall comply with Section 309.

ANSI A117.1, item 309.3 Height. Operable parts shall be placed within one or more of the reach ranges specified in Section 308

###### ANSI A117.1, item 308.1, 2, & 3 Reach Ranges

###### ANSI A117.1, item 308.2 Forward Reach.

308.2.1 Unobstructed. Where a forward reach is unobstructed, the high forward reach shall be 48 inches (1220 mm) maximum and the low forward reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.2.2 Obstructed High Reach. Where a forward reach is over an obstruction, the clear floor or ground space shall extend beneath the element for a distance not less than the required reach depth over the obstruction. The high forward reach shall be 48 inches (1220 mm) maximum where the reach depth is 20 inches (510 mm) maximum. Where the reach depth exceeds 20 inches (510 mm), the high forward reach shall be 44 inches (1120 mm) maximum and the reach depth shall be 25 inches (635 mm) maximum.

ANSI A117.1, item 308.3 Side Reach

308.3.1 Unobstructed. Where the clear floor or ground space allows a parallel approach to an element and the side reach is unobstructed, the high side reach shall be 48 inches (1220 mm) maximum and the low side reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.3.2 Obstructed High Reach. Where a clear floor or ground space allows a parallel approach to an object and the high side reach is over an obstruction, the height of the obstruction shall be 34 inches (865 mm) maximum and the depth of the obstruction shall be 24 inches (610 mm) maximum. The high side reach shall be 48 inches (1220 mm) maximum for a reach depth of 10 inches (255 mm) maximum. Where the reach depth exceeds 10 inches (255 mm), the high side reach shall be 46 inches (1170 mm) maximum for a reach depth of 24 inches (610 mm) maximum.

**Outlets located between 18” and 22” above the finished floor**

ANSI A117.1, item 309.3 Height. Operable parts shall be placed within one or more of the reach ranges specified in Section 308

ANSI A117.1, item 308.1, 2, & 3 Reach Ranges

ANSI A117.1, item 308.2 Forward Reach.

308.2.1 Unobstructed. Where a forward reach is unobstructed, the high forward reach shall be 48 inches (1220 mm) maximum and the low forward reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.2.2 Obstructed High Reach. Where a forward reach is over an obstruction, the clear floor or ground space shall extend beneath the element for a distance not less than the required reach depth over the obstruction. The high forward reach shall be 48 inches (1220 mm) maximum where the reach depth is 20 inches (510 mm) maximum. Where the reach depth exceeds 20 inches (510 mm), the high forward reach shall be 44 inches (1120 mm) maximum and the reach depth shall be 25 inches (635 mm) maximum.

ANSI A117.1, item 308.3 Side Reach

308.3.1 Unobstructed. Where the clear floor or ground space allows a parallel approach to an element and the side reach is unobstructed, the high side reach shall be 48 inches (1220 mm) maximum and the low side reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.3.2 Obstructed High Reach. Where a clear floor or ground space allows a parallel approach to an object and the high side reach is over an obstruction, the height of the obstruction shall be 34 inches (865 mm) maximum and the depth of the obstruction shall be 24 inches (610 mm) maximum. The high side reach shall be 48 inches (1220 mm) maximum for a reach depth of 10 inches (255 mm)

maximum. Where the reach depth exceeds 10 inches (255 mm), the high side reach shall be 46 inches (1170 mm) maximum for a reach depth of 24 inches (610 mm) maximum.

**Wall switches mounted between 42” and 48” above the finished floor**

ANSI A117.1, item 309.3 Height. Operable parts shall be placed within one or more of the reach ranges specified in Section 308

ANSI A117.1, item 308.1, 2, & 3 Reach Ranges

ANSI A117.1, item 308.2 Forward Reach.

308.2.1 Unobstructed. Where a forward reach is unobstructed, the high forward reach shall be 48 inches (1220 mm) maximum and the low forward reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.2.2 Obstructed High Reach. Where a forward reach is over an obstruction, the clear floor or ground space shall extend beneath the element for a distance not less than the required reach depth over the obstruction. The high forward reach shall be 48 inches (1220 mm) maximum where the reach depth is 20 inches (510 mm) maximum. Where the reach depth exceeds 20 inches (510 mm), the high forward reach shall be 44 inches (1120 mm) maximum and the reach depth shall be 25 inches (635 mm) maximum.

ANSI A117.1, item 308.3 Side Reach

308.3.1 Unobstructed. Where the clear floor or ground space allows a parallel approach to an element and the side reach is unobstructed, the high side reach shall be 48 inches (1220 mm) maximum and the low side reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.3.2 Obstructed High Reach. Where a clear floor or ground space allows a parallel approach to an object and the high side reach is over an obstruction, the height of the obstruction shall be 34 inches (865 mm) maximum and the depth of the obstruction shall be 24 inches (610 mm) maximum. The high side reach shall be 48 inches (1220 mm) maximum for a reach depth of 10 inches (255 mm) maximum. Where the reach depth exceeds 10 inches (255 mm), the high side reach shall be 46 inches (1170 mm) maximum for a reach depth of 24 inches (610 mm) maximum.

**Adjustable or variable work center heights ranging between 28” and 45” high**

ANSI 117.1 item 1002.12.3.2 Work Surface Height. The work Surface shall be 34 inches (865 mm) maximum above the floor or ground.

Exception: A counter that is adjustable to provide a work surface at variable heights 29 inches (735 mm) minimum and 36 inches (915 mm) maximum

UFAS 4.34.6.4 Work Surfaces. At least one 30 in (760 mm) section of counter shall provide a work surface that complies with the following requirements

- (1) The counter shall be mounted at a maximum height of 34 in (865 mm) above the floor, measured from the floor to the top of the counter surface, or shall be adjustable or replaceable as a unit to provide alternative heights of 28in, 32 in, and 36 in (710 mm, 815 mm, and 915 mm), measured from the top of the counter to the wall.
- (2) Base cabinets, if provided, shall be removable under the full 30 in (760 mm) minimum frontage of the counter. The finished floor shall extend under the counter to the wall.
- (3) Counter thickness and supporting structure shall be 2 in (50 mm) maximum over the required clear area

- (4) A clear floor space 30 in by 48 in (760 mm by 1220 mm) shall allow a forward approach to the counter. Nineteen inches (485 mm) maximum of the clear floor space may extend underneath the counter. The knee space shall have a minimum clear width of 30 in (760 mm) and a minimum clear depth of 19 in (485 mm).
- (5) There shall be no sharp or abrasive surfaces under such counters.

**Rocker switchplates**

ANSI A117.1, item 309.3 Height. Operable parts shall be placed within one or more of the reach ranges specified in Section 308

ANSI A117.1, item 308.1, 2, & 3 Reach Ranges

ANSI A117.1, item 308.2 Forward Reach.

308.2.1 Unobstructed. Where a forward reach is unobstructed, the high forward reach shall be 48 inches (1220 mm) maximum and the low forward reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.2.2 Obstructed High Reach. Where a forward reach is over an obstruction, the clear floor or ground space shall extend beneath the element for a distance not less than the required reach depth over the obstruction. The high forward reach shall be 48 inches (1220 mm) maximum where the reach depth is 20 inches (510 mm) maximum. Where the reach depth exceeds 20 inches (510 mm), the high forward reach shall be 44 inches (1120 mm) maximum and the reach depth shall be 25 inches (635 mm) maximum.

ANSI A117.1, item 308.3 Side Reach

308.3.1 Unobstructed. Where the clear floor or ground space allows a parallel approach to an element and the side reach is unobstructed, the high side reach shall be 48 inches (1220 mm) maximum and the low side reach shall be 15 inches (380 mm) minimum above the floor or ground.

308.3.2 Obstructed High Reach. Where a clear floor or ground space allows a parallel approach to an object and the high side reach is over an obstruction, the height of the obstruction shall be 34 inches (865 mm) maximum and the depth of the obstruction shall be 24 inches (610 mm) maximum. The high side reach shall be 48 inches (1220 mm) maximum for a reach depth of 10 inches (255 mm) maximum. Where the reach depth exceeds 10 inches (255 mm), the high side reach shall be 46 inches (1170 mm) maximum for a reach depth of 24 inches (610 mm) maximum.

**Dishwasher elevated 6" above the finished floor**

No information found

**Non-slip flooring**

ANSI A117.1, item 302.1 Floor or Ground Surfaces. General. Floor or ground surfaces shall be stable, firm, and slip resistant

Minimum circulation clearance of 40"

ANSI 117.1 1002.12.1.1 Clearance. Clearance between all opposing base cabinets, counter tops, appliances or walls within kitchen work areas shall be 40 inches (1015 mm) minimum.

**Side by side refrigerator**

ANSI 1002.12.6.6. Refrigerator/Freezer. Combination refrigerator and freezer shall have at least 50% of the freezer space 54 inches (137 mm) maximum above the floor or ground. The clear floor or ground space shall be positioned for a parallel approach to the space dedicated to

the refrigerator/freezer with the centerline of the clear floor or ground space offset 24 inches (610 mm) maximum from the centerline of the dedicated space.

UFAS 4.34.6.8 Refrigerator/Freezers. Side-by-side refrigerator/freezers provide the most usable freezer compartments. Locating refrigerators so that their doors can swing back 180 degrees is more convenient for wheelchair users.

## **Bathroom**

### **Single-lever water controls at all plumbing fixtures and faucets**

ANSI 309.4 Operation. Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds (22.2N) maximum.

### **Single-lever controls at all doors**

ANSI A117.1, item 404.2.7 – Door Hardware. Handles, pulls, latches, locks, and other operable parts on accessible doors shall have a shape that is easy to grasp with one hand and does not require tight grasping, pinching or twisting of the wrist to operate. Such hardware shall be 34 inches (865mm) minimum and 48 inches (1220mm) maximum above the floor or ground. Where sliding doors are in the fully open position, operating hardware shall be exposed and usable from both sides.

### **Board blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars**

ANSI A117.1, item 609.8 Grab Bar Structural Strength. Allowable stresses in bending, shear, and tension shall not be exceeded for materials used where a vertical or horizontal force of 250 lb (1112N) is applied at any point on the grab bar, fastener mounting device, or supporting structure.

### **Shower seat**

ANSI A117.1, item 610.3 Shower Compartment Seats. Where a seat is provided in a roll-in shower compartment, it shall be a folding type and shall be on the wall adjacent to the controls. Seats shall be L-shaped or rectangular. The top of the seat shall be 17 inches (430 mm) minimum and 19 inches (485 mm) maximum above the bathroom floor. In a transfer-type shower, the seat shall extend from the back wall to a point within 3 inches (75 mm) of the compartment entry. In a roll-in type shower, the seat shall extend from the control wall to a point within 3 inches (75 mm) of the minimum required seat wall width.

### **Mix valve with pressure balancing and hot water limiter**

BOCA R3, 11 & 2

### **Toilet bowl height between 17” and 19” high.**

ANSI A117.1, item 604.4 Water Closets and Toilet Compartments. Height. The top of water closet seats shall be 17 inches (430 mm) minimum and 19 inches (485 mm) maximum above the floor or ground. Seats shall not return automatically to a lifted position.

**Appendix B**  
**Resident Interview Guide**

Resident: \_\_\_\_\_

Caregiver: \_\_\_\_\_

Relationship of Resident to Caregiver: \_\_\_\_\_

Thank you for agreeing to participate in this interview. I will be asking you several questions about your experience living in an ECHO unit.

1. Tell me about \_\_\_\_\_ (the person living in the ECHO housing host house.

Probes:

Relation

Quality of interpersonal relationship

\*2. Tell me about your health?

Probe:

Chronic illness

Mobility

Mental/Cognitive ability

\*3. What activities do you participate in?

Probe:

Drive

Housework

Prepare food

Bathe yourself

4. Tell me how you learned about the ECHO program.

Probe:

How first involved

Interaction with sponsor/others

Qualifications for host

Qualifications for resident

5a. What about repairs? Has there been a need for any repairs on the ECHO unit?.

5b. What were they?

Probe:

Sponsor responsibilities

Host responsibilities

Inspections

5c. How have the repairs been taken care of?

6. Based on your experience, how long do you expect the unit to last?



\*7a Are there any features of the ECHO unit that have made it easier or more difficult for you to function independently?

Probe:

Room layout

Kitchen

Bathroom

Lighting

Materials

Location on site

\*7b. Can you think of ways the existing features could be improved or any features that could be added??

8. Tell me about your connection and communication with \_\_\_\_\_ (sponsor).

Probe:

During initial process

Since you occupied the unit

\*9a. Have you had contact with any of the following agencies since you were involved in the ECHO program? What did they do?

	Yes	No	Role
HUD	___	___	_____
Social Services	___	___	_____
Contractors	___	___	_____
Others?	___	___	_____

\*9b. How did you work with them.

Now I'd like to talk about your experience with the ECHO unit and Program

\*10. Was the ECHO unit what you expected it to be?

\*11. How satisfied have you been with the ECHO program?

\*12a. What impact do you think living in the ECHO unit has had on your quality of life?

\*12.b For the host/caregiver?

\*13. Would you recommend this program to improve the experience of future participants, and in the ECHO program itself?

\*14. What do you think could be done to improve the ECHO program and process?

15. Is there anything else you would like to tell me about the ECHO unit or program that I have not asked you about?

**Appendix C**  
**Host/Caregiver Interview Guide**

Caregiver: \_\_\_\_\_

Resident: \_\_\_\_\_

Age: \_\_\_\_\_

Relationship between resident and caregiver: \_\_\_\_\_

Thank you for agreeing to participate in this interview. I will be asking you several questions about your experience in hosting an ECHO unit.

\*1. Tell me about \_\_\_\_\_ (the person living in the ECHO housing unit located on their property).

\*Probes:

Typical day

Physical abilities

Mental/cognitive ability/alertness

Caregiving activities/responsibilities

Length of caregiving to date

Quality of interpersonal relationship/Get along well?

2. Tell me how you learned about the ECHO program.

Probe:

How first involved

Interaction with sponsor/others

Qualifications for host

Qualifications for resident

2b. Were there any problems with placing the ECHO unit on your land?

Probe:

Who involved

Problems with water sewer

Problems with the terrain

3a. What about repairs? Has there been a need for any repairs on the ECHO unit?

Probe:

What were they?

3b. How have the repairs been taken care of?

Probe:

Sponsor responsibilities

Host responsibilities

Inspections

4. Based on your experience, how long do you expect the ECHO unit will last?

\*5a. Are there any features of the ECHO unit that have made it easier or more difficult for \_\_\_\_\_ to function independently?

Are there any features of the ECHO unit that have made your job as caregiver easier or more difficult?

\*Probe:

Room layout

Kitchen

- Bathroom
- Lighting
- Materials
- Location on site

\*5b. Can you think of ways the existing features could be improved or any features that could be added?

6. Tell me about your connection and communication with \_\_\_\_\_ (sponsor).

Probe:

During initial process

Since the unit has been occupied

\*7a. Have you had contact with any of the following agencies since as you were involved in the ECHO program? What did they do?

	Yes	No	Role
HUD	___	___	_____
Social Services	___	___	_____
Contractors	___	___	_____
Others?	___	___	_____

7b. How did you worked with them.

Now I'd like to talk about your experience with the ECHO unit and Program

8. Was the ECHO unit what you expected it to be?

9. What do you expect to happen when the unit is no longer needed by \_\_\_\_\_(resident).

10. How satisfied have you been with the ECHO program?

\*11a. What impact do you think living in the ECHO unit has had on the quality of life for \_\_\_\_\_(the resident)?

\*11.b For you?

\*12. Would you recommend this program to others looking for a way to care for and support an older relative or other person?

\*13. What do you think could be done to improve the experience of future participants, and in the ECHO program itself?

\*14. Is there anything else you would like to tell me about the ECHO unit or program that I have not asked you about?

**Appendix D  
ECHO Record**

Date \_\_\_\_\_  
 Resident \_\_\_\_\_ Age \_\_\_\_\_ Caregiver \_\_\_\_\_  
 Phone # \_\_\_\_\_ Phone # \_\_\_\_\_

Part 1

Checklist of Universal Design Features

Present/ Not present	Source of Data PDQ	Score	Floor Plan
			<b>Kitchens</b>
			• 32" door clearance
			Adaptations by residents
			Recommendations
			Would this be helpful?
			• Single-lever controls at all doors
			Adaptations by residents
			Recommendations
			Would this be helpful?
			• Single-lever water controls at all faucets
			Adaptations by residents
			Recommendations

UNIVERSAL DESIGN AND ECHO HOUSING

				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Clear knee space under sink</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Adjustable or variable work center heights ranging between 28” and 45” high</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Rocker light switches</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Outlets located between 18” and 22” above the finished floor</li> </ul>

UNIVERSAL DESIGN AND ECHO HOUSING

				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Wall switches mounted between 42” and 48” above the finished floor</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Dishwasher elevated 6” above the finished floor</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Front-mounted controls on appliances</li> </ul>
				Adaptations by residents
				Recommendations

UNIVERSAL DESIGN AND ECHO HOUSING

				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Non-slip flooring</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Minimum circulation clearance of 40"</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Full extension, pull-out shelves in base cabinets</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Side by side refrigerator</li> </ul>

UNIVERSAL DESIGN AND ECHO HOUSING

				Adaptations by residents
				Recommendations
				Would this be helpful?
				<b>Bathroom</b>
				<ul style="list-style-type: none"> <li>• Non-slip flooring</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• 32" door clearance</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Single-lever controls at all doors</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?



UNIVERSAL DESIGN AND ECHO HOUSING

				<ul style="list-style-type: none"> <li>• Board blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Single-lever water controls at all plumbing fixtures and faucets</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Mix valve with pressure balancing and hot water limiter</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?
				<ul style="list-style-type: none"> <li>• Shower seat</li> </ul>
				Adaptations by residents
				Recommendations

UNIVERSAL DESIGN AND ECHO HOUSING

				Would this be helpful?
				<ul style="list-style-type: none"> <li>Toilet bowl height between 17” and 19” high.</li> </ul>
				Adaptations by residents
				Recommendations
				Would this be helpful?

General Adaptations and Recommendations

				Item
				Adaptations by residents
				Recommendations
				Would this be helpful?

- Resident
- General comments
- Room layout
  - Kitchen
  - Bathroom
  - Lighting
  - Materials
- Location on site
- Caregiver
- General comments
- Room layout
  - Kitchen
  - Bathroom
  - Lighting
  - Materials
- Location on site

Hello,

*Thank you for agreeing to participant in this interview. I will be asking you several questions about your experience living in an ECHO house. If I fail to ask about an area that you want me*

*to know about, please feel free to comment. Also, if you have made any changes to the things I ask about or if you can make recommendations about these things, please do so.*

**Item** 32” door clearance

Resident

1. Do you know how wide the doors are in your kitchen?
  - Yes
  - No
  - NA/Doesn’t know or there are no doors
- If yes, is there a 32” clearance?
  - Yes
  - No
  - NA/Doesn’t know or there are no doors

Caregiver

2. Do you know how wide the doors are in the ECHO home?
  - Yes
  - No
  - NA/Doesn’t know or there are no doors
- If yes, is there a 32” opening?
  - Yes
  - No
  - NA/Doesn’t know or there are no doors

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the 32” door opening impacts your activity as you move in and out of the kitchen of your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• 32” door clearance in the kitchen					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• 32” door clearance in the kitchen					

**Item** Single-lever controls/or handles at all doors

Resident

3. Are there single-lever controls at some of the doors in your kitchen?
  - Yes
  - No

UNIVERSAL DESIGN AND ECHO HOUSING

Caregiver

- Are there single-lever controls/or handles at some of the doors in the ECHO house?
- Yes
- No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the single-lever door handles in your home/the ECHO house impact your being able to open and close doors throughout the space?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Single-lever door controls					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Single-lever door controls					

**Item** Single-level water controls at all the faucets

Resident

4. Do you have single-level water controls on the faucet in your kitchen?
- Yes
  - No

Caregiver

5. Do you have single-level water controls at all the faucets in the ECHO home?
- Yes
  - No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the single-levers at the faucets in the kitchen help you as you prepare food/beverages, clean, and use water in other ways in your kitchen/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Single-lever water controls at all the faucets in the kitchen					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Single-lever water controls at all the faucets in the kitchen					

**Item** Clear knee space under the sink

Resident

6. Do you have no cabinet under the sink in your home?

- Yes
- No

Caregiver

7. Do you have no cabinet under the sink in the ECHO home?

- Yes
- No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way having no cabinet under the sink in the kitchen of the ECHO house affects you in the use of the sink area?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Clear knee space under the kitchen sink					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Clear knee space under the kitchen sink					

**Item** Adjustable or variable work center heights ranging between 28” and 45” high

Resident

8. Are there any counter heights in the kitchen other than the standard 36” high?

- Yes
- No
- If Yes, is it
  - Higher
  - Lower

Caregiver

Are there any counter heights in the kitchen other than the standard 36” high?

- Yes
- No
- If Yes, is it
  - Higher
  - Lower

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the variable work center heights help you as you prepare food, clean, and perform various tasks in the kitchen your home/the ECHO house?

UNIVERSAL DESIGN AND ECHO HOUSING

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Adjustable or variable work center heights ranging between 28” and 45” high					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Adjustable or variable work center heights ranging between 28” and 45” high					

**Item** rocker light switches

Resident

9. “Rocker” light switches are broader and somewhat flatter/closer to the wall than the traditional type. Do you have “rocker” light switches in your house?

- Yes
- No

Caregiver

10. “Rocker” light switches are broader and somewhat flatter/closer to the wall than the traditional type. Do you have “rocker” light switches in your house?

- Yes
- No

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way rocker light switches affect the way you turn on and off the lights in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Rocker switchplates					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Rocker switchplates					

**Item** outlets located between 18” and 22” above the finished floor

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Resident

11. Are the electrical outlets in your home comfortable for you to reach?

- Yes
- No

➤ If no

12. Are the electrical outlets

- too high?
- too low?

Caregiver

13. Are the electrical outlets in the ECHO house comfortable for you to reach?

- Yes
- No

➤ If no

14. Are the electrical outlets

- too high?
- too low?

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the height of electrical outlets effect the way you plug and unplug items in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Outlets located between 18” and 22” above the finished floor					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Outlets located between 18” and 22” above the finished floor					

**Item** Wall light switches mounted between 42” and 48” above the finished floor

Resident

15. Are the wall light switches mounted at a comfortable height for you to operate?

- Yes
- No

➤ If no

16. Are they

- too high?
- too low?

Caregiver

17. Are the wall light switches mounted at a comfortable height for you to operate?

- Yes
- No

- If no
- 18. Are they
  - too high?
  - too low?

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the height of the wall switches effects the way you turn on and off lights in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>• Wall light switches mounted between 42” and 48” above the finished floor</li> </ul>					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>• Wall light switches mounted between 42” and 48” above the finished floor</li> </ul>					

Item dishwasher elevated 6” above the finished floor

Resident

19. Do you have a dishwasher?

- Yes
- No

➤ If yes

20. Is your dishwasher higher than the traditional countertop level?

- Yes
- No

▪ If yes

21. How high (above traditional countertop) does your dishwasher sit?

Caregiver

2. Is there a dishwasher in the ECHO house?

- Yes
- No

➤ If yes

22. Is the dishwasher higher than the traditional countertop level?

- Yes
- No



Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the raised height of the dishwasher affects your use of the dishwasher when you are loading and unloading the it in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Dishwasher elevated 6” above the finished floor					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Dishwasher elevated 6” above the finished floor					

**Item** Front-mounted controls on ranges

Resident

23. Does the range in your home have front-mounted controls?

- Yes
- No

Caregiver

24. Does the range in the ECHO home have front-mounted controls?

- Yes
- No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the front mounted controls affect your use of the appliances in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Front-mounted controls on the range					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Front-mounted controls on the range					

**Item** non-slip flooring

Resident

25. How would you describe the flooring material in your kitchen?

- Slippery
  - Not slippery
    - If slippery
26. Have you ever fallen
- Yes
  - No
    - If no
27. What have you done to keep from falling

Caregiver

28. How would you describe the flooring material in your kitchen?
- Slippery
  - Not slippery
    - If slippery
29. Have you ever fallen
- Yes
  - No
    - If no
30. What have you done to keep from falling

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the non-slip floors effect you as you move around in the kitchen your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Non-slip flooring					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Non-slip flooring					

**Item** Minimum circulation clearance of 40"

Resident

31. Is there a minimum of 40" of clear floor space without obstructions (cabinets, furniture, walls, etc) through the kitchen of your home?
- Yes

- No

Caregiver

- Is there a minimum of 40” of clear floor space without obstructions (cabinets, furniture, walls, etc) through the kitchen of the ECHO home?
- Yes
- No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how the 40” clear circulation path effects your ability to move about and perform tasks in the kitchen of your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Minimum circulation clearance of 40” in kitchen					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Minimum circulation clearance of 40” in kitchen					

**Item** Full-extension, pull-out shelves in base cabinets

Resident

32. Do the shelves in the base cabinets in your kitchen pull out?

- Yes
- No

33. Do the shelves pull-out enough so that you can what is on the back of the shelf?

- Yes
- No

Caregiver

34. Do the shelves in the base cabinets in the ECHO house kitchen pull out?

- Yes
- No

35. Do the shelves pull-out enough so that you can what is on the back of the shelf?

- Yes
- No

*On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how the way full-extension, pull-out shelves in base cabinets effects your ability to store and retrieve stored items in the kitchen of your home/the ECHO house?*

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Full-extension, pull-out shelves in base cabinets					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Full-extension, pull-out shelves in base cabinets					

**Item** Side by side refrigerator

Resident

36. Do you have a side by side refrigerator in your kitchen?

- Yes
- No

Caregiver

37. Do you have a side by side refrigerator in the ECHO house?

- Yes
- No

*On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how the side-by-side refrigerator effects your ability to use the refrigerator in the kitchen of your home/the ECHO house?*

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Side by side refrigerator					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
• Side by side refrigerator					

**Bathroom**

**Item** non-slip flooring

Resident

38. How would you describe the flooring material in your bathroom?

- Slippery
- Not slippery

- If not slippery go to Part 2 effectiveness evaluation
  - If slippery
39. Have you ever fallen
- Yes
  - No
- If no
40. What have you done to keep from falling
41. How would you describe the flooring material in your bathroom?
- Slippery
  - Not slippery
- If slippery
42. Have you ever fallen
- Yes
  - No
- If no
43. What have you done to keep from falling

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the non-slip floors effect you help you as you move around in the bathroom of your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Non-slip flooring					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Non-slip flooring					

**Item** 32” door clearance

Resident

44. Do you know how wide the doors are in the bathroom of your home?
- Yes
  - No
- If yes, is there a 32” clearance?
    - Yes
    - No
    - NA/ doesn’t know or no doors

Caregiver

45. Do you know how wide the doors are in the bathroom of the ECHO home?

- Yes
- No
  - If yes, is there a 32” clearance?
    - Yes
    - No
    - NA/ doesn’t know or no doors

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the 32” clearance impacts your activity as you move through the bathroom of your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• 32” door clearance in the bathroom					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• 32” door clearance in the bathroom					

**Item** Single-lever controls at the bathroom door.

Resident

46. Are there single-lever controls or handles at some of the doors in your bathroom?

- Yes
- No

Caregiver

- Are there single-lever controls or handles at some of the doors in the bathroom of the ECHO house?
  - Yes
  - No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the single-lever handles effect you as you open and close the door of the bathroom in your home/the ECHO house?

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Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Single-lever bathroom door controls					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Single-lever bathroom door controls					

**Item** Single-level water controls at all the bathroom faucets

Resident

- Do you have single-level water controls on the faucet in your bathroom?
- Yes
- No

Caregiver

47. Do you have single-level water controls on the faucet in the ECHO house?

- Yes
- No

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the way the single-lever faucets in the bathroom help you as you use the water there in your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Single-lever water controls at all the faucets in the bathroom					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Single-lever water controls at all the faucets in the bathroom					

**Item** Board blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars

Resident

48. Are there grab bars in your home around the toilet

- Yes
- No

➤ If yes

49. Are the grab bars around the toilet securely attached to the wall?

- Yes
- No

50. Are there grab bars in your home around the tub/shower?

- Yes
- No

➤ If yes

51. Are the grab bars around the tub/shower securely attached to the wall?

- Yes
- No

Caregiver

52. Are there grab bars in the ECHO house around the toilet

- Yes
- No

➤ If yes

53. Are the grab bars around the toilet securely attached to the wall?

- Yes
- No

54. Are there grab bars in the ECHO house around the tub/shower?

- Yes
- No

➤ If yes

55. Are the grab bars around the tub/shower securely attached to the wall?

- Yes
- No

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the secure attachment of grab bars (made possible by the reinforcement of walls in the bathrooms of your home) as helpful to you getting on and off the toilet?

<b>Resident</b>	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Board blocking in walls around the toilet for future placement and relocation of grab bars					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
• Board blocking in walls around the toilet for future placement and relocation of grab bars					



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On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe the secure attachment of grab bars (made possible by the reinforcement of walls in the bathrooms of your home) as helpful to you getting in and out of the tub/shower?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Board blocking in walls around the tub/ shower for future placement and relocation of grab bars</li> </ul>					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Board blocking in walls around the, tub/ shower for future placement and relocation of grab bars</li> </ul>					

**Item** mix valve with pressure balancing and hot water limiter

Resident

56. Does the hot water in your home ever burn/scald you?

- Yes
- No

Caregiver

57. Does the hot water in your home ever burn/scald the resident?

- Yes
- No

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how the consistency of pressure and temperature effects your use of the hot water in the bathroom of your home/the ECHO house?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Mix valve with pressure balancing and hot water limiter in shower</li> </ul>					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bathroom</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Mix valve with pressure balancing and hot water limiter in shower</li> </ul>					

**Item** - seat in shower

Resident

58. Is there a shower seat in your shower?

- Yes
- No

➤ If no

59. Would it be helpful to be able to sit while in your shower?

- Yes
- No

Caregiver

60. Is there a shower seat in the ECHO house shower?

- Yes
- No

➤ If no

61. Would it be helpful to be able to have the resident sit while taking a shower?

- Yes
- No

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how having a seat in the shower of your home/the ECHO house impacts your experience of taking/assisting with a shower?

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bath</b>	1	2	3	4	5
• Shower seat					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bath</b>	1	2	3	4	5
• Shower seat					

**Item** -toilet bowl height between 17” and 19” high

Resident

62. Is the toilet seat in your home higher than a typical toilet?

- Yes
- No

Caregiver

63. Is the toilet seat in the Echo house higher than a typical toilet?

- Yes
- No

Part 2

On a scale of 1-5 with 1 being not helpful and 5 being very helpful, how would you describe how the height of the toilet seat effects the use of the toilet in your home/the ECHO house?

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Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bath</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Toilet bowl height between 17” and 19” high.</li> </ul>					
Caregiver	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Bath</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>Toilet bowl height between 17” and 19” high.</li> </ul>					

Effectiveness of Universal Design Features – Coding Instrument

Resident	Effectiveness Score 1 = not helpful 5=very helpful				
<b>Kitchens</b>	1	2	3	4	5
<ul style="list-style-type: none"> <li>32” door clearance</li> </ul>					
<ul style="list-style-type: none"> <li>Single-lever controls at all doors</li> </ul>					
<ul style="list-style-type: none"> <li>Single-lever water controls at all faucets</li> </ul>					
<ul style="list-style-type: none"> <li>Clear knee space under sink</li> </ul>					
<ul style="list-style-type: none"> <li>Adjustable or variable work center heights ranging between 28” and 45” high</li> </ul>					
<ul style="list-style-type: none"> <li>Rocker switchplates</li> </ul>					
<ul style="list-style-type: none"> <li>Outlets located between 18” and 22” above the finished floor</li> </ul>					
<ul style="list-style-type: none"> <li>Wall switches mounted between 42” and 48” above the finished floor</li> </ul>					
<ul style="list-style-type: none"> <li>Dishwasher elevated 6” above the finished floor</li> </ul>					
<ul style="list-style-type: none"> <li>Front-mounted controls on appliances</li> </ul>					
<ul style="list-style-type: none"> <li>Non-slip flooring</li> </ul>					
<ul style="list-style-type: none"> <li>Minimum circulation clearance of 40”</li> </ul>					
<ul style="list-style-type: none"> <li>Full extension, pull-out shelves in base cabinets</li> </ul>					
<ul style="list-style-type: none"> <li>Side by side refrigerator</li> </ul>					

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<b>Bathroom</b>					
• Entry door 32” clearance					
• Single-lever controls at all doors					
• Single-lever water controls at all plumbing fixtures and faucets					
• Board blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars					
• Mix valve with pressure balancing and hot water limiter					
• Shower seat					
• Toilet bowl height between 17” and 19” high.					

General Health Comments

Resident

- Physical
- Cognitive
- General

Caregiver

- Physical
- Cognitive
- General

Effectiveness of Universal Design Features – Coding Instrument

<b>Caregiver</b>	Effectiveness Score 1 = not helpful 5=very helpful				
	1	2	3	4	5
<b>Kitchens</b>					
• 32” door clearance					
• Single-lever controls at all doors					
• Single-lever water controls at all faucets					
• Clear knee space under sink					
• Adjustable or variable work center heights ranging between 28” and 45” high					
• Rocker switchplates					
• Outlets located between 18” and 22” above the finished floor					
• Wall switches mounted between 42” and 48” above the finished floor					

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• Dishwasher elevated 6” above the finished floor					
• Front-mounted controls on appliances					
• Non-slip flooring					
• Minimum circulation clearance of 40”					
• Full extension, pull-out shelves in base cabinets					
• Side by side refrigerator					
<b>Bathroom</b>					
• Entry door 32” clearance					
• Single-lever controls at all doors					
• Single-lever water controls at all plumbing fixtures and faucets					
• Board blocking in walls around toilet, tub, and shower for future placement and relocation of grab bars					
• Mix valve with pressure balancing and hot water limiter					
• Shower seat					
• Toilet bowl height between 17” and 19” high.					

I’d like to talk to you now about your health. Can you tell me in general how you would describe your/the resident’s general health? On a scale of 1-5 with 1 being poor health and 5 being excellent health, how would you rate your/the resident’s general health?

Part 3

Resident	General Health					Comment
	1	2	3	4	5	
Resident						
Caregiver						

Now I’d like to be a little more specific and talk to you about some of your routine activities. Can you tell me about how you/the resident prepare and eat meals, bath and dress, move about in your home and care for personal hygiene? Do you always require help, occasionally require help, or never require help with the following activities?

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Part 4 -Health and functioning

Resident ____	Requires help		
Task	Never	Occasionally	Always
Preparing food			
Cleaning			
Eating			
Walking			
Bathing			
Toileting			
Dressing			
Health Rating Scale	No assistance with ADLs and IADLs	Requires assistance with ADLs /IADLs	ADL/IADL Score

Part 4 -Health and functioning

Caregiver ____	Requires help		
Task	Never	Occasionally	Always
Preparing food			
Cleaning			
Eating			
Walking			
Bathing			
Toileting			
Dressing			
Health Rating Scale	No assistance with ADLs and IADLs	Requires assistance with ADLs /IADLs	ADL/IADL Score

**Notes**

Resident  
Caregiver

**Appendix E**

**10 ECHO Kitchen Planning Guidelines Checklist**

ECHO Kitchen Planning Guidelines			
		Yes	No
1	No major traffic pattern through work triangle		
2	Work triangle total no more than 26' with no single leg shorter than 4'		
3	Wall cabinet frontage of 186"		
4	Base cabinet frontage of 192"		
5	Landing space beside the range 12" & 15 "		
6	Landing space beside the refrigerator 15 "		
7	Clear floor space of 30" X 48" at sink, range & refrigerator		
8	Sink located between range and refrigerator		
9	36" work centers adjacent to water source		
10	Sink with 24" on one side and 18" on the other at same level		

**8 ECHO Bathroom Planning Guidelines Checklist**

ECHO Bathroom Planning Guidelines			
		Yes	No
1	Clear floor space of 48" X 48" in front of the toilet		
2	Clear floor space of 30" X 48" at the lavatory		
3	Clear floor space of 30" X 60" at the bathtub		
4	Clear floor space of 36" X width of shower + 12"		
5	Minimum center-line from toilet to obstruction of 16"		
6	Minimum center-line from sink to side-wall 15"		
7	Minimum shower interior dimensions 34" X 34"		
8	Tub/shower controls accessible from inside and outside the fixture.		