THE EVALUATION OF UNIVERSAL DESIGN KITCHEN FEATURES BY PEOPLE IN WHEELCHAIRS

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The Evaluation of Universal Design Kitchen Features

by People in Wheelchairs

by

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(Abstract)

The purpose of the study was to investigate the effectiveness of universal design kitchen features by people using wheelchairs. The study examined the features of the GE Real Life Design Kitchen in the Center for Real Life Design at Virginia Tech and determined which universal design features were beneficial to users in wheelchairs. The specific objectives were:

1. to evaluate the universal design features of the GE Real Life Design Kitchen by people in wheelchairs, and
2. to examine how the GE Real Life Design Kitchen is used by people in wheelchairs as they prepare a meal in the space.

Nine participants, with various disabilities, who use a wheelchair on a daily basis were selected for the study. The sample consisted of 5 male and 4 female participants with ages ranging from 28-58 years old. Each participant had varying levels of grip, strength, and memory as a result of their disability. Data for this study were collected through a variety of observation and interviewing methods.

The study was separated into four different sections/activities; the pre-cooking interview, the universal design evaluation, the cooking activity, and the post-cooking

interview. Each participant was asked to test specific universal design features located in the GE Real Life Design Kitchen and was given a set menu and asked to prepare a meal.

The results of this study determined that people who use a wheelchair while cooking are very efficient and do not require much counter space in order to prepare a meal. Appliances with easy to read and use controls are preferred and should be located within good visual range of a person in a wheelchair to be effective. In addition, it was determined that a pull-out cutting board and some type of roll-out tray feature in a base cabinet is useful to a person in a wheelchair. The results concurred with existing recommendations concerning clear floor and open knee spaces at the sink and cooktop areas, and also discovered that clear floor and open knee space is useful under a countertop microwave because it allows the wheelchair user to get their body closer to the task.

Results from this study cannot be generalized to a national population of wheelchair users because of the limitations of the sample. Results, however, are significant in terms of providing consumers, cabinet and appliance manufacturers, policy makers, and designers with valuable insight and information concerning the inclusion of universal design features in kitchens and environments that accommodate the needs of all people, including the person in a wheelchair. In addition, the results of this study imply that not all universal design features recommended in kitchen design are beneficial to people in wheelchairs. Further investigation of some of the universal design features tested is needed.

DEDICATION

There are many people who play a role in our life's goals and achievements. This dissertation is dedicated to a few of the people who have helped me along my journey.

To my parents, Phil and Ruth Cline, thank you for your unconditional love, guidance, inspiration, and support. Your undying faith in me has shaped the essence of my existence.

To my brother Andy, my brother-in-law Steve, and my favorite-sister Sandra, thank you for loving and inspiring me through the years, I respect all three of you for your wisdom and intellect. To the father of my children, thank you for the best gift I have ever received and for that I am truly grateful.

A special dedication is reserved for my two daughters, Laney and Hollybrook. Thank you so much for putting my life into perspective. I love you with all my heart.

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A special thank you to Mary Jo Peterson, for agreeing to serve on my committee. It takes a special type of person to willingly encourage evaluation and criticism of your own work. Her expertise provided me with useful information on my research topic throughout various stages of my research process.

I would like to thank all the participants of my study, for your willingness to participate. I am truly indebted. Thank you.

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CHAPTER 1. INTRODUCTION

Universal design is promoted as a way to design for all people. It represents a paradigm shift, from a model that treats people with disabilities as part of the medical community to a model where "everyone is treated as an equal citizen and a disability is seen merely as a social construct" (Sandhu, 2001, p.3.4). This includes children, adults of all ages, and people with disabilities. Bill McDonough, architect and environmental activist, said in speech given to the Interior Design Educators Council Conference in 2005, that a regulation required by law denotes a design flaw (March 5th, 2005). "If universal design can be achieved, it will no longer be necessary to examine design recommendations in light of special guidelines or codes…" (DeMerchant & Beamish, 1995, p.78).

The term "universal design" has often been accompanied by accessibility guidelines and is sometimes seen as a *trendy synonym* for compliance with the Americans with Disabilities Act (ADA) (Null, 1998; Ostroff, 2001). The design guidelines associated with the ADA have been revised since their inception in an attempt to integrate universal design concepts into every space and product developed (Peterson, 1995). Minimum standards established by the national access guidelines are important, but only scratch the surface for universal design practices. The term universal design goes much deeper than the guidelines established by the government.

Universal design has been promoted as a design approach to meet access requirements without an institutional look. Ron Mace, from the Center for Universal Design at North Carolina State University, first promoted the concept of providing access to all by coining the phrase universal design. "Universal design is the design of products

and environments to be useable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, 1997, p.1).

One segment of the population that finds the access guidelines and universal design principles useful is people using wheelchairs. Among the 237 million people in the United States, six years old and over, 1.8 million use a wheelchair (U.S. Bureau of the Census, 1994). "However, universal design is not based on the assumption that wheelchair-accessible facilities are also accessible to individuals with other disabilities---for some people, barrier-free features can even be hazardous. Universal design avoids these limitations by incorporating a more comprehensive view of human needs and abilities" (Goltsman, 2001, p.64.3).

Everyone in a wheelchair is not the same. People in wheelchairs are a diverse group of people that embody an array of disabilities. Ideally, universal design is "design for all" and spaces designed from this perspective should meet the needs of people in wheelchairs. It is not clear, however, that they actually do; therefore, it is important to investigate if universal design features are useful to specific groups of people with specific needs, like people in wheelchairs. Recommendations for universal design features that are appropriate for people in wheelchairs need to be identified; however, very little research has been conducted to evaluate universally designed environments specifically for people who use wheelchairs. Additionally, research is needed to examine the physical, psychological, and environmental factors that affect people in wheelchairs.

The house is an important place to use universal design because its access is not typically regulated in the United States. People need to function independently in their home before they can hope to tackle the larger world. In addition, people may never know

when they may become disabled, either temporarily or permanently, and will need the benefit of a universally designed home (Trachtman, Mace, Young, & Pace, 1999). Universal design principles, when implemented in the home can make common activities easier for all and provide the opportunity for people to function in their home when faced with a disabling event (Trachtman et al., 1999). The two areas of housing that have received the most attention from a universal design perspective are the bath and the kitchen; however, more research is needed to investigate if those universal design features implemented are beneficial for people in wheelchairs.

Problem Statement

Recent legislative mandates and amendments to the ADA and Fair Housing Act have been the catalyst for manufacturers to create technological advances and products that assist persons with disabilities. Universal design is a broad concept that has been promoted as a way to respond to the Fair Housing Act (FHA) and the ADA design requirements; however, universal design is more expansive than the specific accessibility guidelines established by the Fair Housing Act Guidelines (FHAG) and the Americans with Disabilities Act Accessibility Guidelines (ADAAG). The FHAG and the ADAAG have very few requirements that affect the design of kitchens. Although these government regulations attempt to accommodate people with disabilities, they do not provide enough detailed information on universal design features needed to accommodate people in wheelchairs.

The kitchen is a critical place in the home. Being able to utilize the kitchen and prepare meals independently encourages independence (Null & Cherry, 1996). In 1994, the National Kitchen and Bath Association (NKBA) began re-evaluating their kitchen

planning guidelines and included several universal design concepts that should be incorporated into kitchen planning. The guidelines were then adopted and published in 1996. The GE Real Life Design Kitchen was developed in 1994 and debuted at the National Association of Home Builders 1995 Convention to demonstrate and promote universal design features to builders and consumers. It was also used to assist in promoting the new NKBA 1996 guidelines. Many of the features incorporated into the kitchen design were utilized to illustrate the NKBA planning guidelines. In 2004, the NKBA further revised their guidelines of kitchen planning. Many of the universal design features recommended in the 1996 guidelines remained the same, but the new guidelines incorporated and identified the 1998 American National Standard Institute (ANSI) 117.1 accessibility standards that would be helpful in planning a kitchen where these requirements were needed. NKBA's guidelines are not required by law and exceed the requirements mandated by the FHAG and ADA.

Kitchen designers face many difficulties when trying to incorporate universal design practices into kitchen design. The needs of a person who cooks while standing are very different than the needs of someone who cooks while sitting. It is often not clear if universal design or accessibility features would be useful to people in wheelchairs. In fact, there have been many attempts to add universal design features into people's homes, but little research has been conducted to see if these features are beneficial and are utilized by users, let alone users in wheelchairs.

Purpose Statement

The purpose of the study was to investigate the effectiveness of universal design features of the GE Real Life Design Kitchen in the Center for Real Life Kitchen Design at

Virginia Tech by people using wheelchairs. The study determined if the universal design features were beneficial to people in wheelchairs. The specific objectives were:

1. to evaluate the universal design features of the GE Real Life Design Kitchen by people in wheelchairs, and
2. to examine how the GE Real Life Design Kitchen is used by people in wheelchairs as they prepare a meal in the space.

This study is one of the first research projects to actually evaluate people in wheelchairs utilizing universal design features in the kitchen. Information from this study will be useful to the future development of universally designed spaces and products.

Research Questions

The research questions were:

1. How effective are the universal design features in the GE Real Life Design Kitchen for people in wheelchairs?
2. How effective is the GE Real Life Design Kitchen for people in wheelchairs preparing a meal?

Theoretical Framework

The theoretical frameworks utilized for this study investigated models and theories that are all inter-related to Lewin's person-environment interaction model. Lewin's framework explored the idea that one's behavior is the result of the interaction between the person and his or her perceived environment (Lewin, 1951). As a result of his work, many person-behavior-environment models have emerged (Steinfeld & Danford, 1999).

Three different person-behavior-environment models were employed in this research. Lawton and Nahemow's model of Competence Press (1973) (see Figure 1.)

proposed that for people with lessened abilities, the impact of the environmental factors *(environmental press)* is greater. Because people in wheelchairs often must compensate for their limitations, the environmental demands must be specifically syncronized with the abilities of the individual to obtain an optimal fit between the person and the environment. Steidl and Bratton (1968) studied the workplace within the home. Their model, the concept of Work, Worker, and Workplace (see Figure 2.) determined conditions that accelerated the activities that required the most effort and strain on the worker, lessening the amount of time needed for those tasks and in turn, lessening the amount of strain on the individual. Faletti's model of Human Factors or Person-Environment Transaction (1984) (see Figure 3.) took into account the relationship of the person to the environment while attempting to accomplish daily activities. While each framework brings different components to the conceptual model of this study, all three of these frameworks are similar in that they recognize that the environment is a contributing factor to how a person performs a specific task, works more efficiently, and functions independently.

Environmental-Press Model: Considerable attention has focused on the relationship between the individual and the environment. A person's physical and/or cognitive disabilities, combined with the environmental setting in which a person lives, may affect the person's ability to perform certain tasks. Lawton and Nahemow's (1973) model of environmental-press theory indicated that a person's response to a stimuli or environment was determined by the competence and functional capabilities that the person may possess. As a result of their work, a competence press model was developed. This model consists of two variables: 1) the person's ability and capability to use the physical space and 2) the demands the space places on the individual (See Figure 1).

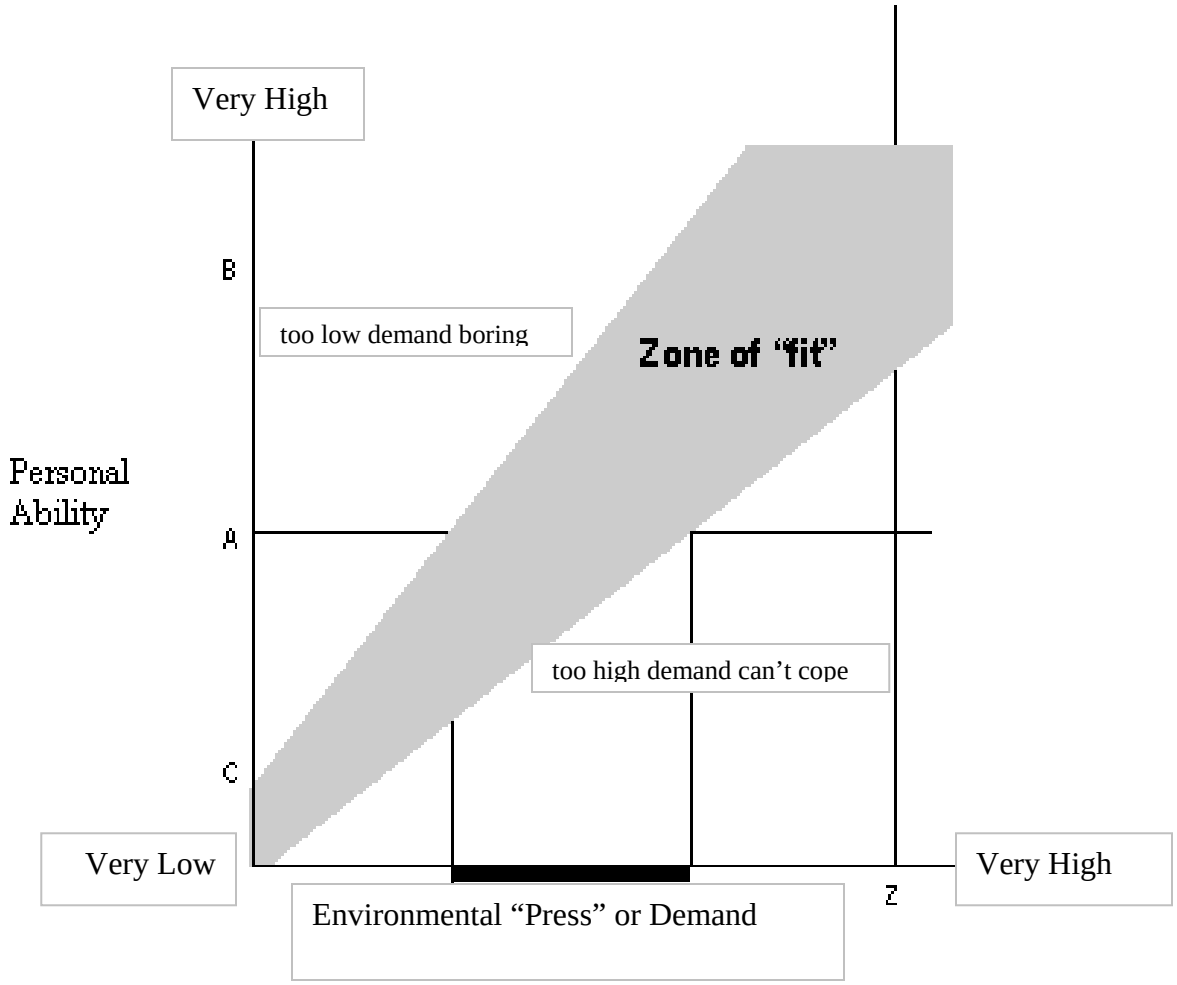

Figure 1. Lawton and Nahemow's Competence Press Model (Adapted from Lawton & Nahemow, 1973). Used with permission.

These variables were placed on the X and Y axes of the graph to represent a continuum. The goal of the model was to determine whether individuals were properly matched with their environment. If people *fit* their environment, then individual satisfaction and ability to use the space increased. Likewise, if a *fit* does not occur then problems of boredom or frustration arose. This model could also illustrate the relationship

between a person in a wheelchair and their kitchen. If an optimal fit does not occur, a person in a wheelchair may not cook at home or may find cooking frustrating and stressful.

Steinfeld and Danford (1999) operationalized Lawton and Nahemow's theory of environmental press to include the monitoring of participants within the space. Their argument was that unless the environmental press became unbearable or intolerable (violated tolerance thresholds), sufficiently enough to prompt a change in the situation or environment, then most of time, the environment would become the dominate factor in determining how people behave (outcome). They observed that many times people would put themselves at risk of injury or use an assistive device to complete a task by themselves; therefore, coping with the environment and falling within the optimal fit zone. For example, one might be able to get a heavy can off the top shelf by stretching or stepping on a chair in order to complete the task. Steinfeld and Danford developed the Decision Tree for Environmental Functional Independence Measure (see Appendix G) to provide observers an instrument in which to classify participants' ability to complete a task within an environment.

The decision tree measured levels of independence in completing a task or activity by scoring the individual performing the task. Users received a score from 1-10 based upon their ability to complete a task. A perfect score (10) on the decision tree would mean that the user completed the task without assistance, risking personal injury, or utilizing extra time (see Appendix G). Steinfeld and Danford's research was primarily conducted in rehabilitation facilities (1999).

Work, Worker, and Workplace Model: In 1968, Steidl and Bratton developed a person-behavior-environment model of the three dimensions of work as it related to the

home (See Figure 2). This framework was applicable to studies that aimed at appraising the use of the human resource for the measurement of human costs of work to homemaking activities (Steidl & Bratton, 1968). The objective was to determine the amount of work done in the home and thereby minimize the human costs of household work.

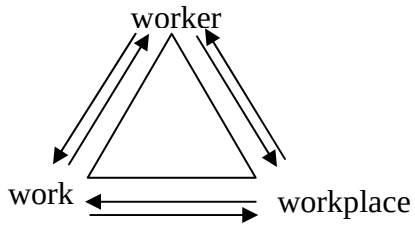

Figure 2. The concept of Work, Worker, and Workplace (Steidl & Bratton, 1968). Used with permission.

The three components of work were: the task or work (behavior), the person or worker (or user), and the workplace (environment). These components were interrelated and each process was capable of affecting the other two. Each process "…cannot be completely isolated" (Steidl & Bratton, 1968, p.1). Steidl and Bratton (1968) studied the workplace within the home and determined conditions to accelerate the activities that required effort and strain on the worker, lessening the amount of time needed for those tasks. The location of vertical and horizontal spaces, the arrangement of items within the space, the amount of space needed for certain activities and specific features were examined in these studies. Understanding the importance of the location, placement, and arrangement of items within the kitchen setting was important to all users. Placing items in the kitchen by examining *first use* and locating activities that take place within the work centers of the kitchen, had been the discussion of kitchen organization and management

since the 1940s (Wilson, 1947). During that time, kitchen organization and management had not been discussed within the context of universal design.

In 1996, the NKBA recognized the importance of addressing universal design issues when they revised its guidelines to specifically address issues of universal design within the kitchen setting. These guidelines did not address the reality that specific kitchen features are not the same for all users, yet alone wheelchair users. A few kitchen studies considered the kitchen arrangement, placement of items, and activities as they pertained to wheelchair users; however, most were conducted before the concept of universal design emerged.

Human Factors Model of Person-Environment Transactions: Another framework that emerged from Lewin's person-environment model was the Human Factors Model of Person-Environment Transaction (Faletti, 1984) that took into account the relationship of the person to the environment during attempted accomplishment of daily activities (see Figure 3). The basis of this model was that an individual with a set of limitations must interact with the environment. In addition, the environment creates more limitations or obstacles for the user to achieve the outcome or task. Faletti's model showed the importance of understanding the users characteristics and capabilities in addition to recognizing the environment as an equal contributing factor to the result.

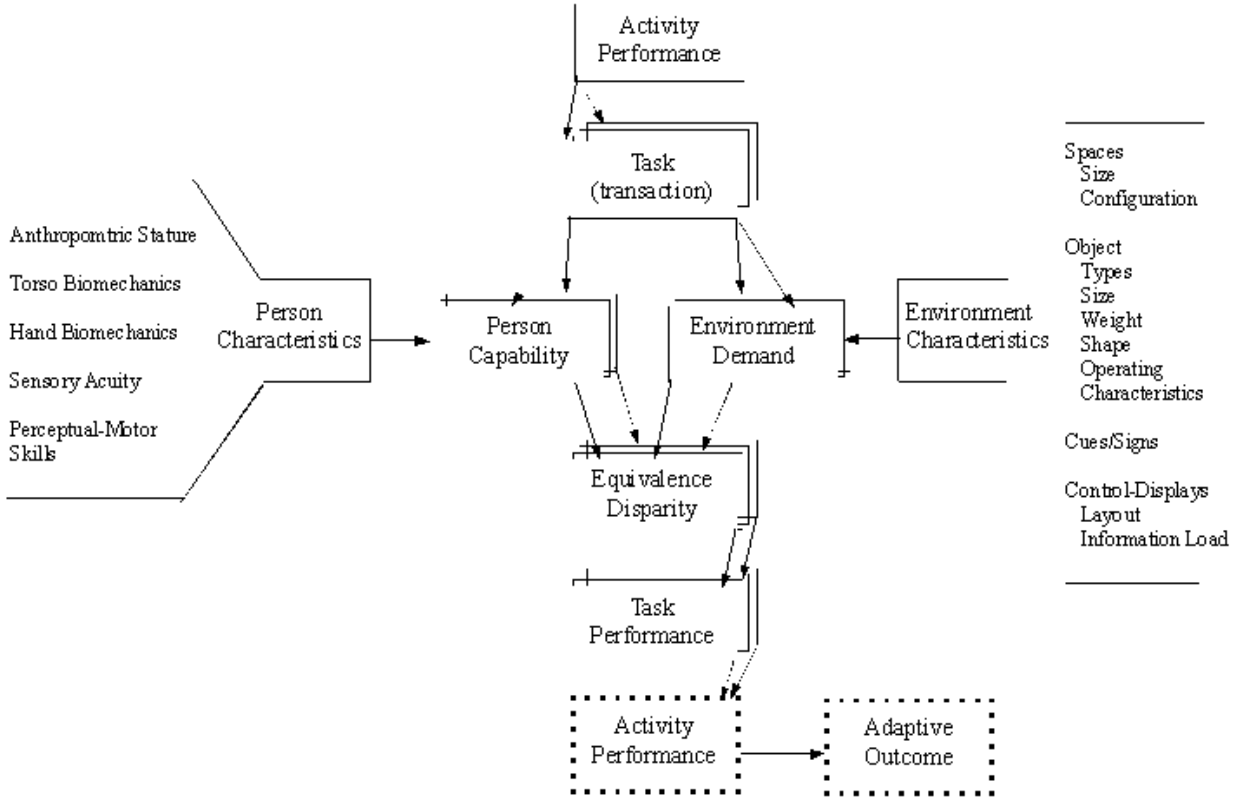

Figure 3. Human Factors Model or Person-Environment Transaction (Faletti, 1984). Used with permission.

The three models were utilized as the basis for this study because each model recognized the interaction between the person, the environment, and the behavior. However, each theoretical framework incorporated a different aspect of the interaction that can take place, all of which need to be considered for this study. Lawton and Nahemow believed in the idea of optimal fit between the person's ability and the environment. Steidl and Bratton actually looked at the kitchen environment and the work within that environment as a factor. Faletti took into account the physical characteristics of a person and their ability to accomplish activities of daily living. Each framework identified that the

environment is a contributing component to one's ability to perform certain tasks independently.

Justification of the Study

"Poorly designed physical environments can impair, disable, and handicap anyone" (Steinfeld & Danford, 1999, p.135). However, people with disabilities face an even greater challenge than able bodied individuals. While universally designed environments are meant to be supportive of all, they can lessen the degree of disability a person possesses if the physical environment is included in the initial design equation as a measure of influence on a person's disability.

While many writings have been published concerning universal design recommendations, much of the written material is based on assumptions about human behavior and its relationship to the environment. The two most common assumptions are that accessible environments are environments where one can function *independently* and that there is some level of function that can be called *minimally acceptable* (Steinfeld & Danford, 1999). The terms *independently* and *minimally acceptable* are vague in definition and allow for various interpretations of the terms. Essential to these concerns is the lack of adequate theory that most accessibility research has been based upon.

Most universal design recommendations have been based upon assumptions about human behavior, attempting to accommodate the 5^{th} to 95^{th} percentile of all people. For example, 95 percent of all people can walk through a doorway with a 6 foot-8 inch clearance; however, 5 percent of the population is too tall to be able to clear that height without lowering their body in order to pass through the doorway. This philosophy, while accommodating most people in a given population, potentially discriminated against ten

percent of that population which fell either below the 5th percentile or above the 95th percentile. In addition, most recommendations assumed a person only possesses one disability rather than a combination of limiting factors. Most of the universal design guidelines were implemented without testing. Even simple observations of users within a space designed with universal design features would provide more basis for universal design recommendations. However, Steinfeld and Danford (1999) argued that simple observation is not enough. For example, in 1979, Steinfeld, Schroeder, and Bishop found a common accessibility guideline regarding a ramp slope requirement of 1:12 would accommodate only 60% of those people in wheelchairs tested in traveling distances greater than 30 feet. However, the FHAG and the ADAAG supported the ANSI 117.1-1992 Standard (4.8.2) that states "ramps in new construction shall have a slope no steeper than 1:12." The slope standard may have been based upon a person using a wheelchair who has not experienced any other physical or mental disabilities, but according to Steinfeld, Schroeder, and Bishop, 40% of the people in a wheelchair would have difficulty with a ramp with the recommended slope standard. If the ramp is too steep, many wheelchair users do not have the upper body strength to push themselves up the slope without resulting in excessive fatigue.

While the FHAG and the ADAAG have promoted and required accessible design in multifamily housing and commercial spaces, many of these guidelines have not been tested within actual environmental settings. While human factors research has often used the 5th and 95th percentiles to define boundaries of acceptable fit for the population, these percentiles did not necessarily include people with disabilities who were already at the extremes of the population (Steinfeld & Danford, 1999).

Users with disabilities have not tested many of the universal design features recommended for specific areas. In addition, it may be that universal features were not suitable for all people with disabilities. To complicate matters, design guidelines and standards for people in wheelchairs were linked more closely with barrier-free design (design that eliminated obstacles in a space) and clearance recommendations than with universal design. Therefore, this study, which evaluated wheelchair users in a space that has implemented numerous universal design recommendations and took into account the participant's range of abilities to accomplish activities of daily living (ADLs) while evaluating the environment the participant was experiencing, was a step in understanding how universal design features could benefit, assist, and/or hinder the person in a wheelchair. The results of this study will provide consumers, marketers, policy makers, and designers with valuable insight and information concerning the design of a space and the inclusion of universal design features in environments that accommodate the needs of all people, including the person in a wheelchair.

Delimitations

By definition, universal design features are features that accommodate all people. Participants in wheelchairs in the New River Valley and the surrounding region were selected for this study. In addition, the specific environment evaluated limited this study. The GE Real Life Design Kitchen, was not designed specifically for wheelchair users, and not all universal design guidelines for kitchen design have been fulfilled within the chosen space. Participant interaction with kitchen accessories was limited to only those available in the GE Real Life Design Kitchen.

Limitations

This study did not attempt to evaluate the use of universal design features by a wide range of users. This study only examined people in wheelchairs. The purposive sampling procedure decreased the generalizability of findings. The results were only applicable to this sample or others with similar characteristics. This study was not generalizable to all areas of universal kitchen design, but can be the basis for making recommendations and improvements in the area of kitchen design.

Significance and Contributions of the Study

The purpose of the study was to investigate the effectiveness of universal design features in the GE Real Life Design Kitchen by people using wheelchairs. The study determined which universal design features were beneficial to users in wheelchairs. This study had significance for several reasons. The significant issues concerning this study were:

1. There have not been very many studies that have tested specific guidelines and standards required by national laws. Universal design recommendations originated out of these national laws and were greatly expanded upon in attempts to accommodate all users. Part of the problem lies in the fact that the majority of research conducted has grouped all disabilities into one homogenous group. Standards and guidelines have been created without consideration for the user's degree of activities of daily living (ADLs) and the environmental setting in which the guidelines are implemented. This study will further question and evaluate these standards.

2. The national accessibility guidelines have limited recommendations affecting kitchen design. Most guidelines have to do with clearances rather than assistive features. Universal design recommendations established for the kitchen by the NKBA guidelines are numerous and go beyond the national accessibility guidelines; however, it is not clear which universal design features should be incorporated into the design of a kitchen for a person in a wheelchair. Designers need to know which universal design features are the most appropriate for a client that uses a wheelchair. The results of this study may demonstrate the need to re-examine these guidelines and classify their importance to specific users in order to provide more adaptable environments for all people including those in wheelchairs.

Definition of Terms

Accessible design: Products and environments that are easy to approach, reach, enter or use by people with disabilities (Deardorff & Birdsong, 2003).

Activities of Daily Living (ADLs): Basic daily personal care activities including eating, toileting, transferring, dressing, and bathing. Instrumental personal care activities including meal preparation and house work. "The level of functioning one possesses and the ability for independent living depends on being able to accomplish certain tasks" (Moore, 2001, p.2.8).

Adaptable design: Design with flexible features that can be adjusted for the personal needs of specific users in a short time by unskilled laborers without involving structural or finish material change (Story, 1998; Mace, 1990).

Anthropometry: "The science dealing specifically with the measurement of the human body to determine differences in individuals, groups, etc." (Panero & Zelnik, 1979, p.23). Anthropometric data collected for specific users enables the designer to make design decisions based upon a user's specific measurements and reach ranges.

Americans with Disabilities Act Accessibility Guidelines (ADAAG): Guidelines that enforce the Americans with Disabilities Act which prohibits discrimination on the basis of disability by public accommodations and requires places of public accommodation and commercial facilities to be designed, constructed, and altered to be in compliance with the accessibility guidelines established by this law (Salmen, 2001).

Barrier-free design: Design that eliminates obstacles in a space while accommodating persons with disabilities (Wilkoff & Abed, 1994).

Fair Housing Act Guidelines (FHAG): Guidelines that enforce the 1998 Fair Housing Act Amendment which established design and construction standards to ensure that multi-family housing (with four or more units) will be accessible to people with disabilities (Steinfeld & Shea, 2001).

Guidelines: Design rules that enforce a national law usually created by an enforcement agency of a government entity (Salmen, 2001).

Law: General rules and legislation that are passed by Congress. The law normally requires more specific regulations to be developed and normally identifies the agency responsible for development and enforcement of those guidelines (Salmen, 2001).

Lifespan design: Products and environments that consider the needs of children through older persons (Deardorff & Birdsong, 2003).

People in wheelchairs: Persons who regularly prepare meals in their home while in a wheelchair.

Recommendations: Products and environments including clearances that are good ideas to consider when designing (Salmen, 2001).

Standards: Accepted design rules that are recognized by the industry as good design practices. A standard is not enforceable until it is referenced or adopted into a regulation or guideline (Salmen, 2001).

Uniform Federal Accessibility Standards (UFAS): Guidelines that enforce the law pertaining to the Architectural Barriers Act and the Rehabilitation Act. UFAS prescibes a common set of specific accessibility rules for designing, building, altering, and leasing Federal facilities.

Universal design: "The design of products and environments to be useable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, 1997, p.1).

Universal features: Products located in the GE Real Life Design Kitchen that were implemented with the intent of universal design.

CHAPTER 2: REVIEW OF LITERATURE

The review of literature consists of seven parts, beginning with a discussion of the characteristics of people in wheelchairs. The second part provides a general overview of the history of barrier-free and universal design, leading into the third section that discusses universal design as it relates specifically to housing. The fourth part of the review of literature discusses the development of the kitchen industry as well as research in kitchen design, leading into the fifth section covering kitchen design for people in wheelchairs. The sixth part contains an overview of the accessibility standards and how they are applied to kitchen design. The seventh and concluding part discusses the development and design features of the GE Real Life Design Kitchen.

People in Wheelchairs

The history of the wheelchair dates back to the ancient Egyptians who used hand pushed carts for people who could not get around. The wheelchair was basically a chair on wheels that was pushed from behind. The mid 20th century wheelchair had spoke wheels and wire wound rubber tires and was very heavy to lift and sometimes difficult to operate. "Someone needing a wheelchair at that time simply would have gone to a doctor and received a prescription for a wheelchair, and that chair would have been fairly standard in size and appearance…. Nothing else was available" (Halverson & Belknap, 2006, P.1). Many advances in new technologies have greatly improved the mobility and function of the wheelchair today. Louis Slangen, vice president of Invacare, a company that creates wheelchairs notes that "…wheelchairs serve the same purpose today as they did many years ago, but they do it farther, lighter, longer, and more comfortably than ever before" (L. Slangen, personal communication, May 5, 2005). There are several different types of

wheelchairs. Manual, electric, and specialty wheelchairs, all come with literally hundreds of options available for today's wheelchair user. An electric scooter is considered a wheelchair alternative. The user must decide what type of wheelchair or scooter best meets their needs when selecting a wheelchair type (Halverson & Belknap, 2006).

There are many causes of mobility impairments that lead to a person requiring a wheelchair. Some are acquired at birth, others stem from accidents or illnesses that occur later in life. Mobility impairments include upper and/or lower body disabilities. People may be required to use a wheelchair as a result of a variety of causes including spinal cord injury, cerebral palsy, polio, multiple sclerosis, severe arthritis, amputation due to an injury, diabetes and vascular disease, muscular dystrophy, and spina bifida. These conditions may affect basic mobility, coordination and balance, strength and endurance, and other varied aspects of body function and everyday living. The sample selected for the study utilized a wheelchair caused by one of the following: rheumatoid arthritis, multiple sclerosis, muscular dystrophy, and spinal cord and brain injuries.

Rheumatoid arthritis usually attacks the joints in a person's hands, arms, legs and feet. "Weeks or months may pass between arthritic attacks in the initial stages; however, in many cases gradually the condition begins to appear more often until some people cannot ignore the almost constant pain" (Anderson, 1981, p.22). "In rheumatoid arthritis, multiple joints are usually inflamed in a symmetrical pattern (both sides of the body affected)" (Sheil, 2006, p.2). Continual inflammation can cause destruction to body tissues, cartilage and bone, which leads to a cartilage loss and erosion of the bones as well as the muscles, resulting in joint deformity, damage, and loss of function (Sheil, 2006). People with

rheumatoid arthritis may be confined to a wheelchair when their condition reaches a severe stage.

Multiple sclerosis attacks the nervous system while muscular dystrophy is a disease that affects the muscles in the body. Both are very different diseases but affect the body in the same manner and can cause lack of strength in the upper arms. Persons diagnosed with these diseases often need the assistance of a wheelchair for mobility, usually tire easily and their condition tends to worsen over time (Anderson, 1981).

A spinal cord injury usually begins with a sudden, traumatic blow to the spine that fractures or dislocates vertebrae. An injury that damages the nerves in the spinal cord can cause paraplegia and quadriplegia. Paraplegia is described as "paralysis of the legs and lower part of the body, both motion and sensation being affected" (Anderson, 1981, p.18). Quadriplegia is more severe and includes some or total paralysis in both arms and legs (Anderson, 1981). The spinal cord is a system of nerves approximately 17 inches long, the higher up on the spinal cord an injury occurs, the more severe the injury. The spinal cord is separated into three regions; the cervical region (C), the thoracic (T), and the lower back or lumbar (L). The cervical region is the highest and injuries in this region are associated with quadriplegia (Anderson, 1981). A shorthand code describing a person's physical condition was developed to simplify the medical classification of a person. For example, a C6 quadriplegic has damaged the 6^{th} vertebra of the cervical region (Anderson, 1981).

Brain injury is often defined differently in published reports. Some use the term brain injury to mean acute traumatic damage to the central nervous system (CNS) and others use the term head injury, which allows inclusion of skull injuries, fractures, or soft tissue damage to the face or head without any obvious neurologic consequences (Kraus &

Black, 1984). Kraus and Black define brain injury as "physician-diagnosed physical damage from acute mechanical energy exchange resulting in concussion, hemorrhage, contusion, or laceration of the brain" (Kraus & Black, 1984, p.186). A brain injury can result in impairments in one or more functions, including arousal, attention, language, memory, reasoning, abstract thinking, judgment, problem-solving, sensory abilities, perceptual abilities, motor abilities, psychosocial behavior, information processing and speech.

Barrier-Free and Universal Design

In the late 1950s, the term barrier-free design became associated with efforts to remove barriers from the built environment for people with disabilities. The disability rights movement blossomed with the end of the Vietnam War. The veterans from that war insisted on access to government buildings and made a valid protest for the design of and access to government buildings that veterans could visit and utilize. The veterans demands were the catalyst that led to the passage of federal legislation, the Rehabilitation Act of 1973, requiring architectural accessibility in federally financed facilities (Salmen, 2001). It was a crucial factor in shifting disability issues from the realm of social services and therapeutic practice to a political and civil rights context (Welch, 1995). Section 504 of the Act specifically required that federal programs be conducted in barrier-free environments, but it also allowed services to be offered at alternative sites that were barrier-free and away from the building in which the majority of the service being provided was housed. The term barrier-free design was specifically linked to the disabled and carried a negative connotation. It created a distinction between people with disabilities and the rest of society. “This insistence that somehow it was reasonable to identify and isolate people

according to their age and physical and mental capacities resulted in…" (Moore, 2001, p. 2.4) consumers being classified into two types: average *normal* people and *special* populations, such as the disabled or elderly. When the term universal design was coined by Ron Mace, from the Center for Universal Design at North Carolina State in 1985 a new movement in architecture and design was born.

The design community embraced the idea of becoming more responsive to meeting the needs of a diverse consumer population. The universal design concept considered the lifespan of the individual, and the design of products and environments that considered the needs of people, from child to old age, was encouraged.

The concept of providing access to all is a design approach that implies equity and social justice by design (Ostroff, 2001). "Universal design is the design of products and environments to be useable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, 1997, p.1). Universal design incorporates the idea of social inclusion.

The Fair Housing Act Amendments of 1988, the Americans with Disabilities Act of 1990, and the Telecommunications Act of 1996 were the catalyst to implementing accessibility standards for all people. Unfortunately, the term universal design has been inappropriately linked with the ADAAG and the FHAG. While the ADAAG and FHAG provide minimum standards required by law, the idea of universal design goes beyond the standards and issues of compliance and "…offers a powerful rationale for responding to the broad diversity of users who have to interact with the built environment" (Sandhu, 2001, p. 3.4). Historically, specialized products and environments have been developed to meet the needs of people with varying abilities, creating expensive and unattractive products and

spaces, to accommodate a "missing" ability (Null, 1988). Universal design attempts to create aesthetically pleasing products and environments for all people. Universal design is not a euphemism for accessibility. It is a term that re-establishes an important goal of good design, to meet the needs of as many users as possible (Welch, 1995).

The Center for Universal Design established a list titled the *Principles of Universal Design*. The seven principles are recognized as follows today:

> Principle 1: Equitable Use; Principle 2: Flexibility in Use; Principle 3: Simple and Intuitive Use; Principle 4: Perceptible Information; Principle 5: Tolerance for Error; Principle 6: Low Physical Effort; and Principle 7: Size and Space for Approach and Use (Story, 2001).

Practitioners in many disciplines have adopted the principles and have applied them for a variety of purposes. The visual and functional integration of accessibility features must be considered from the outset. This integration, creates a universal design feature that goes unnoticed (Story, 2001).

Universal design is also referred to as lifespan design. All people benefit from accessible places and products at many stages in the passage from childhood to old age. Universal design improves independence, affordability, marketability, and user image and identity (Null, 1988). The case for universal design is frequently made by citing national census data and projections. Based upon recent census data, a broad estimate of 53 million Americans have at least one or more physical or mental disabilities (Center for Accessible Society, 2000). By 2030, it is predicted that one in every five Americans will be over 65 (Welch, 1995).

Universal Design in Housing

There are several laws governing accessible housing for multiple unit facilities. The Fair Housing Act of 1988 is the most recent and affects new construction with four or more units ready for occupancy after March 13, 1991. There are no nationwide requirements in the United States that single-family or other forms of private housing be accessible or barrier-free. There is little incentive for people associated with the housing industry to design or manufacture universal design products targeted at the single-family home owner. Most accessible housing is built by and for persons with disabilities on an individual basis. When you think of the term *home*, ideas of comfort and safety come to mind. Home is where your personality is expressed and you are surrounded by your personal possessions; however, "… if at some point your body changes due to an accident, illness, or aging, then normal houses become less like homes and more like obstacle courses" (Null, 1998, p. 219).

The idea for universal design in housing grew out of the realization that certain features adapted or added in a home for a disabled person were useful to others. This realization became the platform for justifying the inclusion of universal design into housing design and practice. "A home should allow for each individual's uniqueness, and universal design offers the platform from which adaptations can be made to support that uniqueness throughout the lifespan" (Null, 1998, p. 221).

Real estate agents argue that universally designed homes are not marketable because of the stigma and customization that is specifically individualized for the residents make the home unattractive to buyers (Young & Pace, 2001). However, one can argue if the universal design features are implemented correctly they will go unnoticed and be

useful to all people. "When well designed, bathrooms with a little extra floor space are perceived as luxurious" (Young & Pace, 2001, p. 34.5) and can accommodate user mobility with the assistance of an aid or allow for additional space for user personalization, then the design accomplishes the essence of universal design. Another example would be utilizing lever-type handles instead of doorknobs throughout the home to allow for easier access in opening doors for all people.

The *next-generation universal home* project was conceived as a holistic environment, designed to benefit multiple users in a flexible format. The School of Design at North Carolina State University and the staff of the Center for Universal Design designed the home as a collaborative experience. The original illustration appeared in the Wall Street Journal on September 14, 1998. The goal was to provide evolutionary thinking in home design and to raise public awareness of the possibilities in applying current technology and innovative building methods in residential construction. (Young & Pace, 2001).

The *next-generation universal home's* kitchen modifications included various universal design features. The home illustration suggests that the design provided a continuous adjustable counter surface that raised and lowered, and included the sink and cooktop. This counter surface would have a clear floor space underneath which could provide a space for a chair, wheelchair, moveable bins, or cabinets. The microwave oven was set at counter height with a shelf in front and knee space below. The conventional oven was mounted low with one rack the same height as the adjacent countertop. The dishwasher and refrigerator were raised off the floor. The door entrance was level with the outside surface and was located close to the kitchen. Perhaps the most interesting universal

design concept integrated into the *next-generation* kitchen was described as a storage system with moveable shelves that extended into the attic or basement and eliminated the need for upper cabinet storage, making it accessible for all people. The proposed kitchen design was still conventional in visual appearance but provided more opportunities to be useable by multiple users.

Ultimately, understanding what universal design is and what it means to all users is the first step towards making universal design a reality. "As the concept becomes more widely understood and embraced, construction techniques will reflect these universal design elements and features making them commonplace and, soon the new paradigm" (Young & Pace, 2001, p.34.20).

Research In Kitchen Design

Catherine Beecher and her sister Harriet Beecher Stowe were the pioneers of research in kitchen design (1869). Research in kitchen design began primarily with the study of household work and management principles within the home. Beecher (1873) discussed in her writings the various aspects of successfully running a household and how to plan an efficient kitchen. The goal of her writings was to simplify household work and make recommendations for resourceful homemaking.

The first standardized kitchen planning guidelines were published in the 1920s by home economists who proposed various layouts to increase work efficiency in the kitchen (Cheever, 1991; Beamish, Parrott, Emmel, & Peterson, in press). Home economists recognized that the organization of a space could result in enhanced function and better home management.

The U.S. Department of Agriculture's Agricultural Experiment Station (AES) and the U.S. Cooperative Extension Service played a major role in developing and publishing the first guidelines for the modern kitchen. Home economists and instructors at state universities received funding through these agencies to investigate and disseminate the ways to improve rural housing conditions (Beamish et al., in press).

The placement of items in the kitchen by examining *first use* and the activities that take place within the kitchen, have been the discussion of kitchen organization and management since the 1940s (Wilson, 1947). Mary Knoll Heiner and Helen McCullough published a booklet through Cornell University titled "Functional Kitchen Storage" in 1948. This booklet identified average food and equipment utilized by typical American families and determined the amount of space and cabinets needed to create a functional storage system. Heiner and McCullough also identified various activities that take place in the kitchen. They recommended the type of cabinet storage and countertop frontage required for the various tasks and activities mentioned. Until the early 1990s, most kitchen specialists, followed the recommendations and guidelines established by Heiner and McCullough (Cheever, 1992)

In 1968, Steidl and Bratton developed a model of the three dimensions of work as it relates to the home. This framework is applicable to studies aimed at appraising the use of the human resource for the measurement of human costs of work to homemaking activities (Steidl & Bratton, 1968). The objective was to determine the amount of work done in the home, and to be able to minimize the human costs of household work.

Steidl and Bratton studied the workplace within the home to determine conditions to accelerate the activities that required the effort and strain on the worker, lessening the

amount of time needed for those tasks. The kitchen environment (workplace) was studied to determine the conditions that expedite activity and require the least amount of effort and strain on the worker. The location of vertical and horizontal spaces, the arrangement of items within the space, the amount of space needed for certain activities and specific features were examined in these studies (Steidl & Bratton, 1968). Understanding the importance of the location, placement and arrangement of items within the kitchen setting is important to all users.

The Small Homes Council at the University of Illinois was organized in 1944. The President of the University determined that soldiers coming home from the war would be needing good, low-cost housing, and valuable research would be needed on various issues related to housing. The Council had members from architecture, mechanical engineering, home economics, and industry. A significant amount of research in work-energy relationships and motion-activity measurements was conducted. Recommendations developed in the early Council studies formed the basis for establishing the work triangle, work centers, and kitchen planning principles (Dufrense, 2005). The National Kitchen and Bath Association (NKBA) aligned with the Small Homes Council, in 1975, in issuing the five volume Kitchen Industry Technical Manual (Jones & Kapple, 1975). This manual was based upon many of the concepts published in Heiner and McCullough's 1948 publication. The manual made recommendations for minimum and liberal sized kitchens. The manuals were the primary resource for designers and consumers in the kitchen industry. The first Certified Kitchen Designer (CKD) examination was based upon the 21 principles listed in the 1975 publication by Jones and Kapple (Beamish et al., in press).

In 1992, Yust and Olson of the University of Minnesota completed a study entitled "Residential Kitchens: Planning Principles for the 90s." This study was sponsored by the NKBA. The goal of the study was to determine relationships that have surfaced in the kitchen since the 1948 and the 1975 manuals were published. The study looked at kitchen technologies and design issues that integrated family roles, more than one cook, preferences, and kitchen management styles. The survey consisted of 101 families that were recent clients of a CKD. The study determined that an overwhelming number of families (over 90 %) were satisfied with the kitchen arrangement, counter space, and storage provided; however, the kitchens scored poorly based upon the guidelines in the technical manuals (Beamish et al., in press).

The result of the Yust and Olsen study led the NKBA to sponsor an additional study conducted by Ellen Cheever (1992). The Utensil Survey Project was conducted to develop a new list of equipment and utensils found in a typical American kitchen and to establish appropriate storage guidelines to accommodate these items. The original list of equipment established from the 1948 publication was utilized and adapted to include additional utensils incorporated into the home since that time. The survey asked families to identify what equipment and utensils they kept in their kitchen, how often they used specific equipment and/or utensils, where they used the item, and where the item was stored. The result from this study determined "that the number of items stored in the kitchen had increased 110 percent from the number reported in the research of Heiner and McCullough" (Beamish et al., in press) in 1948. This growth in the number of kitchen items present in the home reinforces the need for universally designed kitchens in order for people to be able to utilize these items in an efficient manner.

In 1992, the NKBA made significant changes to their Kitchen Planning Guidelines based upon the previous studies mentioned. These guidelines were updated further in 1996 to better include universal design concepts in kitchen planning. In 2000, the NKBA decided to review its guidelines again and funded two additional studies at Virginia Tech within the Housing Program. The first study entitled "Someone's in the Kitchen" was a combination of several methodologies that determined the following: what types of food, utensils, appliances, and products are stored and used; what type of activities occur; how storage and counter space are utilized; different work centers, food preparation and cooking patterns used and criteria established for cabinet usage and storage in the kitchen. The researchers found that kitchens are busy places, with frequent cooking and other household activities (Emmel, Beamish, & Parrott, 2001). They found that people cook on a regular and frequent basis, especially in family or couple households. People eat, cook, socialize, and manage household duties in their kitchens and normally involve more than one person in the process. Sixty-seven percent of the participants in their study ate in the kitchen regularly. They established that generally one person in 67% of the households will do the cooking, or if there are two cooks, they generally take turns doing the cooking. The study discovered that the microwave oven is frequently the primary cooking appliance used today. Sixty-three percent of their sample reported using their microwave oven as much as or more than the range/cook top. They also confirmed that the sink is the main focal point for food preparation. In addition, the researchers uncovered concepts pertaining to major and small appliances in the kitchen. It was found that many people had kitchens with a pantry or a tall storage cabinet. When people analyzed their current kitchen situation, the

researchers found people were generally satisfied with their kitchens but given a chance to make changes they generally would opt for more storage, cabinets, and counter space.

The second study conducted by the same researchers from Virginia Tech in 2003 was developed to document information about items used and stored in kitchens and to determine the amount of shelf and drawer storage needed to store these items effectively (Parrott, Beamish, & Emmel, 2003). The study determined that a kitchen should be designed based upon linear shelf/drawer frontage, rather than wall and base cabinet requirements. The NKBA revised its guidelines in 2004 to incorporate the findings from the 2001 and 2003 studies conducted at Virginia Tech. The new guidelines provide designers with more flexibility in planning storage that is accessible. Storage recommendations are based upon the size of the client's kitchen and where the storage is best needed for the user (Beamish et al., in press).

Kitchen standards and guidelines have been developed and updated throughout the years by applying the results of various research studies. The NKBA continues to sponsor research that investigates and explores how trends, modifications, and new technologies change the way people utilize their kitchens. The addition of universal design concepts into the 1996 standards shows a progressive stance by NKBA; however, further research is needed to test the universal design recommendations to determine if they are in tune with today's kitchen user.

Research on Kitchens Designed for People in Wheelchairs

In the past, various agricultural research centers and housing specialists conducted research investigating kitchen efficiency. In 1956, the "Take-It-Easy Kitchen" was designed for the cook to take fewer steps and to sit down during meal preparation,

eliminating one-third of the required standing time (Howard & Tayloe, 1956). The Beltsville Energy Saving Kitchen of 1959 was planned to "… reduce walking, lifting, and reaching and to eliminate some motions necessary when conventional designs and arrangements were used" (U.S. Department of Agriculture, 1959, P.2). Some of the design ideas suggested in these studies are reminiscent of universal design features utilized today. Both of the above mentioned kitchens recommend removing the base cabinet in front of the sink to provide knee room and to allow for work at the sink to be completed while in the sitting position. These kitchen efficiency studies produced many useful ideas that were modified and that continue to be utilized today for designing kitchens for people in wheelchairs.

One of the first research experiments to address the space and design requirements for a kitchen designed for a person in a wheelchair was conducted by McCullough and Farnham in 1960. A series of tests and measurements were made of the following: the participants in their wheelchairs; space requirements for maneuvering the wheelchair; vertical and horizontal reach measurements; comfortable working heights for wheelchair users; and the necessary clearance of work areas while in a wheelchair. After obtaining the above measurements, McCullough and Farnham had the participants test various kitchen and laundry appliances for accessibility and ease of use. Based upon their previous findings, the researchers had the participants test three different kitchen arrangements (L-shaped, U-shaped, and Galley). Despite the wide range of individual measurements of the participants, the research showed "that there are certain general dimensions and planning guides which can provide comfortable, safe work areas for many wheelchair homemakers" (McCullough & Farnham, 1960, p.36). These recommendations concluded that the work

counter height should be 30 to 31 inches above finished floor (AFF) and should include the sink and the cooktop at the work counter height. In addition, they found the work counter needed a space at least 24 inches wide under these areas. The document recommended a five foot clearance for ease of movement throughout, which is consistent with standard turn around clearances today.

In 1968, the Institute of Rehabilitation Medicine conducted a study on the meal preparation problems of the handicapped and elderly. Only a small portion of the study was devoted strictly to people in wheelchairs. This portion of the study primarily utilized one person, a young quadriplegic, as a basis for observations for testing of a wheelchair user. However, some useful suggestions for accessories in the kitchen and on the wheelchair were made as a result of this study. A device called a "narrower" was recommended for decreasing the width of a folding wheelchair by 3 inches. Lapboards to assist with carrying pots and food items and Velcro carryalls for holding utensils were some of the suggestions highlighted in the study (Institute of Rehabilitation Medicine, 1970).

Model kitchens became the footprint for designing an accessible kitchen in the early 1970s. During this time, most of the research and design in accessibility was developed in Sweden and Europe. Sven-Olof Brattgard researched the activities of daily living among the severely disabled and developed a prototype kitchen known as the Fokus kitchen (Raschko, 1991). The purpose of the Fokus kitchen was to provide access and flexibility to all users. The kitchen was extremely adjustable since cabinets and counters were placed on an adjustable wall track and console system.

Although many design recommendations for accessible kitchens have been published in books and brochures, very few studies have been conducted recently that pertain directly to persons in wheelchairs.

Appliance companies, including Maytag, GE, and Whirlpool, have developed actual model kitchens. Through pamplets and brochures the companies promoted kitchen planning and designs for people with disabilities. They promoted these design solutions as convenient, functional and stylish. Examples included a raised dishwasher, clear floor space under the sink, and lowered work surfaces to accommodate the seated user. In addition to design, they began producing appliances that met the needs of people with disabilities. Locating controls at the front of appliances, making Braille style knobs, and developing the side-by-side refrigerator were some of the features they introduced to the consumer (General Electric, 1979; General Electric, (n.d.); Maytag (n.d.); Whirlpool Corporation, (n.d.)). In the 1990s, GE Appliances sponsored a model kitchen, the Real Life Design Kitchen, which incorporated universal design principles and accessibility standards. The kitchen was presented at various trade show exhibits across the country allowing kitchen designers and builders to see and experience first hand a universally designed kitchen based on the NKBA guidelines for accessible kitchens.

It has been well documented that it is difficult to achieve universal usability, especially in kitchen design when the needs of a standing user are different from those of a seated one (Yearns, Patterson, & Bice, 2005; Story, Mueller, & Mace, 1998; Vanderheiden & Vanderheiden, 1992). In 1993 the Rhode Island School of Design began a five-year project to develop *The Universal Kitchen.* Their goal was to address the issues of a variety of cooks who stand and sit while preparing meals, by designing kitchen cabinets as

modular units that could be manually or electronically adjusted for the individual user. *The Universal Kitchen* was conceived as a "'…kit of parts,' with interchangeable modular components for refrigeration, cooking, water delivery, and storage" (Rhode Island School of Design, 2006, P3.). *The Universal Kitchen* prototype was exhibited at the Cooper-Hewitt National Design Museum in 1998 (Rhode Island School of Design, 2006).

In 2003, Yearns, Patterson and Bice (2005) began a research project to develop a prototype for a universal designed kitchen to meet the needs of older women who prepare meals in their homes. The major issues that their kitchen prototype addressed were ways to lessen climbing and reaching, to reduce bending, and to compensate for lack of strength (Yearns, Patterson, & Bice, 2005). Their kitchen prototype was also based on a modular system and allowed for flexibility in height and cabinet type. Although both modular kitchen projects noted above show great progress towards universal kitchen design, neither prototype has been tested with people in wheelchairs.

Accessibility Standards

It is estimated that 53 million Americans have at least one or more physical or mental disabilities (Center for Accessible Society, 2000). In 1961, the American National Standards Institute (ANSI) developed standard A117.1 *Accessible and Usable Facilities*, as a result of research conducted under a grant sponsored by the Easter Seal Research Foundation. These standards, and subsequent revisions, were guidelines for making the built environment accessible to people with disabilities and were the first criteria presented for accessibility. The Architectural Barriers Act (ABA) of 1968, requires all people to have access to facilities designed, built, altered, or leased with federal funds. The Rehabilitation Act of 1973, which prohibited discrimination against people with disabilities

in all federal programs, marks one of the first efforts to promote handicapped accessibility. This Act, assisted in starting the movement toward requiring accessibility for all people to gain access to public facilities. In 1984, as a requirement for enforcing the Rehabilitation Act, the Uniform Federal Accessibility Standards (UFAS) were developed as the mandatory standards for all federal agencies (Grist, et al., 1996). Four federal agencies were responsible for developing the standards for the design of federal facilities: the Department of Defense, the Department of Housing and Urban Development, the General Services Administration, and the U.S. Postal Service. All federal agencies are responsible for ensuring compliance with UFAS when funding the design, construction, alteration, or leasing facilities of public spaces. These standards serve as the basis for the guidelines established to enforce the law.

Congress originally adopted the Fair Housing Act in 1968, and in 1988 Congress passed an amendment to the Act to include the protection of people with disabilities from being discriminated against in housing and housing related transactions (Stratton, 2001). Prior to 1988, standards and guidelines recommended by ANSI 117.1 were required by individual states or communities within their building code regulations. The Fair Housing Act primarily protects people against discrimination in housing and housing-related transactions. In 1990, the Americans with Disabilities Act (ADA) was passed into law. The ADA primarily protects people's access to public buildings and facilities. These two government initiatives brought national awareness to the importance of designing spaces to accommodate the needs of people with disabilities. These Acts represent significant changes in the philosophy regarding accessible design from the previous three decades. The Fair Housing Act and the ADA are no longer options for local municipalities, they are

civil rights laws that are required to be uniformly applied throughout the country (Grist, et, al., 1996). These standards and guidelines (FHAG and ADAAG) have been recently (2004) added to the International Building Code (IBC) and were revised to ensure consistency among the IBC, FHAG, ADAAG, ABA, UFAS, and ANSI. The IBC adopted these standards and guidelines with the intention of providing housing, buildings, and facilities that are accessible to and usable by people with physical disabilities. In addition, the IBC often references ANSI 117.1. Accessibility standards for this review are divided into three sections; FHAG, ANSI standards, and NKBA guidelines.

Fair Housing Accessibility Guidelines

The FHAG that are associated with kitchen design are primarily located under Requirement 7: Usable Kitchens and Bathrooms. The Fair Housing Act enforces these accessibility standards in multifamily housing projects that contain four or more attached dwelling units. These guidelines are primarily connected with floor clearance space and allow minimal levels of accessibility in the kitchen. The kitchen guidelines required by the FHAG are summarized as follows:

A clear floor space must measure at least 30 inches by 48 inches at the sink and at all major appliances (Stratton, 2001). The clear floor space must either accommodate a person in a wheelchair making a side (parallel) or front (perpendicular) approach to the appliance. Clear floor spaces are allowed to overlap and are measured from the center of each appliance (Stratton, 2001). "For most kitchen arrangements, the minimum clearance allowed between the face of opposing base cabinets, countertops, appliances, or walls is 40 inches" (Stratton, 2001, p. 68) except in the case of a U-shaped kitchen. A U-shaped kitchen with a sink, range, or cooktop located at the base of the U, requires an unobstructed

turning circle that measures at least 60 inches in diameter, unless the base cabinets located at the sink, range, or cooktop have been removed allowing for clear knee space and permitting the person in a wheelchair to approach it from a forward direction. The FHAG refers to ANSI A117.1 regarding the guidelines required for kneespace. ANSI 117.1-1998 Standard 4.2.4.3: Knee clearance must be at least 30 inches wide, provide a maximum depth of 25 inches and have a height clearance of at least 27 inches. Knee clearance for accessible seating complies with the previous requirements except it requires a depth of 19 inches minimum. Toe clearance must be 6 inches deep maximum and 9 inches high minimum. These standards provide additional clarification to issues of clear floor space and wheelchair mobility.

Lastly, the FHAG addresses the issue of reach range for kitchen controls in Requirement 5: Light Switches, Electrical Outlets, Thermostats. The maximum countertop projection allowed is 25 ½ inches. The reach range over the countertop obstruction can be no higher than 46 inches AFF for a parallel or side approach. A forward reach requires a clear knee space under the obstruction as deep as the reach distance and can be no higher than 44 inches AFF.

ANSI Standards

Both the FHAG and ADAAG reference ANSI 117.1-1998 to a great extent. UFAS and ANSI 117.1-1998 almost identically mirror each other in terms of additional specifications that go beyond the FHAG. Accessibility standards published in ANSI 117.1-1998 and UFAS provide more requirements than the FHAG concerning clear floor space and accessible dwellings. UFAS and ANSI number their specifications differently. The

ASNI 117.1-1998 kitchen guidelines that support additional information from the FHAG above are summarized below.

Dwelling Units: ANSI 117.1-1998 Standard 4.33 lists requirements for accessible dwelling units. Adaptable dwelling units with permanently installed fixtures complying with standards 4.33.3 (bathrooms) and 4.33.4 (kitchens) shall be considered accessible dwelling units. Adaptable dwelling units complying with those two standards typically have finished walls and flooring surfaces behind and under cabinets that are removable. The counter surfaces are either adjustable or already at the appropriate heights. Standard 4.33.4.4. requires a 30 inch minimum counter frontage with an adjustable counter height between 28-36 inches AFF or a fixed height to the top of the counter at 34 inches AFF with clear floor space provided underneath. Standard 4.33.4.4.2 states base cabinets, if provided shall be removable under the full 30 inch minimum frontage of the counter. The finished floor shall extend under the counter to the wall and in addition, there shall be no sharp or abrasive surfaces under the counter. The sink shall have a 30 inch minimum of counter frontage with clear floor space underneath with an adjustable (28-36 inches) or fixed counter at 34 inches AFF. At least one sink bowl shall be a maximum of 6.5 inches deep and the faucet controls shall be operable with one hand.

In addition to the above, the ANSI standards provide additional specifications concerning appliances (4.33.4.6 – 4.33.4.9) and cabinet storage (4.33.4.10). Ovens shall be self-cleaning or be located next to an adjustable height counter with knee space below. Oven controls shall be on the front panel. Range/Cooktop controls should not require reaching over the burners to operate and in addition, if an open knee space is provided underneath, the open space must be insulated. Dishwashers must be front-loading with

pull-out racks, and all racks must be accessible from the front of the machine. If the refrigerator/freezer is a side-by-side combination, at least 50% of the refrigerator and freezer storage space must be located within 54 inches AFF. Other refrigerator/freezer combination types (over and under) shall have at least 100% of the refrigerator space and its controls and at least 50% of the freezer space and its controls within 54 inches AFF. Freezers with less than 100% of the storage volume located within the acceptable forward and side reach range as specified in 4.2.5 and 4.2.6 shall be self-defrosting. All cabinets and storage shelves above the countertop will have at least one shelf at a maximum height of 48 inches, and door pulls for base and wall cabinets shall be mounted as high and as low as possible, respectively.

In addition to the required specifications, ANSI 117.1-1998 also makes recommendations through statements such as, "although not required by these specifications …" and "…are easier for people in wheelchairs to use" (p.39). For example, ANSI recommends utilizing a cooktop placed in a counter with adjustable heights to add convenience for a person in a wheelchair (ANSI, 1998). Recommendations are not enforceable by law but are considered to be helpful suggestions.

NKBA Guidelines

Multifamily housing must apply the FHAG requirements; however, there are currently no federal laws in place that cover accessible housing for single-family homes. The NKBA's kitchen planning guidelines are considered to be industry recommendations for single-family homes. The NKBA is recognized as the leading authority for the kitchen and bath industry. Since 1975, the NKBA has published industry accepted guidelines/recommendations. Over the years, NKBA has revised its recommended

guidelines in order to keep abreast of the current trends, changes and demands of the client and industry. In 1996, the NKBA revised its guidelines of kitchen planning to incorporate better universal design practices in kitchen planning. The 2004 revision provides a clear understanding of the kitchen planning guidelines, including the recommended industry standard, building code requirements, and how to adapt or apply the guidelines for accessibility issues. The access standards reference parts of ANSI 117.1 that apply to kitchen guidelines.

The revised kitchen planning guidelines of NKBA utilize the 1998 ANSI 117.1 standards for accessible kitchens as a code reference and provide recommendations that exceed these standards. The recommendations are summarized as follows:

- Swinging doors should provide at least a 34 inch clear opening.
- The sum of the distance between the three work centers should not exceed 26 feet, with no single leg measuring less than 4 feet and more than 9 feet.
- A full height, full depth, tall obstacle should not separate two primary work centers and no major traffic pattern should cross through the basic work triangle.
- Work aisle width should be 42 inches for a single cook and at least 48 inches for multiple cooks.
- The width of a walkway should be 36 inches and, if two walkways are perpendicular to each other one walkway should be at least 42 inches wide.
- There should be 36 inches between the dining table and a wall or obstruction for a seated diner where no traffic passes and 60 inches should be allowed for the seating area to allow for a person in a wheelchair to pass.

- Seating area should provide a space that is between 30-36 inches wide, it should be a minimum of 19 inches deep and the counter height should be placed between 28-34 inches AFF.
- Recommended clear knee space should be 36 inches wide by 27 inches high by 19 inches deep.
- When the countertop located near the sink is not the same height as the sink, provide a 24 inch landing area at the same height as the sink on one side of the sink and 3 inch countertop frontage on the other side of the sink.
- The dishwasher should be raised 6-12 inches when it can be planned with appropriate landing areas at the sink.
- Determine the location of the microwave oven after considering the user's height and abilities; ideally, the bottom of the microwave is 3 inches below the principle user's shoulder, but no more than 54 inches AFF.
- Controls should be no higher than 48" AFF.
- Provide a 15 inch landing area for the oven and microwave; the 15 inch landing area can either be above, below, or immediately adjacent to, the handle side of the microwave.
- Specify clipped or rounded countertop edges rather than sharp edges on countertops.
- Plan storage of frequently used items 15-48 inches AFF and no higher than 44 inches AFF if over a counter.
- Lighting should be provided by multiple sources and should be adjustable.

GE Real Life Design Kitchen

The GE Real Life Design Kitchen was sponsored by GE Appliances and designed by Mary Jo Peterson, a Certified Kitchen Designer (CKD) and was utilized for this research study. It uses standard appliances and cabinets in a non-traditional way. Designed with innovative universal design features, the main purpose of the GE Real Life Design Kitchen was to be an example of good kitchen design that is user friendly for all people including children, older people, and people with disabilities. Peterson's design intent was to feature "… design concepts that adapt to people, rather than people adapting to design" (1995, p.172).

The client profile for the kitchen included two parents in their 40s, an able-bodied 17 year old son, a 72 year old grandmother with arthritis who sometimes uses a walker and is at risk of developing hearing, vision, and memory loss as she ages, and a seven year old daughter with sharp senses and short attention span (Peterson, 1995). Although the client profile did not include requiring accommodations for the wheelchair user, the varied universal design features present, in addition to the generous walkways and work aisles, makes the GE Real Life Design Kitchen an appropriate setting to conduct this study.

There are numerous design details that make the kitchen adaptable to a variety of users with various abilities. For example, the GE Real Life Design Kitchen incorporates three counter heights: 30 inches for seated users, the traditional 36 inch counter top height and a 45 inch counter surface for taller individuals. "The clear floor space in this kitchen is generous and offers sufficient room for maneuvering a wheelchair, assisting another person, or simply working with someone else" (Mullick & Levine, 2001, p.41.6). Some

base cabinets and appliances have been raised off the floor nine inches for improved wheelchair and walker access. Specific features of the kitchen are described below.

Refrigerator/Freezer: The refrigerator/freezer is a side-by-side, GE appliance, with a clear floor space that exceeds ANSI 117.1 requirement of 30 inches by 48 inches (see Figure 4).

Microwave Oven: The GE Real Life Design Kitchen features two different microwave ovens to assist with cooking and food preparation. Figures 5 and 6 show both placements within the kitchen. In Figure 5, the microwave oven has a side hinge door and is located in the corner. Figure 6 shows a photo of the microwave oven with a bottom hinged door. When the door is open, it is level with the height of a moveable table beneath which is 29 ½ inches above finished floor (AFF).

Figure 4. Refrigerator

Figure 5. Microwave Oven A

Figure 6. Microwave Oven B

Oven: The oven has touch controls which are within the recommended reach range for a person in a wheelchair, the oven door opens at table height, with a clear floor space that exceeds the ANSI 117.1 requirement (see Figure 7).

Dishwasher: The kitchen features two different dishwashers. Figure 8 shows the dishwasher that is located to the left of the primary sink in the kitchen which is adjustable (see Figure 8). In Figure 9, the raised dishwasher allows for easy access; it is located to the right of the secondary sink, also shown in Figure 9, and is positioned opposite the shallow dish and glass storage located at the back of the island.

Sink: Two sinks are located within the GE Real Life Design Kitchen and assist in creating two different work triangles within the space. The primary sink, shown in Figure 8, is a double-bowl sink, with clear floor space underneath and the counter is motorized, which allows for adjustability between the heights of 32 inches and 42 inches AFF. The secondary sink shown in Figure 9 features an open knee space, a filtered water dispenser, and a lowered counter height for the sink and adjacent counter space. The additional counter space to the left of the sink provides an additional 24 inch by 24 inch of clear counter surface for food preparation.

Figure 7. Oven

Figure 8. Dishwasher A

Figure 9. Dishwasher B

Cooktop: The glass smoothtop cooktop has easy touch controls and a safety indicator that stays on until the unit cools down. The doors below the cooktop are on hinges that fold back on either side, providing a clear knee space (27.25 inches wide x 11.5 inches deep x 29.125 inches tall) below the cooktop (see Figure 10). The cooktop also features a motorized downdraft ventilation system that raises and lowers with the touch of a button located on the front of the cabinet frame and is revealed when the cabinet doors are opened.

Rolling Surfaces: Two rolling carts and one rolling table provide additional counter surfaces and increase the flexibility of the space, (see Figures 11 and 12).

Figure 10. Cooktop

Figure 11. Roll-out Table & Roll-out Cart T7

Figure 12. Roll-out Cart T6

Cabinet Accessories: The GE Real Life Design Kitchen features many different cabinet accessory features that can only be recognized when the cabinet is opened and the feature is exposed.

Roll-out Features: Figures 13, 14, 15, and 16 all show different types of roll-out features present in the kitchen design. Figure 13 shows a 9 inch pull-out pantry cabinet that rolls forward, takes up a minimum amount of cabinet storage space and is open on both sides for easy condiment access. Figure 14 shows one of the many pots and pans drawer bases located within the space. The three drawer cabinet has reinforced glides and deeper storage that allows for heavy and large cooking appliances and utensil storage with easy retrieval associated with pull-out drawers. Figure 15 illustrates the base cabinet with the pull-out veggie bins. Roll-out trays, as seen in Figure 16, are located throughout the kitchen design and provide easy access to the back of the base cabinet.

Cutting Surfaces: Figures 17 and 18 show the two different types of cutting surfaces provided in the kitchen layout. Figure 17 represents a chopping block cutting surface in a top drawer of a base cabinet and is located in two areas of the kitchen: to the left of the main dishwasher; and to the left of the refrigerator. Figure 18 shows a cutting surface that is located in the second drawer of the cabinet which provides a cutting/work surface approximately 30 inches AFF. This cutting surface has a circle cut out in order to hold a bowl as seen in Figure 18. The height of this feature should accommodate anyone who is working in a seated position. These cutting surfaces provide additional pull-out work surfaces at a lowered height than the countertop.

Figure 13. Pull-out Pantry

Figure 14. Pots and Pans Base

Figure 15. Veggie Bin

Figure 16. Pull-out tray cabinets

Pull-down Shelves: The wall cabinets to the right and the left of the double-bowl sink have a pull-down shelf unit installed inside the cabinets. Figure 19 shows the pull-down shelf unit utilized for this study.

Figure 17. Cutting Surface Figure 18. Cutting Surface Figure 19. Pull-down Shelf

In addition to the features described above, the GE Real Life Design Kitchen, has numerous other details that incorporate good universal design practices that would go unnoticed to the untrained eye. Countertops are light cream in color and have raised, contrasting dark blue inserts to contain spills and to provide visual and tactile cues to people with visual impairments. The kitchen incorporates an aesthetically pleasing use of open shelving, an open dish rack, and base cabinets with shatterproof glass that allows for clear view, eliminating the need to remember where items are stored. These base cabinets also provide easy access to the stored items. "This kitchen considers the range of users and supports its use by all members of a family, including, for example, able-bodied adults, older people, wheelchair or walker users, children and tall people" (Mullick & Levine, 2001, p.41.6).

CHAPTER 3: METHODOLOGY

The major purpose of the study was to evaluate the universal design features of the GE Real Life Design Kitchen by people using wheelchairs, in order to: see if the design features were beneficial to the user; discover the cooking patterns of people in wheelchairs; and recommend universal design features that were useful in the GE Real Life Design Kitchen. This study utilized interviews and observation techniques with a purposive sampling of people in wheelchairs. This study was approved by Virginia Tech's Institutional Review Board (see Appendix A).

Research Design

The research design for this study was exploratory. The use of interviews and observation is commonly used in exploratory research. The methodology was modeled and adapted after a previous study funded by the NKBA titled, "Someone's In The Kitchen" (Emmel, Beamish & Parrott, 2001). This study determined different cooking patterns and behaviors for a range of users.

The pre-cooking interview and observation portions of this study were adapted from the procedures previously used in the study by Emmel, Beamish & Parrott (2001). The universal design evaluation activity assessed the ability of the participant to complete specific tasks, evaluated specific universal design features in the GE Real Life Design Kitchen, and recorded a range of anthropometric data gathered from the participant. The post-cooking interview consisted of in-depth interviews about the respondents' experiences with the universal design features and the cooking experience. A direct approach was used; therefore, the participants knew the true purpose of the project. This approach is useful when the main purpose of the study is to gain insights into the participant's perceptions

(Malhotra, 1999). Informed participants understand the objectives of the study and are more likely to reveal unexpected information.

Unlike causal research that is rigid and does not allow for feedback, exploratory research is much more informal and provides flexibility in the discovery process. Flexibility is an essential component to exploratory research. Since very little testing of universal design features in the kitchen have been conducted, it was important to uncover information that may not have been considered when the features for the kitchen were designed. Unexpected findings are normally obtained from a flexible research design (Creswell, 1994; Malhotra, 1999; Silverman, 2000).

Design Validity and Reliability

Exploratory research is often unstructured and normally obtains unexpected findings; however, this does not mean that the research design is without control (Malhotra, 1999; Silverman, 2000). Many controls are set in place to assist in the removal of error and bias from the study. Information was gathered from a variety of methods utilizing a triangulation approach to data gathering. Triangulation strengthens the reliability and validity of the study, especially when multiple research questions and corroboration of information is explored (Baker, 1999; Silverman, 2000). This method assists in removing inherent bias from the study (Creswell, 1994). To establish internal validity, the information for this research was gathered through various methods of inquiry including: interviewing participants before they simulated activities; observation and behavioral mapping of cooking patterns and activities; and conducting interviews after the cooking activities.

The pre-cooking assessment interview instrument provided pertinent information about the participant's household, food preparation patterns, cooking activities, and an assessment of activities of daily living (ADLs) related to food preparation. The instrument also included questions about the participant's present kitchen and its use related to storage, counter space, and appliances. It provided insight into individual perceptions and satisfaction of each participants' current kitchen arrangement prior to the cooking activity. The pre-cooking assessment interview was conducted prior to the cooking activity. Observations were recorded during the cooking activity and through review of tapes taken during the cooking activity sessions. On the same day the participant visited the Center for Real Life Kitchen Design, and after they had finished the cooking activity, a post-cooking interview was completed. This avoided errors associated with maturation, history, and mortality.

The variables selected for the study were not used to determine cause-and-effect, but to gain background information and insight into the participant's satisfaction and perceptions of universal design features in the GE Real Life Design Kitchen. Although, this research does not lend itself to generalization and is difficult to quantify, the research does allow for "… flexibility and will normally produce a wider range of insight, information and ideas…" (Malhotra, 1999, p.156). One of the major reasons for the exploratory nature of this study was to allow for detailed feedback and comments concerning the universal design features applied in the GE Real Life Design Kitchen.

Setting

The GE Real Life Design Kitchen was sponsored by GE Appliances, designed by Mary Jo Peterson, and donated to Virginia Tech in 1998. It is part of the Center for Real

Life Kitchen Design. The Center houses five fully operational kitchen settings in the 1,500 square foot facility. The GE Real Life Design Kitchen was designed with innovative universal design features, such as an adjustable height sink, pull-down cabinet shelves, multiple height counters, and a cook top with space underneath. The main purpose of the GE Real Life Design Kitchen is to serve as an example of good kitchen design that is user friendly for all people, including children, older people, and people with disabilities. Featuring "… design concepts that adapt to people, rather than people adapting to design. It acknowledges a wide range of physical and mental abilities in today's families" (Peterson, 1995). Figure 20 shows the kitchen layout as an island kitchen with a secondary work triangle integrated into the design solution.

Some of the specialized universal design features are noted in the layout (See Figure 20) and in Chapter 2 of this document. Additional features include specialized controls on appliances, color contrast of surfaces for visual acuity, cove and increased task lighting and general illumination to assist people with visual difficulties and glare reduction, and raised toe kick height, at the base of the bottom cabinet, for increased wheelchair and walker mobility. Some of the original appliances specified by Mary Jo Peterson are no longer a part of the design, as they were updated later, both when GE donated the kitchen to Virginia Tech in 1998 and since it has been placed there.

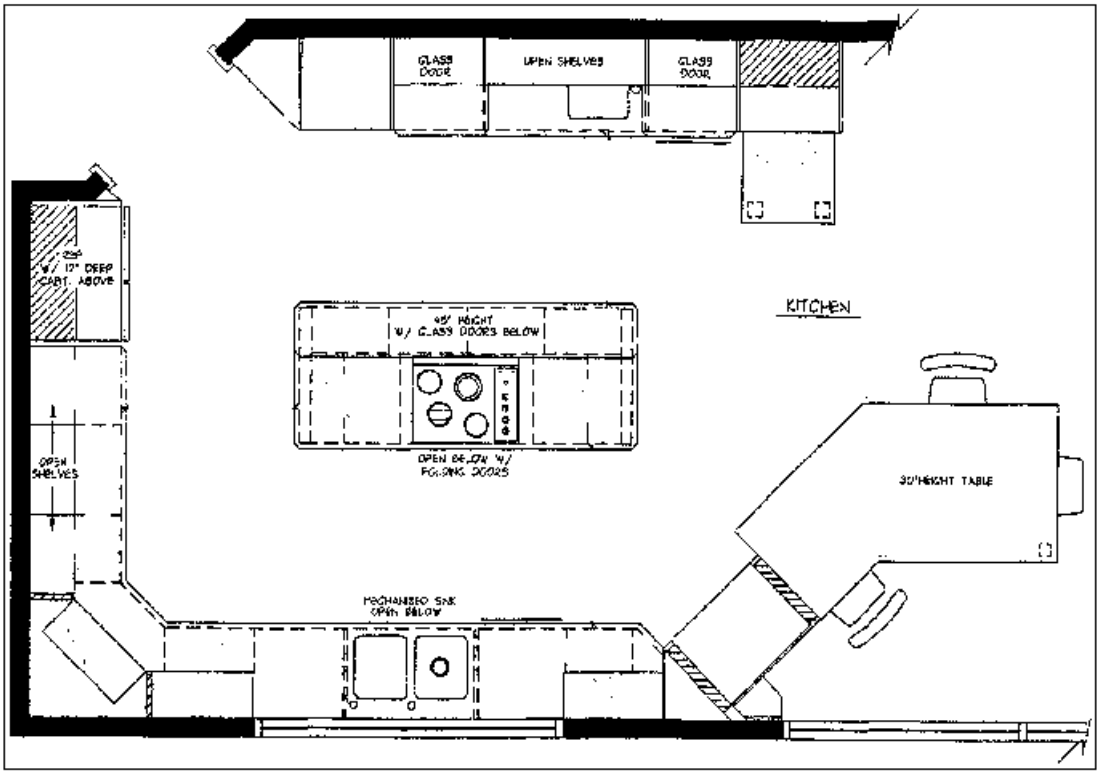

Figure 20. The GE Real Life Design Kitchen Layout (Adapted from Peterson, 1995, p.174). Used with permission.

Sample

The participants for this study were determined by a purposive sample. A purpose sample knows the true nature of the purpose, or goals and objectives of the research study being conducted (Compton & Hall, 1972). The participants were chosen based upon the established sample profile and the availability and willingness of the participants (Babbie, 1990; Silverman, 2000). To protect the rights of the wheelchair user, Virginia Tech's American with Disabilities Act (ADA) Coordinator assisted with the initial contact of potential participants. An e-mail message and flyer (See Appendix B) was submitted through the ADA Coordinator's office, explaining the purpose and requirements of the study. Interested participants contacted the researcher to make a further inquiry and to

volunteer for participation in the study. The ADA Coordinator also contacted various employers in the area who have previously hired people in wheelchairs to see if they would also be willing to offer assistance in finding participants that qualify for the study. In addition, a snowball sampling technique was utilized to assist in identifying other participants and two willing participants that met the sample profile were found through this method (Malhotra, 1999). The ADA Coordinator's office sent out additional reminder e-mails to the original list encouraging participation and contacted some participants directly via the telephone. Additionally, the ADA Coordinator contacted the director of the Blue Ridge Independent Living Center, who agreed to e-mail the flyer to possible participants (See Appendix B).

The total number of participants was 9 individuals. Silverman argues that sample size is not an important factor in being able to generalize a study, but the importance lies within the sample itself. "… Sampling demands that we think critically about the parameters of the population we are interested in and choose our sample case carefully on this basis" (Silverman, 2000. p.104.). Each participant had to meet the sample profile in order to participate in the study. The target sample includes adult males and females living within the New River Valley and surrounding region. The participants had to meet the following profile: 1) responsible for preparing at least one meal a week in their own kitchen, 2) use a wheelchair while cooking, 3) able to provide their own transportation to the testing site, 4) able to allow four to five hours for the study, and 5) agree to be videotaped or photographed for recording purposes. The selection criteria ensured each participant's familiarity with prior cooking activities and challenges associated with food preparation tasks while using a wheelchair. These criteria requirements formed the basis

and provided the most accurate testing of the universal design features in the GE Real Life Design Kitchen for this particular group of users.

Instruments

Participants that volunteered for the study were screened (See Appendix C) to make certain they met the sample profile for the study. Each viable participant was then asked to sketch a diagram of their current kitchen and bring any additional support documents, such as photographs, or diagrams with them to the study.

The study was separated into four different sections/activities; the pre-cooking interview, the universal design evaluation, the cooking activity, and the post-cooking interview. Eight different data collection instruments were used. Each section/activity contained one or more instruments. Participants were given the choice of either completing the study in one day or separating the study into two different sections and two different days. The pre-cooking interview incorporated the pre-cooking assessment interview sheet and was conducted in the GE Real Life Design Kitchen prior to becoming familiar with the kitchen's features and layout. Two instruments were developed for the universal design evaluation portion of the study; the universal design evaluation form and the universal design decision tree. The cooking activity incorporated four different instruments to assist in the investigation of meal preparation in the GE Real Life Design Kitchen: diagram for kitchen set up, cooking activity menu, menu task matrix, and the behavioral map of cooking patterns. The final section of the study utilized one instrument, the post-cooking interview guide; it provided follow-up questions and allowed for feedback concerning the participant's cooking activity. All activities in the GE Real Life Kitchen Design were videotaped for recording purposes and to help eliminate observer bias.

Pre-Cooking Assessment Interview

A pre-cooking interview instrument and cooking activity were developed by the housing faculty members at Virginia Tech as part of the National Kitchen and Bath (NKBA) study "Someone's in the Kitchen" and was modified by the researcher for this study. The adapted pre-cooking assessment interview instrument was designed to gather information about the participant's household, food preparation patterns, cooking activities, and appliance usage (See Appendix D). It also investigated specific patterns of kitchen use by examining a variety of activities that might take place in the kitchen and assessed the participants' range of motion, strength, and handedness through an assessment of ADLs related to food preparation.

Universal Design Evaluation Instruments

Two instruments were developed for this section of the study: the universal design evaluation form and the universal design decision tree. This portion of the study was video taped utilizing a video camera attached to a tri-pod. The camera was placed in close proximity of various tasks preformed to obtain the best view of the task at hand. This portion of the tape was reviewed and evaluated by the researcher utilizing the universal design evaluation decision tree matrix after all the participants had finished the study.

Universal Design Evaluation Form: The instrument's purpose was threefold: collecting anthropometric data, evaluating specific universal design features of the GE Real Life Design Kitchen, and orienting the participants to the kitchen (See Appendix E). Collecting specific anthropometric data from each participant allowed the researcher to recognize variances in the reach, size, and clearance needs of the participants. In addition,

the universal design activity specifically tests certain universal design features of the GE Real Life Design Kitchen by having the participant perform and evaluate various tasks.

The participants performed 18 different tasks related to 18 different features of the kitchen. At four different times during the study, the participants were asked to compare similar tasks to determine which task, appliance, or feature was easier to use, requiring 22 task evaluations for this section. The researcher read the directions for each task out loud to the participants and pointed in the area where the task was to take place. All cabinets, accessories, and appliances were labeled. The labeling was printed on white paper with black ink. Times New Roman, 96 point font was used. The participants evaluated the features and tasks based upon ease of use and visual appeal. At the end of each task, the participants were asked if they had any additional comments they would like to add. Figure 21 shows a diagram of where each task occurred.

These tasks include: taking items from the freezer to the microwave (Tasks 1 and 2); adjusting the sink height utilizing the motorized mechanism (Task 3); placing a coffee mug and plate from the sink into the dishwasher (Tasks 4 and 5); utilizing roll-out carts and cutting boards to assist in the cutting of a vegetable (Tasks 6, 7, 8, and 9); operating a pull-down shelf from inside a wall cabinet (Task 10); opening various roll-out drawers and trays to retrieve items (Tasks 11, 12, 13, 14, and 15); opening a base cabinet with reduced depth and push-touch cabinet opening mechanism and removing a plate from the bottom shelf (Task 16); removing and serving a casserole dish from the oven (Task 17); and utilizing open floor space under the cooktop in order to simulate stirring a pot (Task 18).

The participants evaluated the features and tasks based upon ease of use and visual appeal. At the end of each task, the participants were asked if they had any additional

comments they would like to add. The universal design evaluation activity also oriented the participants to various features of the GE Real Life Design Kitchen that they may utilize in the cooking activity.

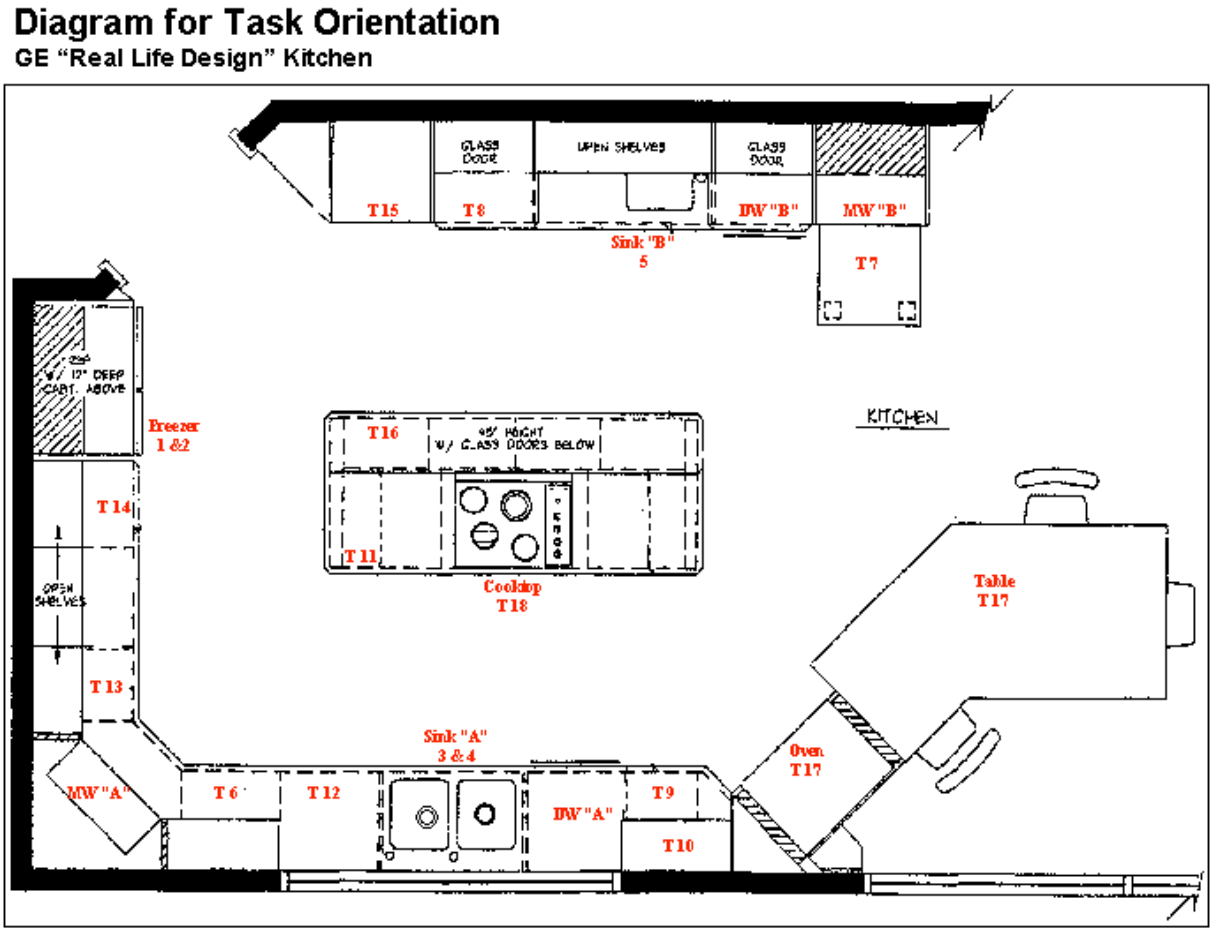

Figure 21. Diagram for Task Orientation (see Appendix F)

Universal Design Evaluation Decision Tree: While reviewing the universal design activity on the videotape, the researcher assessed the participant's ability to complete each task based upon Steinfeld and Danford's (1999) decision tree for environmental function (See Appendix G). This instrument assisted the researcher in objectively classifying the participants' ability in completing the tasks for each universal design feature tested.

To provide a holistic understanding of the participants' perceptions of the universal design features tested, it was important to have a clear understanding of the person, behavior and the environment present. The two instruments used together combined the participant's perception of the features with the participant's ability to complete the task. The universal design evaluation instruments were utilized together to assist in the evaluation of the universal design features of the GE Real Life Design Kitchen.

Cooking Activity Instruments

The cooking activity incorporates four different instruments: diagram for kitchen set up, cooking activity menu, menu task matrix, and the behavioral map of cooking patterns. These instruments were needed to assist with the evaluation of how a person in a wheelchair prepares meals in the GE Real Life Design Kitchen. The cooking activity was designed to analyze how each participant organized the kitchen prior to cooking (See Appendix H) and to record cooking patterns and activities that take place during the preparation of the set menu (See Appendix I). Specific tasks were evaluated during the actual meal preparation on the Menu Task Matrix (Appendix J) and included: getting ingredients from storage and refrigerator; washing and cutting vegetables; utilizing the counter surface; roll-out cart and table surface; assembling, measuring and mixing ingredients; microwave defrosting; surface and oven cooking; loading the dishwasher and hand washing. The Menu Task Matrix instrument was adapted from Emmel, et al. (2001). Upon completion of the universal design feature assessment, the participants were given all the ingredients and cooking utensils required to prepare the meal. They were then asked to tell the researcher where to place the items for their best use of the kitchen and ease in

preparation. Participants were not allowed to place items on the countertop unless it was appropriate to do so in their own household.

This portion of the study utilized the Menu Task Matrix instrument (See Appendix J) to make certain that the appropriate ingredients and utensils were present and to assist in the recording of specific cooking behaviors and activities. The cooking activity was video taped to record all movements and cooking activities in the GE Real Life Design Kitchen. A video camera placed on a tri-pod located near the table surface in the GE Real Life Design Kitchen and marked on the behavioral mapping diagram documented the cooking activity from a fixed vantage point. Once the cooking activity was completed, the researcher utilized the Behavioral Map of Cooking Patterns to record the actions of the cooking activity (See Appendix K).

Post-Cooking Interview Guide

After the cooking activity, an additional instrument for conducting the post-cooking interview was used (See Appendix L). The post-cooking interview consisted of questions utilizing laddering and in-depth interviewing techniques. The main purpose of in-depth interviews was to obtain meaningful responses to questions and to uncover hidden issues (Malhotra, 1999). Laddering is the type of in-depth interviewing technique that was utilized in the post-cooking interview portion of the study. "In laddering, the line of questioning proceeds from product characteristics to user characteristics" (Malhotra, 1999, p.159). An interview guide sheet assisted the interviewer in asking specific fixed response and open-ended questions concerning the participants cooking activity experience. Open-ended questions allow for more personal feedback concerning the participants' perceptions of the experience. To ensure uninterrupted flow of discussion and accurate recording of

information obtained, the interviewer video taped the post-cooking interview session in addition to taking quick notes during the process.

Data Collection Procedures

Utilizing different data collection procedures strengthens the reliability of a qualitative study (Baker, 1999; Silverman, 2000). To gain valuable data and decrease the likelihood of misinterpretation by the researcher, various interviewing and observation techniques were integrated into the study. The various data collection methods and techniques are described below.

Each participant was given the choice of either completing the study all in one day (approximately 4 hours) or of separating the study into two sections on two different days (approximately 2 hours each day). The data for each participant was collected following initial phone contact that qualified the participants for the study to make certain that they met the criteria established (See Appendix C) and to schedule a day for them to come to the Center for Real Life Kitchen Design in Wallace Hall to participate in the study. At the end of the pre-qualifying process, the respondents were asked to bring a diagram and/or any additional records or photographs of their current kitchen to Wallace Hall when they participated in the cooking activity.

On the day of the study, the participants were greeted by the researcher and the study was explained to them. The participants signed the informed consent and photographic release forms (See Appendix M & N), turned in their kitchen sketch and additional documents to the researcher. The researcher then examined the documents to gain further information about the participants' kitchen, such as layout, modifications, and organization. The researcher made copies of the documents when necessary and then

proceeded with the study. All data and information from each participant was collected on the same day, unless the participant selected the two day study option, then data was collected on both days.

The pre-cooking assessment interview was given in the Center for Real Life Kitchen Design that houses the GE Real Life Design Kitchen, four additional kitchens, and a classroom. The pre-cooking assessment interview was taken prior to the participants' exposure to the GE Real Life Design Kitchen. The pre-cooking interview process provided insight into each participant's perceptions prior to the cooking activities of this study. This should have reduced the learning effect error and measurement error. Participants were given a copy of the pre-cooking assessment interview guide (See Appendix D) to follow during the interview.

The universal design evaluation, cooking activity, and post-cooking interview discussion were video taped in order to observe and document all activities and information obtained. In addition to video taping the process, the researcher recorded the information on a form during the universal design evaluation and post-cooking interview portions of the study. The researcher reviewed the tapes and recorded the activities according to the instruments developed and created behavioral maps of each participant. Behavioral patterns can only be recorded during observation. This process allows the researcher to gain information and record the actions in which the participant is unaware or unable to communicate (Malhotra, 1999). The observational method reduces a reporting bias that could be present in the interviewing process. The post-interview guide directed the follow-up questions concerning the participants' experiences and perception of cooking in the GE Real Life Design Kitchen. The interview consisted of fixed response and open-ended

questions. The interview continued until no new information was being discussed. To insure control of the post-cooking interview process, an interview guide was followed (see Appendix L).

Data Analysis

The purpose of the study was to investigate the effectiveness of universal design features of the GE Real Life Design Kitchen by people using wheelchairs. The study determined if the universal design features were beneficial to users in wheelchairs. The specific objectives of the study were:

1. to evaluate the universal design features of the GE Real Life Design Kitchen by people in wheelchairs, and
2. to examine how the GE Real Life Design Kitchen is used by people in wheelchairs as they prepare a meal in the space.

The data analysis was divided into three parts based upon the objectives of the study:

1.) The researcher analyzed the participant's responses during the universal design evaluation activity and evaluated certain universal design features of the GE Real Life Design Kitchen by people using wheelchairs, specifically evaluating the reported ease of use and the reported visual appeal of the universal design features. This data was presented in frequencies and percentages.

In addition, the researcher utilized a decision-tree instrument (Appendix G) adapted from Steinfeld and Danford (1999) and evaluated the observed ease of use for each specific task outlined in the universal design evaluation form.

2.) The researcher examined how the GE Real Life Design Kitchen was used by people in wheelchairs as they prepared a meal in the kitchen space through the analysis of the behavioral maps and video analysis check sheet. A summary of this analysis documented the following behaviors: where different food preparation and cooking activities occurred; how the participants organized themselves before, during and after the cooking activity; and what type of traffic patterns developed throughout the cooking activity.

In addition, the post-cooking interview provided open-ended questions for the participants to answer.

3.) These questions were asked to further clarify the participants' experiences with the universal design features and layout of the GE Real Life Design Kitchen. This portion of the study was evaluated utilizing an open coding analysis. "Open coding is the part of the analysis that pertains specifically to the naming and categorizing of phenomena through close examination of data… During open coding, data are broken down into discrete parts, closely examined, compared for similarities and differences" (Strauss & Corbin, 1990, p.62). The video and audio recordings of the post-interview, along with the researcher's notes were utilized to develop emerging themes and to offer suggestions from the post-cooking interview.

The video taping of participants during the study allowed for systematic observation of the participants behaviors during the pre-cooking, cooking, and post-cooking process.

The purpose of this method was to supplement, enhance, and enrich the information found throughout the interviewing and recording processes.

CHAPTER 4. ANALYSIS

This chapter discusses the findings of the study and consists of four sections: description of subjects, evaluation of universal design features, observations of meal preparation, and analysis of the post-cooking interview. In section one, the participants' characteristics are described. In section two, the analysis is organized by the tasks tested in the GE Real Life Design Kitchen. Section three discusses observations from the meal preparation, and the last section summarizes comments obtained from the post-cooking interview.

Subjects

A total of 11 subjects were recruited for this study. Of the 11 recruited, two were excluded from this study. One did not meet the criterion of using a wheelchair while cooking. The other determined that she did not have the four hours of time available to complete the study. These subjects did not meet the sample criteria discussed in the Sample section of Chapter 3 and established before the study. Their participation would have affected the evaluation of data collected. The remaining nine participants were contacted by phone to schedule a date and time for data collection and agreed to participate in the study.

Demographic information for the participants is shown in Table 4.1. The sample consisted of 5 male and 4 female participants with ages ranging from 28-58 years old. All selected participants used a wheelchair on a daily basis for a variety of disabilities. Each participant had varying levels of grip, strength, and memory as a result of their disability.

Frank was a 37 year old male with multiple sclerosis. At the time of the study, he had been using a wheelchair for 10 years. Frank had the second longest horizontal forward

reach (32.5 inches) and the longest forward reach stretching (52.5”). His ability to bend and reach is among the highest with a 20 inch difference, but as a result of his disability, he fatigues easily and does not have great strength in which to complete certain tasks. This would account for his low rating of the pull down shelf accessory in Task 10. His reach range enables him to reach the shelf unit but his strength does not allow for ease of utilizing the feature.

Phil was a 54 year old male with multiple sclerosis. At the time of the study he had been using an electric wheelchair for 6 years. He noted that his failing short-term memory and fatigue are the biggest obstacles for his meal preparation and that his wife often assists him in the kitchen. He recently had purchased a side opening bottom freezer refrigerator and believes it to be the best refrigerator option for a wheelchair user. In addition, he noted that he usually uses plastic cups and Corelle™ dishes for weight purposes and to prevent breakage if items were dropped.

Harvey was a 58 year old male with a brain injury. At the time of the study, he had been using an electric wheelchair for 3.5 years. He commented that he had very limited functional use of his left hand and limited peripheral vision in both eyes. Harvey tired easily, struggled to maintain focus, and noted short term memory loss as an issue. He brought his wife with him to the study, and she assisted him at various times throughout the study. Harvey took the longest amount of time to complete the cooking activity and appeared to be very fatigued by the end of the day.

Kim was a 42 year old female with muscular dystrophy. At the time of the study, she had been using a wheelchair for 7 years. Kim brought a reacher and tongs to assist her with the meal preparation portion of the study. Kim had very limited horizontal forward

reach (27”) and could only bend forward 2 more inches when asked to stretch forward (29”). She could not complete Task 10 for this reason. She also noted that in her current living situation she could not reach the freezer (top mounted). During the pre-cooking assessment interview, Kim described activities requiring her to raise her arms, lift items out of upper cabinets or the oven, and bend over to retrieve things as very difficult to do.

Kathy was a 46 year old female with rheumatoid arthritis. At the time of the study, she had been using a wheelchair for 36 years. She brought a reacher to assist her with the cooking activity. Kathy had very limited horizontal forward reach (21”) and could only bend forward one more inch when asked to stretch forward (22”). She could not complete Task 10 for this reason. She noted that she normally would have utilized her reacher for Task 10 but found it difficult to utilize the reacher for this task because the pull down shelf unit had a wire edge in which she could not lift the items over. She was the only participant that utilized her legs to help her maneuver her wheelchair around the space, for this reason her footrests are not attached to her wheelchair.

Jill was a 41 year old female with a spinal cord injury. Her medical diagnosis was described as a T6 paraplegic. At the time of the study, she had been using a wheelchair for 16 years. Other than the loss of the ability to use her legs, Jill’s ability to lift, move, and bend were noted as above average and she noted her strength to be average. Jill had recently built a new home and had designed her kitchen to accommodate her specific needs. Special features that she included in the design of her kitchen included a sink base cabinet with hinged pocket doors to provide a clear knee space under the sink. A lowered counter space area with clear knee space underneath to serve as a food preparation area that was located directly next to the double wall oven. The double wall oven was inserted into

the oven cabinet at the lowest possible height. In addition, the angular U-shape of Jill's kitchen layout allowed for a 5'-0" turn around area throughout the entire kitchen space.

Craig was a 53 year old male with a spinal cord injury. His medical diagnosis was described as a T7 paraplegic. At the time of the study, he had been using a wheelchair for 8.5 years. Craig had the second longest differential between the horizontal forward reach measurement and the stretching measurement (16.5" difference). His ability to bend and reach is among the highest with possibly the greatest strength and grip ability among all the participants. He was one of only three participants that liked the pull-down shelf feature in Task 10 and thought it would make his kitchen preparation easier. He was the only participant who utilized this feature during the meal preparation activity.

Mike was a 48 year old male with a spinal cord injury. His medical diagnosis was described as a T12, L1 paraplegic. At the time of the study, he had been using a wheelchair for 12 years. Mike noted that he prepares dinner on a regular basis for his wife and two children. When he cooks he sometimes uses a reacher to assist him with retrieving items from the upper cabinets. He did not bring a reacher to the research study site. Mike's kitchen at home had been modified while under construction to accommodate his wheelchair. Modifications included knee space next to sink, a microwave oven built into the base cabinet, elevated toe kick, and roll out shelves placed in all base cabinets. When asked if there was anything about his kitchen that he would change he commented that he wished there was knee space under the sink.

Mary was a 28 year old female with a spinal cord injury. She was the youngest of all the participants and although she was fairly strong, she had the least ability to grip among the group. Her medical diagnosis was described as a C6 quadriplegic. She does not

have much feeling in her hands and must use the back of her hands to test how hot something is while cooking. Mary brought her dog to the research study site. She did not use his assistance for this study, but she noted that he normally assists her by picking up things and opening and closing doors. In addition, she brought a special knife and cutting board that assists her with cutting. Due to her inability to grasp, she was unable to complete Task 10.

Basic anthropometric measurements were taken of all the participants with the use of a tape measure and wooden ruler. These measurements do not reflect scientific anthropometric data and cannot be utilized in other studies; however, they do reflect the range of reach, wheelchair dimensions, and eye height measurements taken for this study (see Table 4.2). The horizontal forward reach measurement ranged from 21 inches to 38 inches and the vertical reach height sitting ranged from 47 inches to 69 inches. The participants utilized a wide variety of wheelchairs, two electric and seven manual wheelchairs. The dimension of the width (22-25.75 inches) and arm height (26.5-30.5 inches) of each wheelchair varied within 3 to 4 inches. The depth of the chair had a greater range of differences, ranging from 27.5 inches deep to 35 inches deep.

Table 4.1
Demographics of Sample

Name	Gender	Age	Disability	Yrs in Wheelchair	Horizontal reach/ Stretch reach
Frank	Male	37	multiple sclerosis	10 years	32.5" / 52.5"
Phil	Male	54	multiple sclerosis	6 years	38" / 48.5"
Harvey	Male	58	brain injury	3 years	29.25" / 35.5" wife assisted
Kim	Female	42	muscular dystrophy	7 years	27" / 29" reacher
Kathy	Female	46	rheumatoid arthritis	36 years	21" / 22" reacher
Jill	Female	41	paraplegic: T6	16 years	29.5" / 41"
Craig	Male	53	paraplegic: T7	8.5 years	29.5" / 47"
Mike	Male	48	paraplegic: T 12, L1	21 years	31" / 39.5"
Mary	Female	28	quadriplegic: C6	12 years	29" / 34" special knife & dog assisted

Living Situation

Apartment	(2)	Townhouse/Condo	(1)	House	(6)		
Multi-Floor	(1)	Single floor layout	(8)				
Rent	(2)	Own	(7)				
1 Bedroom	(2)	2 Bedroom	(2)	3 Bedroom	(4)	4 Bedroom	(1)

Table 4.2
Anthropometric Data of Sample

	Frank	Phil	Harvey	Kim	Kathy	Jill	Craig	Mike	Mary
MEASUREMENTS									
Side Approach Horizontal Reach Sitting	27"	25"	27"	24 1/2"	27"	26"	25 1/2"	16"	21"
Vertical Reach Height Sitting	66"	61 1/2"	66"	62"	67"	69"	67"	47"	60"
Sitting Height	51 1/4"	48 1/4"	54"	52"	52 3/4"	55"	53"	48"	47"
Eye Height Sitting	47 1/2"	44"	48 1/4"	47"	50"	51 1/2"	48 1/2"	45"	43"
Shoulder Height Sitting	40 1/4"	39"	43 1/2"	42"	42 1/2"	44 1/4"	43 1/4"	37 3/4"	39 1/2"
Top of Arm Height Sitting	28 1/2"	28 1/2"	31 1/2"	32 3/4"	30 3/4"	29 1/2"	34 1/2"	30"	29 1/4"
Under Knee to Toe Length	14 1/2"	10 1/2"	16"	17"	9 1/2"	13"	15"	11"	10"
Thigh to Floor	25 1/2"	25"	26 1/2"	25 1/2"	25 3/4"	26 1/2"	27"	22 1/2"	22"
Horizontal Forward Reach	32 1/2"	29"	38"	29 1/2"	29 1/2"	31"	29 1/4"	21"	27"
Horizontal Forward Reach Stretching	52 1/2"	34"	48 1/2"	47"	41"	39 1/2"	35 1/2"	30"	33"
Wheelchair Width	24"	22"	24"	25"	24 1/2"	23 1/2"	25 1/2"	22 1/2"	25 3/4"
Wheelchair Depth	28"	30"	35"	30"	32"	26"	27 1/2"	34"	30 1/2"
Foot Rest Extension Depth	17"	14"	17"	14"	10 1/2"	13 1/2"	11"	N/A	N/A
Wheelchair Arm Height	N/A	26 3/4"	29"	29 3/4"	N/A	27"	30 1/2"	28 1/4"	26 1/2"
Floor to top of Toe in Footrest	7"	7 3/4"	8"	9 1/4"	7 1/2"	6 3/9"	7"	N/A	N/A

Universal Design Evaluation

The participants were asked to test certain universal design features and standards present in the GE Real Life Design Kitchen. The findings from this part of the study are described in this section. This section is divided into 22 parts to reflect each assigned task. Each part contains the directions given to the participants, a diagram and illustration of the task being performed, an evaluation of the ratings from each task or a comparison of two or more tasks, and a discussion about the comments and or suggestions about the feature(s) tested.

After all the participants had finished the study, the researcher then evaluated each task performed utilizing Steinfeld and Danford's (1999) decision tree matrix for environmental function (See Appendix G). The purpose of the decision tree was to determine if the actual participant's perception of a particular task ease of use was congruent with the researcher's perception. The majority of all tasks for all participants scored either a 9 or 10 on a 10 point scale. A score of 10 indicated that the participants completed the task in a reasonable amount of time and without the use of an assistive device, devoid of modifying the environment, or risking personal safety.

Universal Design Evaluation Task One

Directions

Take the box labeled “A” out of freezer, open the box and place the container in microwave oven “A”. Take container out of microwave oven “A” and place it on the counter (See Figure 22).

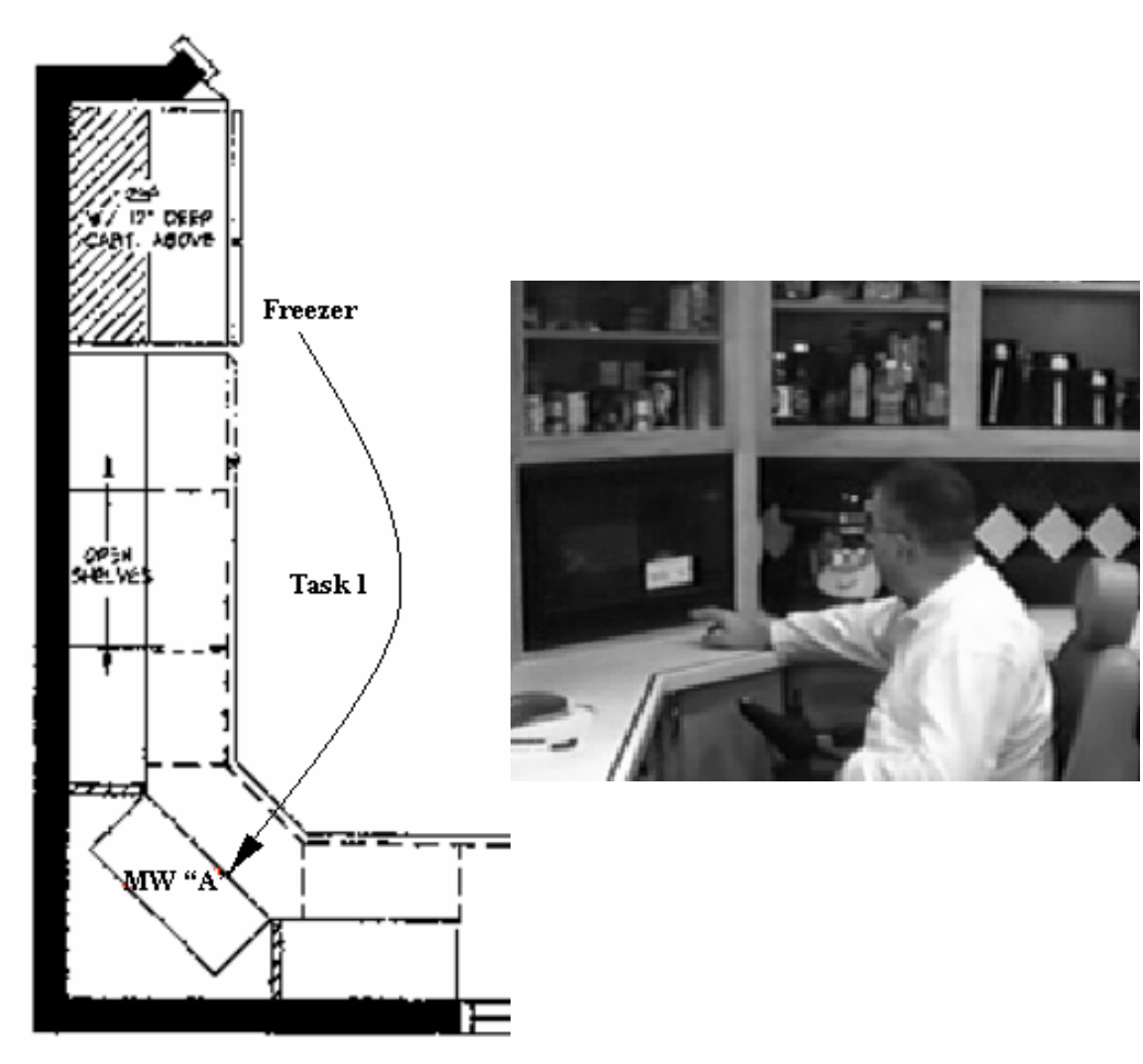

Figure 22. Task One Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the participants' ease of use of the microwave oven feature including the movement to the microwave oven from the refrigerator. The participants evaluated the task based on a five point scale. A score of five was the highest rating possible and a score of 1 was the lowest rating possible. Although everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, the problems noted were related to the task of getting close enough to open the microwave oven door (See Table 4.3).

Table 4.3

Ratings for Task One

	Task Ratings				
	1	**2**	**3**	**4**	**5**
Ease of clearance and movement from freezer to microwave oven				2	7
Ease of opening freezer door			1	1	7
Ease of opening microwave oven door		1	1	2	5
Ease of placing container on counter			1	1	7
Visual appeal of features				2	7

Discussion

When asked if this feature, with the microwave oven placement on the countertop, would make kitchen preparation easier, 55 percent of the participants said yes. The comments surrounding this feature within the GE Real Life Design Kitchen all pertained to making the feature more useable. Suggestions included taking out the base cabinet under the microwave oven and moving the microwave oven forward on the counter surface. All suggestions (4) if implemented would allow for more room for the participant to get closer to the microwave oven. The suggestions came from the four participants that did not think

this feature would be useful. The participants indicated that if the suggested changes were implemented then they would find this feature useful.

Universal Design Evaluation Task Two

Directions

Take the box labeled “B” out of freezer, open the box and place the container in microwave oven “B”. Take container out of microwave oven “B” and place it on the pull-out table (See Figure 23).

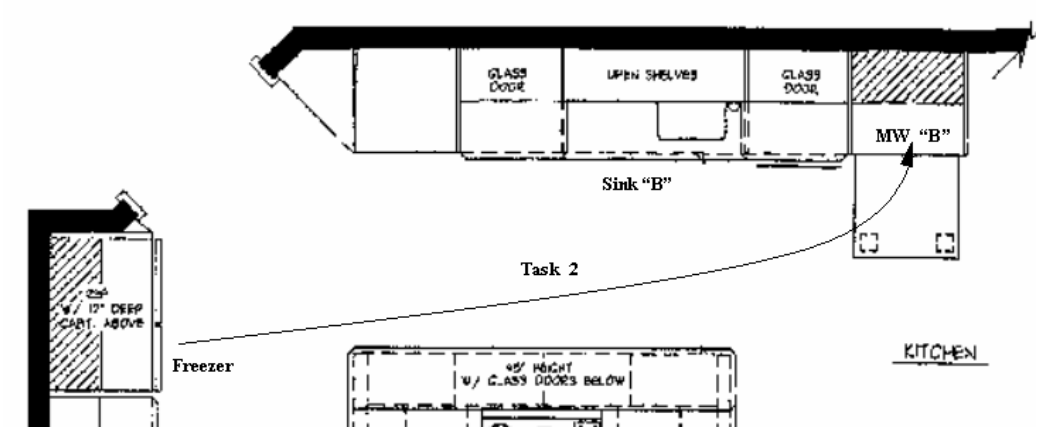

Figure 23. Task Two Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the participants' ease of use of the microwave oven feature including the movement to the microwave oven from the refrigerator. The participants evaluated the task based on a five point scale. Although everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, the problems noted were related to the microwave oven placement being fairly far from the refrigerator and the task of opening the microwave oven door (See Table 4.4).

Table 4.4

Ratings for Task Two

	1	**2**	**3**	**4**	**5**
Ease of clearance and movement from freezer to microwave oven				2	7
Ease of opening freezer door		1		1	7
Ease of opening microwave oven door		1		3	5
Ease of placing container on counter				1	8
Visual appeal of features		1	1	2	5

Discussion

When asked if this feature, with the microwave oven placement in a cabinet with a pull-out table underneath, would make their kitchen preparation easier, 66 percent of the participants said yes, one more person than the previous task. The comments about this feature pertained to making the feature more user friendly. Besides moving the microwave oven closer to the refrigerator, the rest of the comments discussed the relationship of the microwave oven to the table. Some of the participants pulled under the table and approached the microwave oven from the side. Three participants mentioned that it was awkward or difficult to approach the microwave oven from the side, especially because all of those participants favored their right side and they had to twist and reach across their

bodies in order to complete the task. One participant suggested eliminating the half wall to the right of the microwave oven. In the original design by Peterson, the microwave oven was accessible by either side. Another comment suggested that the table become a slide-out tray at the table height with no legs to provide greater flexibility of use. The suggestions came from the three participants who did not think this feature would be useful and one additional participant who said the feature was useful but could be improved. The participants indicated that if the suggested changes were implemented they would find this feature useful.

Comparison of Task One and Task Two

Directions

The researcher then asked the participants to compare Tasks One and Two. They had to decide which task was easier, which microwave oven was easier, which microwave oven placement was easier to access and which placement made it easier to remove the container from the microwave oven and place it on the counter or table.

Comparison

The participants evaluated Task One and Two. No definitive task, appliance or work surface prevailed (see Table 4.5)

Table 4.5

Ratings for Task One and Task Two Comparisons

Which task was easier to perform?	"Task 1"	5	"Task 2"	4
Which microwave oven placement is easier to utilize?	"A"	5	"B"	4
Which microwave oven is easier to utilize?	"A"	4	"B"	5
Which placement made it easier to place container on counter or table?	"A"	3	"B"	6

Discussion

All participants but one thought that either Task One or Task Two features would make their kitchen preparation easier. Frank, the one participant who did not like either feature, commented that task one would be useful if there was knee space associated with the microwave oven placement. For those participants with poor grip, Mary and Kathy, their comments indicated that they would score lower on Steinfeld and Danford's universal design evaluation decision tree (See Appendix G). They said that if they actually cooked something in the microwave oven, they would have difficulty taking the container out of either appliance. They noted they either wait till the food from the microwave oven has cooled, scoring a nine on the universal design evaluation decision tree, or they would ask someone in their home for assistance, scoring a one on the universal design evaluation decision tree. No definitive preference of task or feature prevailed with the exception of the last question. Sixty-six percent of the participants indicated in the last comparison question (see Table 4.5) that the placement of the microwave oven in Task 2 made it easier to place a container on the counter or table. This was probably due to the clear knee space underneath the table that allowed for the participants to get closer to the microwave oven. In summary, 88% of all participants indicated that one of these two features would be beneficial.

Universal Design Evaluation Task Three

Directions

Adjust sink "A" utilizing the adjustability mechanism of the sink. Place the sink at the appropriate height for your greatest ease of use. Get water out of the faucet in the glass provided, and place it on the counter (see Figure 24).

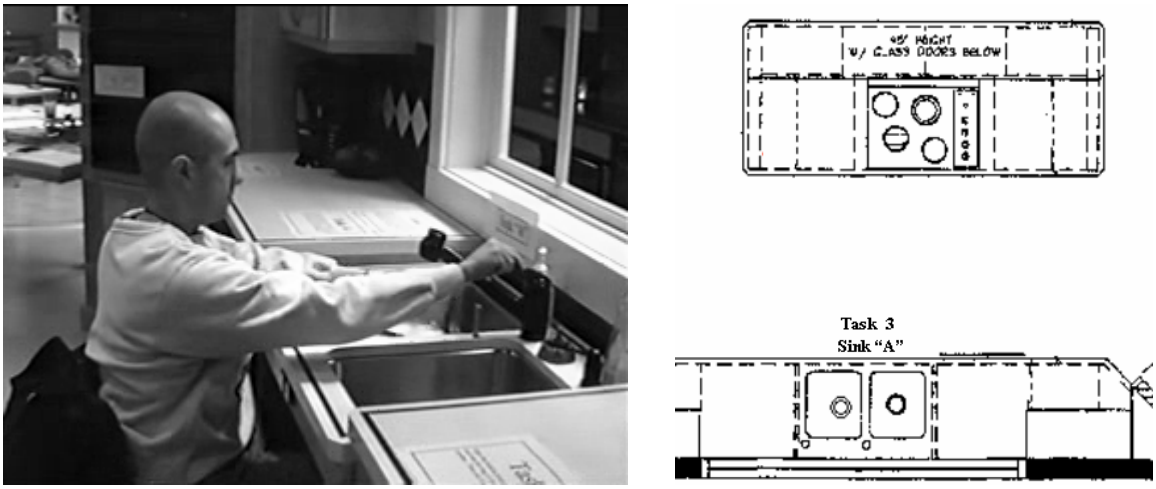

Figure 24. Task Three Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the adjustable sink mechanism. Everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The problems noted were related to the faucet handle length or placement and not having the counter space next to the sink at the same height (see Table 4.6).

Table 4.6

Ratings for Task Three

	1	2	3	4	5
Ease of clearance and floor space under sink			1	1	7
Ease of adjusting the sink					9
Ease of turning on faucet				3	6
Visual appeal of feature			1	2	6

Note: Sink heights in inches: 32.5, 32.5, 32.75, 33.125, 33.5, 34, 34.25, 34.625, 35.5

Discussion

When asked if this feature, with the adjustable sink mechanism, would make kitchen preparation easier, 100 percent of the participants said yes. The comments surrounding this feature pertained to making the feature more user friendly. Four participants suggested either a longer handle on the faucet or moving the faucet closer to the front of the counter. One suggestion that the researcher found to be very inventive was to make the water on and off mechanism mimic that of a water fountain push button that could be placed on the front of the sink next to the up and down switches. Mike commented that the sink with the knee space could be at a fixed position. He was concerned about the durability of the adjustable mechanism. Harvey thought the sink feature was very helpful, but it needed more counter space on the same level as the sink on both sides and thought the sink did not "feel" sturdy enough for him to put his weight on it, he noted that he sometimes puts his weight onto a work surface for leverage or to steady himself, so this made him uncertain of the sink's stability. A few other participants inquired about the reliability of the mechanism and suggested more counter space at the

same level. The sink height when adjusted ranged from 32.5 inches AFF to 35.5 inches AFF.

Universal Design Evaluation Task Four

Directions

Take a mug and a plate out of sink "A" and place them into dishwasher "A". Place the mug in the top rack of the dishwasher and place the plate on the bottom rack of the dishwasher (see Figure 25).

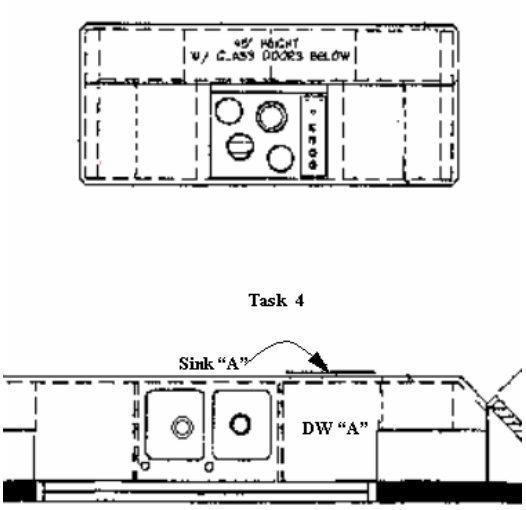

Figure 25. Task Four Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the placement of the dishwasher directly next to the sink. Although everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, the problems noted were related to the task of opening the dishwasher door and placing the plate in the bottom rack of the dishwasher (See Table 4.7).

Table 4.7

Ratings for Task Four

	1	2	3	4	5
Ease of clearance and movement from sink to dishwasher				3	6
Ease of opening dishwasher door			2	3	4
Ease of taking mug out of sink				2	7
Ease of taking plate out of sink				2	7
Ease of placing mug in dishwasher				2	7
Ease of placing plate in dishwasher			2	3	4
Visual appeal of feature				3	6

Discussion

When asked if this feature, having the dishwasher next to the sink, would make kitchen preparation easier, 88 percent of the participants said yes. The comments about this feature concerned the opening of the dishwasher door and placing the dish on the bottom rack. All participants liked the placement of the dishwasher next to the sink. Some of the participants thought the dishwasher door was either too heavy or too awkward to open. One participant suggested a push button to open the door and then it could slowly lower into position without requiring the user to manually lower it. Some of the participants rated the ease of placing the plate in the dishwasher lower because they found it more difficult to reach the lower rack.

Universal Design Evaluation Task Five

Directions

Take a mug and a plate out of sink "B" and place them into dishwasher "B". Place the mug in the top rack of the dishwasher and place the plate on the bottom rack of the dishwasher (see Figure 26).

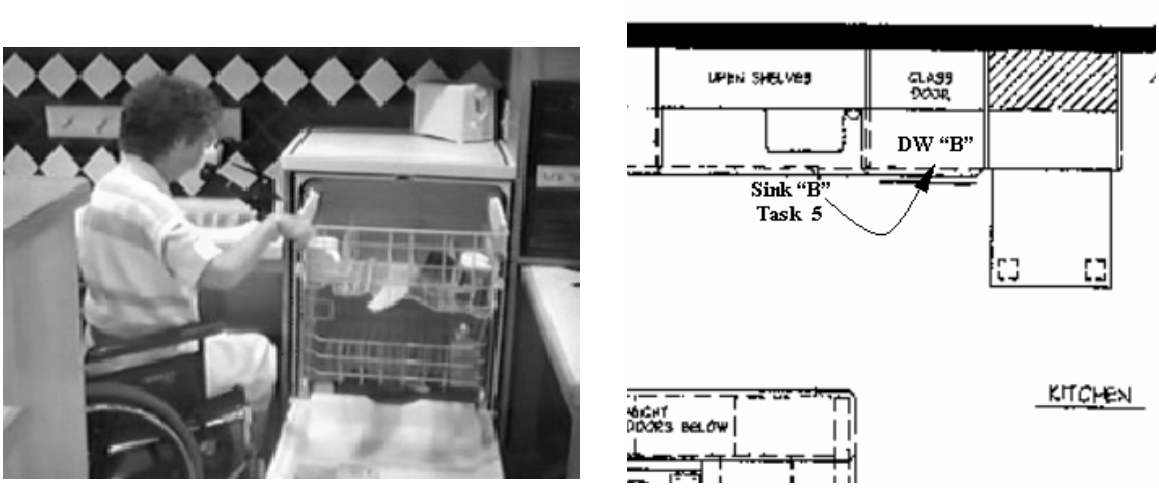

Figure 26. Task Five Diagram and Participant Photograph

Evaluation

This task evaluated the raised dishwasher feature that was placed directly next to the sink. Although everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, most of the problems noted were related to the clear floor space under the sink (See Table 4.8).

Table 4.8

Ratings for Task Five

	1	**2**	**3**	**4**	**5**
Ease of clearance and movement from sink to dishwasher	1	1		4	3
Ease of opening dishwasher door		1		1	7
Ease of taking mug out of sink		1	1	2	5
Ease of taking plate out of sink			1	1	7
Ease of placing mug in dishwasher			1	1	7
Ease of placing plate in dishwasher		1		3	6
Visual appeal of feature	1			3	5

Discussion

When asked if this feature, a raised dishwasher, would make kitchen preparation easier, 88 percent of the participants said yes. The biggest concern about this feature was the limited knee space under the sink. Many participants felt that they could not get under the sink well enough to perform the task. Even though the evaluation form did not officially ask them about the faucet for this task, the majority of participants commented that they preferred having the faucet on the side of the sink and closer to the front of the counter. One participant, Craig, did not like the raised dishwasher. He thought it looked visually awkward and rated it the lowest score possible on visual appeal. In addition, he found it difficult to place the mug in the top rack. He said the rack was too high to be able to visually see and it was difficult to place the mug over the rack. Jill liked the higher dishwasher, but did not like the higher counter.

Comparison of Task Four and Task Five

Directions

The researcher then asked the participants to compare Tasks Four and Five. They had to decide which task was easier, and which dishwasher placement was easier to utilize.

Comparison

The participants evaluated Task Four and Five based on selecting which of the tasks and dishwasher placement they preferred. No definitive task was noted as easier to perform over the other; however, the majority (77%) of the participants noted that the higher dishwasher was easier to use (see Table 4.9).

Table 4.9

Ratings for Task Four and Five Comparisons

Which task was easier to perform?	"Task 4"	4	"Task 5"	5
Which dishwasher placement is easier to utilize?	"A"	2	"B"	7

Discussion

All participants thought that either Task Four or Task Five features would make their kitchen preparation easier. It was noted by two participants that the dishwashers were not exactly the same and that the dishwasher for Task Five has higher sides on the top rack. The majority of the participants commented that they liked having the faucet on the side of the sink, and two noted that there was more counter surface at the same height as the sink and preferred that to the other sink. Many of the participants commented that they would like to merge the features they liked of both tasks together to create one really good sink and dishwasher combination. The design preference that emerged would consist of a fixed lowered sink surface with counter space on both sides of the sink and at the same height, a

faucet on the side of the sink and closer to the front of the counter, deep knee space under the sink, and a raised dishwasher with an easy opening mechanism.

Universal Design Evaluation Task Six

Directions

Pull out the cart labeled “T6” and place it near sink “A”. Utilize the cart surface to slice a cucumber, with the cutting board, knife and cucumber provided (see Figure 27).

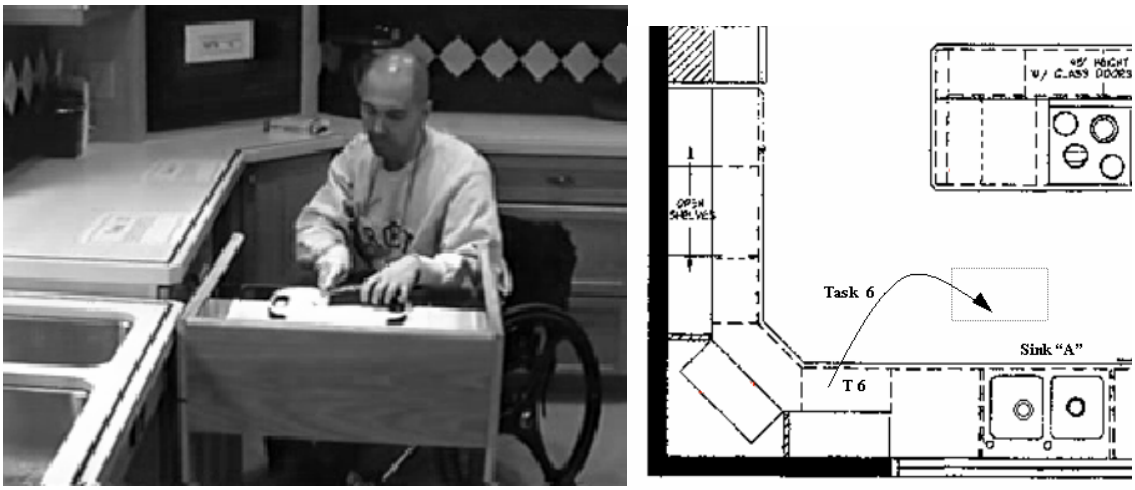

Figure 27. Task Six Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the pull-out cart feature that blended in with the cabinetry when not in use. Five of the participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The other four participants completed the task after they received assistance pulling out the cart. Since they required assistance, they received a score of 5 on the universal design evaluation decision tree. The score of 5 noted that the participants received supervision or setup assistance. Major

problems by the majority of participants were noted in relation to being able to move the cart with ease (see Table 4.10).

Table 4.10

Ratings for Task Six

	1	**2**	**3**	**4**	**5**
Ease of clearance and floor space to move roll out cart			5	1	3
Ease of moving roll out cart	2	5	2		
Ease of slicing cucumber near sink		3	1	1	4
Visual appeal of feature		1	4		4

Note: 4 participants received assistance in moving roll out cart.

Discussion

When asked if this feature, a large pull-out cart, would make your kitchen preparation easier, 88 percent of the participants said no. Many of the participants thought a cart was a good idea but that the cart utilized in Task 6 was too heavy and the wheels did not roll right in order to make this feature a desired one for wheelchair users. Three of the participants rated the feature in regards to slicing the cucumber near the sink as a 2 due to the fact that they could not get the cart very close to the sink and it made for an awkward arrangement. The visual appeal of the feature received an average rating and generated a comment from one participant that the feature blended into the cabinets too much and that one might forget to use the rolling cart.

Universal Design Evaluation Task Seven

Directions

Pull out cart labeled “T7” and place it near sink “B”. Utilize the cart surface to slice a cucumber, with the cutting board, knife and cucumber provided (see Figure 28).

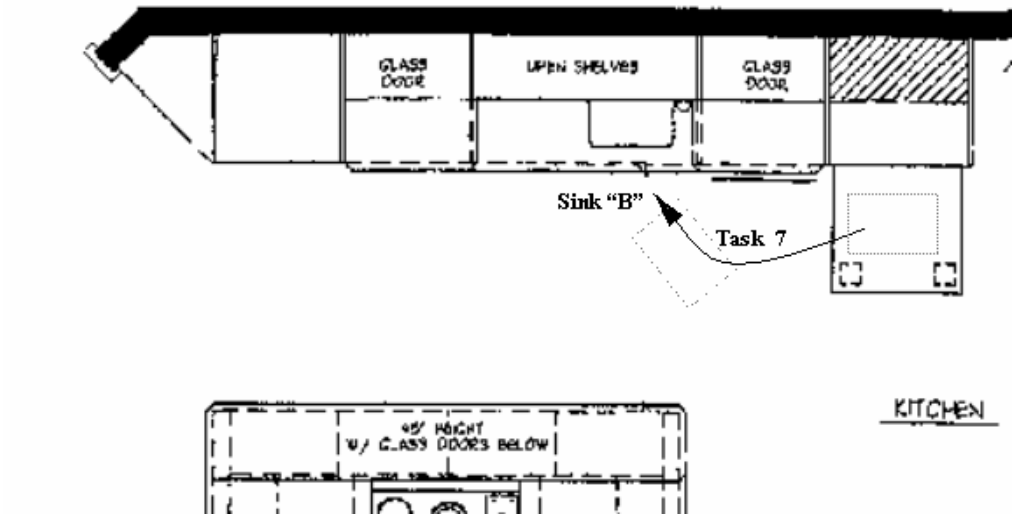

Figure 28. Task Seven Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the small pull-out cart that was placed under the pull-out table (See Table 4.11). Everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, and the ratings suggested that this cart was better than the cart from Task 6 (See Table 4.11).

Table 4.11

Ratings for Task Seven

	1	**2**	**3**	**4**	**5**
Ease of clearance and floor space to move roll out cart		2		3	4
Ease of moving roll out cart		1	2	3	3
Ease of slicing cucumber near sink		2	1	3	3
Visual appeal of feature		2	1	2	4

Discussion

When asked if this feature, a small pull-out cart, would make your kitchen preparation easier, 55 percent of the participants said yes, three more people than the previous task. Mary said she would use it to set stuff on while she was cooking. Phil noted that the height of this cart seemed better than the previous cart. He also suggested the handle should be placed on the side of the cart rather than cut into the top. He found it difficult to grasp the cart for this reason. Those participants were the only ones who commented about this feature.

Universal Design Evaluation Task Eight

Directions

Pull out cutting surface labeled “T8” and slice a cucumber, with the knife provided. Place a bowl in the slot provided and place cucumber slices in bowl (see Figure 29).

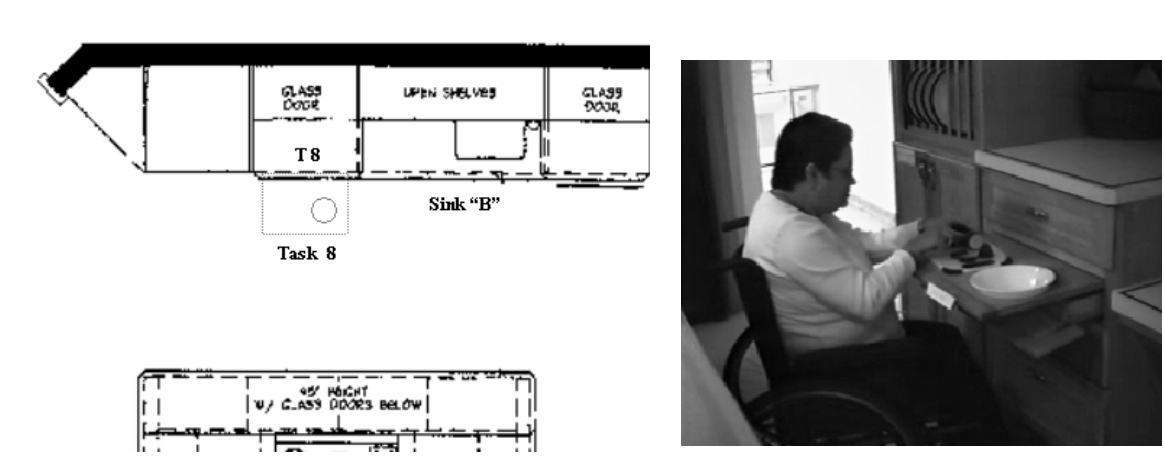

Figure 29. Task Eight Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the cutting board feature next to the sink with a hole cut-out for a bowl. Everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The problems noted included the clearance of floor space to perform the task and ease in which the feature could be opened and accessed (See Table 4.12).

Table 4.12

Ratings for Task Eight

	1	2	3	4	5
Ease of clearance and floor space to open cutting surface			2	4	3
Ease of moving cutting surface			1	6	2
Ease of slicing cucumber near sink on cutting board			1	3	5
Ease of placing bowl in slot				1	8
Visual appeal of feature			1	2	6

Discussion

When asked if this feature, the pull-out cutting board, would make your kitchen preparation easier, 77 percent of the participants said yes, one participant said no, and another participant said maybe. The comments about this feature all pertained to making the feature more useable. Two participants thought the feature should be placed within the lower work surface that contained the sink, this would in turn, make the feature closer to the sink. A few of the participants had a difficult time opening the cutting board within the drawer and suggested a handle be placed on the front of the cutting surface in order to grip and open it easier.

Universal Design Evaluation Task Nine

Directions

Pull out cutting surface “T9” and slice a cucumber, with the knife provided (see Figure 30).

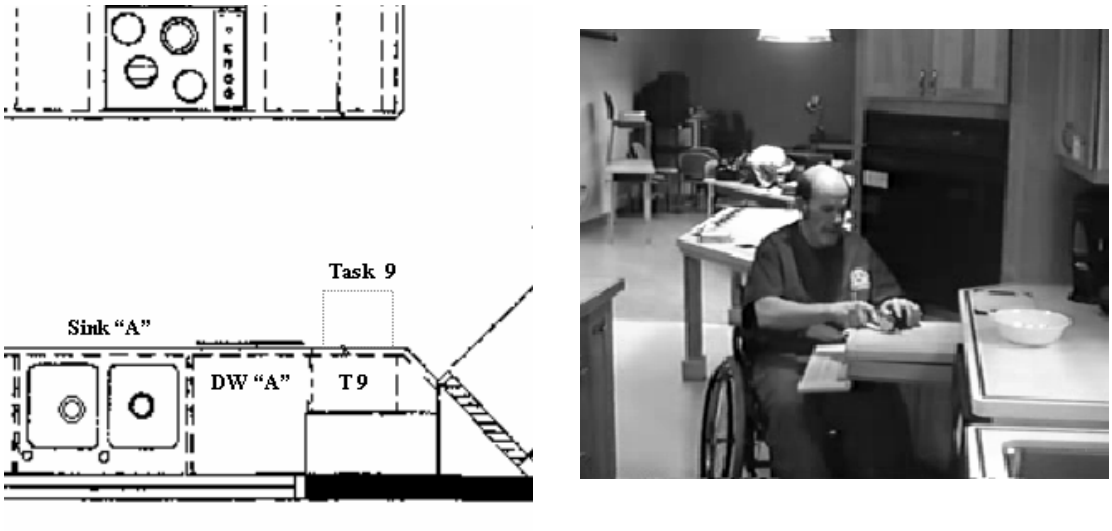

Figure 30. Task Nine Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the cutting board feature contained within a cabinet drawer next to the dishwasher. Everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree, the ratings for Task Nine are shown below (See Table 4.13).

Table 4.13

Ratings for Task Nine

	1	2	3	4	5
Ease of clearance and floor space to open cutting surface			1	3	5
Ease of moving cutting surface			2	3	4
Ease of slicing cucumber near sink on cutting board			2	2	5
Visual appeal of feature				2	7

Discussion

There were few comments surrounding this feature, a pull-out cutting board, since the participants realized that they were going to compare all of the tasks. Phil noted one problem and made one suggestion. He said that the cutting surface did not provide enough surface area to be well utilized. In addition, he suggested that the drawer front that flips down to gain access to the cutting board could have a different opening mechanism such as a magnetic latch to make the feature easier to open and close. In addition, he said that he liked that the cutting surface had a drawer underneath it. He said he would keep his cutting utensils under the cutting surface in the drawer.

Comparison of Task Six, Task Seven, Task Eight and Task Nine

Directions

The researcher then asked the participants to compare Task Six, Task Seven, Task Eight and Task Nine. They had to decide which task was easiest, and had the best visual appeal. In addition, they had to determine which rolling cart was easier to use and which cutting surface was easier to open. The final question asked the participant to determine which feature they would prefer to have in their home.

Comparison

Comparisons of Task Six, Task Seven, Task Eight and Task Nine were based on the questions listed below in Table 4.14. Participants noted a huge preference (88%) for the smaller pull-out cart featured in Task Seven over the cart in Task Six; however, when the participants were given the option to have a rolling cart or a cutting surface placed in their home, only one participant chose the Task Seven rolling cart feature. When the participants compared the pull-out cutting board features, no definitive cutting surface was considered to be easier to open; however, the majority (66%) of the participants noted their preference to have a cutting surface feature placed in their home (see Table 4.14).

Table 4.14

Ratings for Task Six, Task Seven, Task Eight and Task Nine Comparisons

	T6	**T7**	**T8**	**T9**
Which surface was the easiest to utilize?		1	3	5
Which surface had the best visual appeal?		2	2	5
Which roll cart was easier to utilize?	1	8	---	---
Which cutting surface was easier to open?	---	---	4	5
Given your choice to place any of the following features anywhere in your current kitchen, which would you choose to have in your home?*		1	2	4

*Note: 2 of the participants indicated that they would not prefer any of the features tested.

Discussion

The majority of the participants justified which feature they would choose to have placed in their home. Four of the participants selected the Task Nine cutting board as their preferred feature. Comments explaining why they chose this feature ranged from it being at the right height (2), being sturdier (3), to being much easier to use (3). All four said that

they would place the feature directly next to the sink. The other three participants that chose a feature, wanted to create a hybrid of the feature they selected. Kim and Phil chose the Task Eight cutting surface and said that they would place it next to the sink. Phil wanted the feature to have two holes to hold two bowls and for his wheelchair approach towards the cutting surface be straight on as in the Task Nine feature. Kim wanted to add a loop or a handle to the front of the cutting surface, making it easier to grip and open. Mary was the only participant to select a rolling cart (Task Seven feature) as her preferred feature. She made the most suggestions about altering the feature she selected. She wanted to merge the features she liked of all the tasks together to create one really good rolling cart. She wanted the rolling cart to have a lip added around the top surface so she could set stuff on it and roll it around and items would not fall off while she was moving the cart around. She wanted to add a cutting surface like the feature in Task Nine as part of the cart. She wanted the cutting surface to have a drain incorporated into the feature. She also wanted to have the knob on the front of the cutting surface replaced with a handle or a deep groove on the underside to make it easier for her to pull out the cutting surface. Two of the participants, Jill and Frank, chose not to select any of the features for their home. Jill commented that she really needs a stable surface when cutting with a knife and that she preferred the counter. Frank noted that the drawers were bulkier and heavier than they needed to be. He felt that the features tested were visually appealing but functioned poorly.

Universal Design Evaluation Task Ten

Directions

Open door in cabinet “T10” and use the pull-down shelf to get out a container and place it on the counter (see Figure 31).

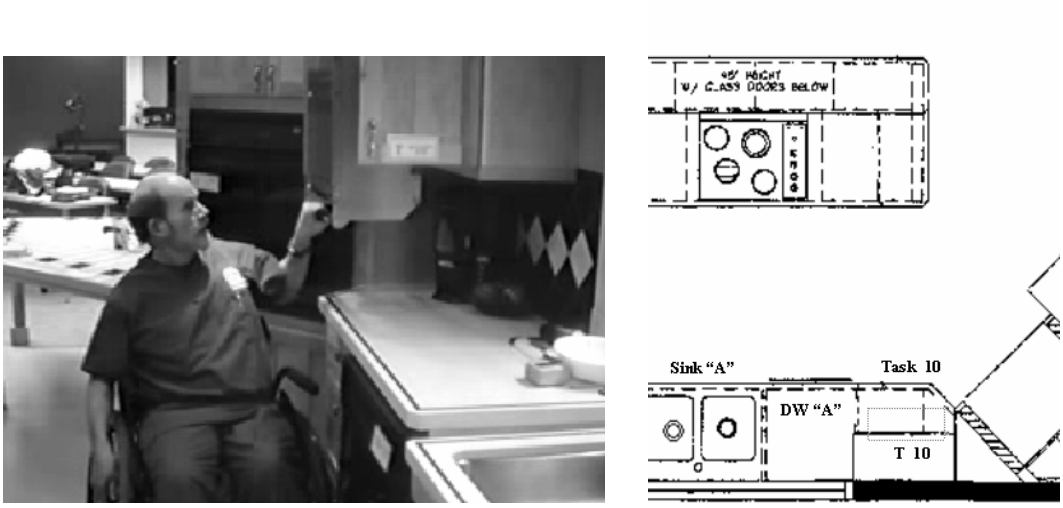

Figure 31. Task Ten Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the pull-down shelf feature. Six participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The problems noted were related to the tension on the pull down shelf and the amount of strength it required to complete the task. (see Table 4.15).

Table 4.15

Ratings for Task Ten

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door		2	3	2	2
Ease of using the pull down shelf	3	1	3	2	9
Visual Appeal of Feature	1		2	3	3

Discussion

Of all the features tested in the universal design evaluation portion of the study, this feature received the lowest ratings. When asked if this feature, a pull-down shelf in the upper cabinet, would make your kitchen preparation easier and given the choice would you have this feature added to your kitchen, 77 percent of the participants said no. The comments about this feature pertained to the ineffectiveness of the feature. Many of the participants noted that the tension was too tight and it required too much strength to utilize the pull down shelf. In addition, many commented that the unit was too bulky and took up too much space within the cabinet. Mike said, "it takes up too much room for the value (personal conversation, 2005)." Frank mentioned that the task would be easier if a knee space was provided underneath the wall cabinet. Phil noted that if the shelf unit was motorized at the push of a button it would be useful and he would want it added to his home. The two participants that found this feature useful and would want it added to their home were both male and had good strength.

Universal Design Evaluation Task Eleven

Directions

Pull out the door in base cabinet "T11" and take the bag of rice off the bottom shelf and place it on the counter and then put it back and close the door (see Figure 32).

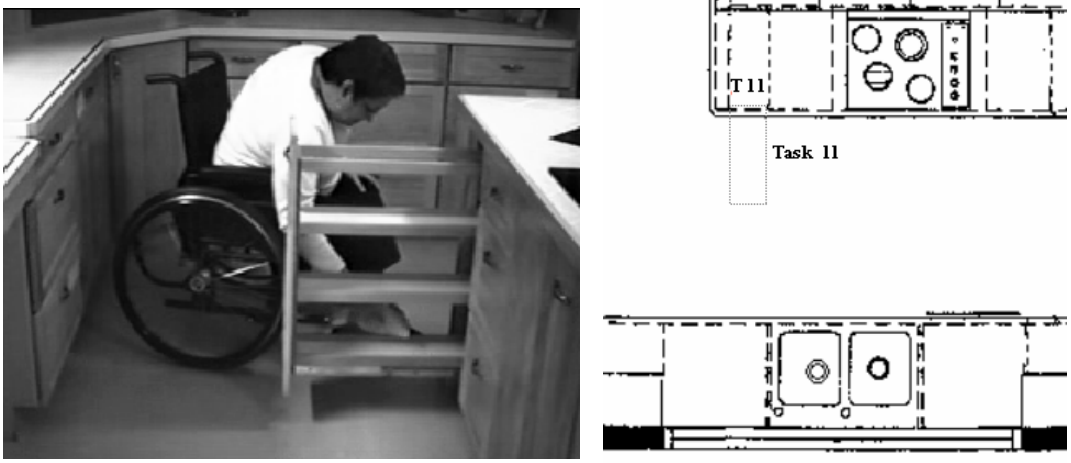

Figure 32. Task Eleven Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the pull-out base pantry feature. All participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree. Ratings for Task Eleven are shown below (see Table 4.16).

Table 4.16

Ratings for Task Eleven

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door				2	7
Ease of using the pull-out door					9
Visual appeal of feature					9

Discussion

Of all the features tested in the universal design evaluation portion of the study, this feature received one of the highest ratings. When asked if this feature, a pull-out base pantry, would make kitchen preparation easier and given the choice to have this feature added to their kitchen, 100 percent of the participants said yes. Frank commented that this feature was his favorite thus far in the study and given the opportunity, he would place the Task 11 feature throughout his kitchen.

Universal Design Evaluation Task Twelve

Directions

Open the bottom drawer in base cabinet "T12" and take the bag of rice out and place it on the counter. Then put it back and close the drawer (see Figure 33).

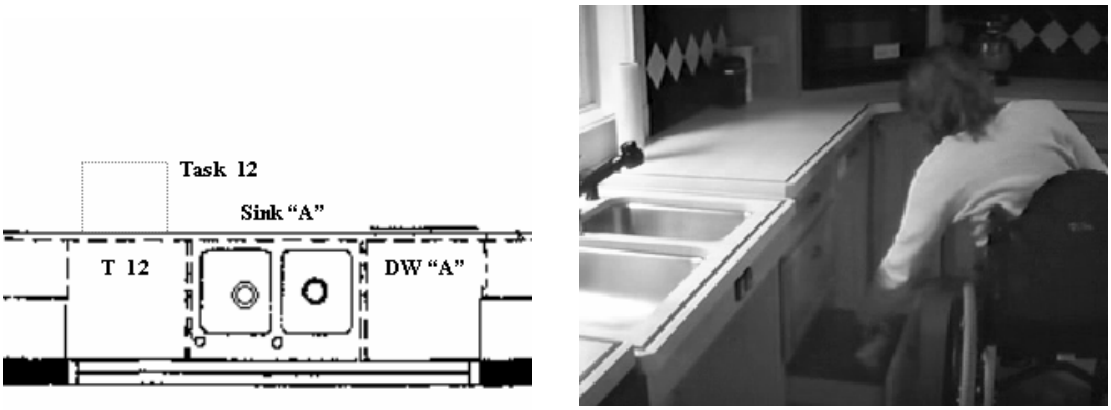

Figure 33. Task Twelve Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the pull-out drawer feature with extended and studier glides. All participants but one completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The ratings for Task Twelve are noted

below (see Table 4.17). One participant, Kathy, felt that she could not safely complete the task because of how far she would have to bend over. She completed the task using the second drawer of the cabinet instead of the bottom drawer. Kathy also noted during her pre-interview assessment that she could not retrieve items from the floor and found retrieving items from her base cabinet a bit difficult.

Table 4.17

Ratings for Task Twelve

	1	**2**	**3**	**4**	**5**
Ease of clearance and floor space to open cabinet door				2	7
Ease of using the pull–out drawer					9
Visual appeal of feature					9

Discussion

This feature, the pull-out drawer, received one of the highest ratings among the 18 universal design features tested. When asked if this feature would make kitchen preparation easier and given the choice to have this feature added to their current kitchen, 77 percent of the participants said yes. Mike commented that he already owned this feature and answered no to the above question. The researcher asked if he liked this feature in his current kitchen he said yes and that it made meal preparation easier in his kitchen at home. Based upon discussion with the participant, the researcher concluded that 88 percent of the participants found this feature useful and would have it added to their current kitchen.

Universal Design Evaluation Task Thirteen

Directions

Open door in base cabinet "T13" and pull out the bottom veggie bin drawer. Take the bag of rice and place it on the counter. Then put it back and close the drawer (see Figure 34).

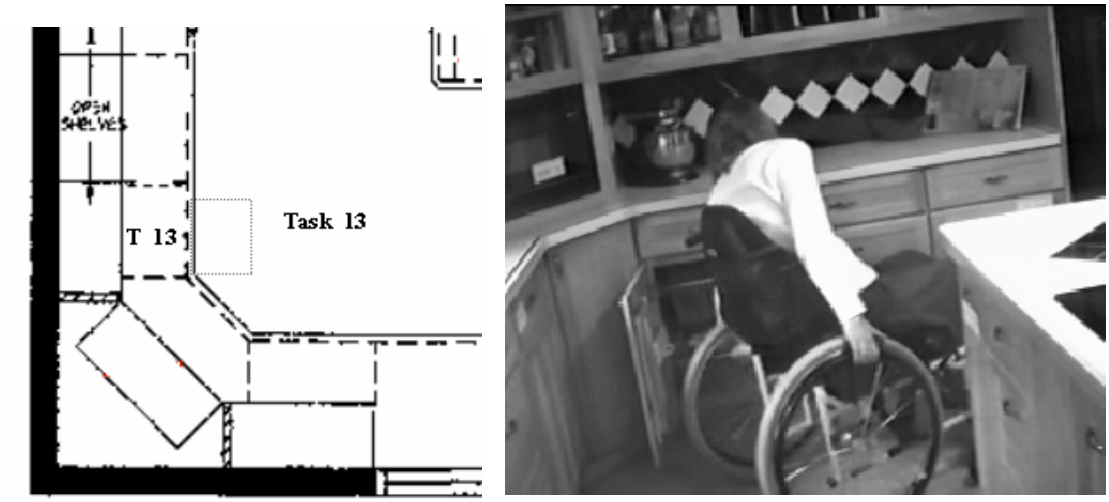

Figure 34. Task Thirteen Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the pull-out veggie bin tray feature. All participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The problems noted were associated with the visual appeal and the ease in which the veggie bin slid out of the cabinet (see Table 4.18).

Table 4.18

Ratings for Task Thirteen

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door				2	7
Ease of using the veggie bin drawer			1	2	6
Visual appeal of feature		1		1	7

Discussion

When asked if this feature, a pull-out veggie bin, would make kitchen preparation easier, 77 percent of the participants said yes. The only comment regarding this feature pertained to making the feature more user friendly. One participant noted that the actual veggie bin did not slide very well and suggested that the glide on the veggie bin container could work more like the drawer mechanism in Task Twelve. That participant did not like the visual appeal of the feature and rated it as a 2 on a scale from 1 to 5, 5 being the highest rating.

Universal Design Evaluation Task Fourteen

Directions

Open up the pull-out tray drawer in base cabinet "T14" and take the bag of rice out of the tray and place it on the counter and then put it back and close the drawer (see Figure 35).

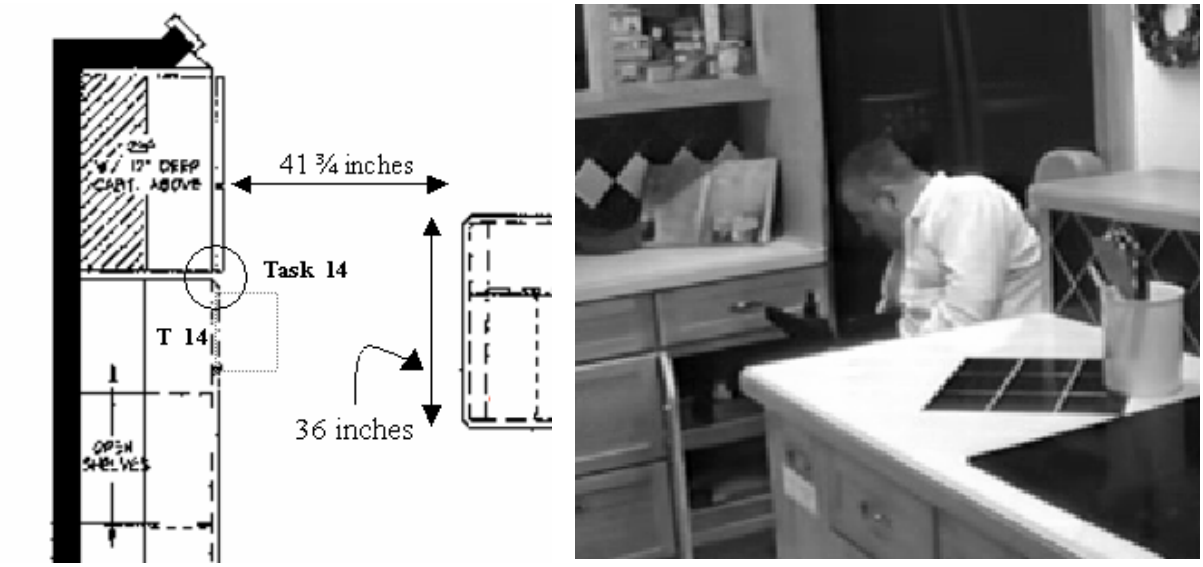

Figure 35. Task Fourteen Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the pull-out tray feature placed within the base cabinet. Although all participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree, the problems noted were related to the amount of floor clearance space provided to complete the task (see Table 4.19).

Table 4.19

Ratings for Task Fourteen

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door		1	1	2	5
Ease of using the pull-out tray drawer		1		1	7
Visual appeal of feature				1	8

Discussion

When asked if this feature, a pull-out tray drawer, would make kitchen preparation easier, 77 percent of the participants said yes. Mike commented that he already owned this feature and did not answer the above question. The researcher asked if he liked this feature in his current kitchen he said yes. He thought that it made meal preparation easier in his kitchen at home. Based upon discussion with the participant, the researcher concluded that 88 percent of the participants found this feature useful and would have it added to their current kitchen. The biggest concern about this feature was the limited floor clearance space of 41 ¾ inches wide between the cabinet and the island. This measurement well exceeds the ANSI A117.1-1992 requirement regarding standard 4.33.4.2 concerning clear floor space (see Figure 35). The ANSI standard requires a clear floor space 30 inches by 48 inches that allows either a forward or parallel approach. A few participants felt that it was a bit difficult to approach the cabinet. Even though the approach exceeds the required clear floor space, the placement of the cabinet next to the refrigerator may have added the increased difficulty in the ratings. The refrigerator, while built into the cabinet, protrudes 1 inch into the floor space (see circle on Figure 35). The majority of the participants did not find the floor clearance to be an issue with this task. One participant, Phil, thought the door size was too large and increased the difficulty in opening the door; however, his rating of

the question about floor clearance and ease to open the cabinet door was a score of 4 out of 5 points. Jill was the participant who gave a score of 2 for the first two questions regarding the task and feature, but gave no additional comments explaining her low rating (see Table 4.18).

Universal Design Evaluation Task Fifteen

Directions

Open up the pull-out tray drawer in base cabinet "T15" and take the bag of rice out of the tray, place it on the counter, put it back, and close the drawer (see Figure 36).

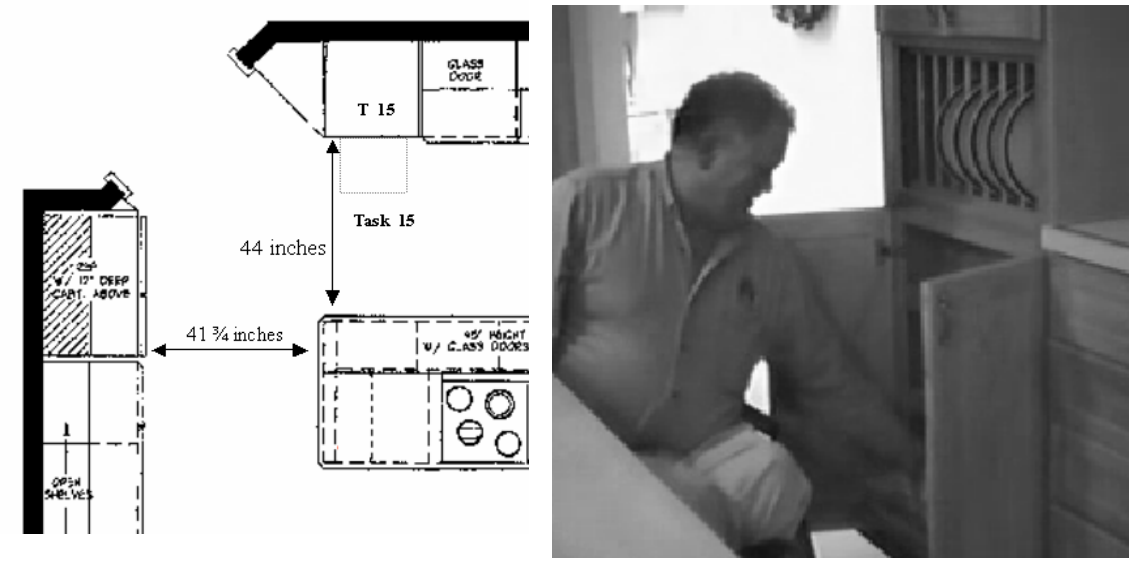

Figure 36. Task Fifteen Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the pull-out tray drawer placed within a base cabinet that had a raised toe kick height. Everyone completed the task and scored a perfect score (10) on the universal design evaluation decision tree. The ratings for Task Nine are shown below (See Table 4.20).

Table 4.20

Ratings for Task Fifteen

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door				3	6
Ease of using the pull-out tray drawer				2	7
Visual Appeal of Feature				1	8

Discussion

There were few comments surrounding this feature since the participants realized that they were going to compare all of the tasks. Jill noted that the double doors of the cabinet made this feature easier to utilize than the previous task, but noted that this feature, with raised toe kick, was not necessary to make her meal preparation easier. Jill noted, in the pre-cooking assessment interview, that pulling out and removing items from the base cabinet in her current kitchen was not difficult. All of the other participants indicated that this feature would make their meal preparation easier. Mike noted that he currently has this feature in his kitchen at home.

Comparison of Task Eleven, Task Twelve, Task Thirteen, Task Fourteen, and Task Fifteen

Directions

The researcher then asked the participants to compare Task Eleven, Task Twelve, Task Thirteen, Task Fourteen, and Task Fifteen. They had to decide which task was easier and which pull-out feature had the best visual appeal.

Comparison

The participants evaluated the five tasks based on selecting which of the cabinet features was the easiest to take out and replace the bag of rice. The features located in Task

Eleven and Task Fifteen each received 33 percent of the participants noting the respective feature as a preference (see Table 4.21).

Table 4.21

Ratings for Task Eleven, Task Twelve, Task Thirteen, Task Fourteen, and Task Fifteen Comparisons

	T11	T12	T13	T14	T15
Which cabinet was the easiest to take something off the bottom shelf, tray, or drawer?	**3**	**1**	**1**	**1**	**3**
Which cabinet had the best visual appeal?*	**2**	**1**	**1**		**3**

*Note: One participant was undecided

Discussion

All participants (100%) indicated that some or all of these pull-out features would make their meal preparation easier and would choose to place some or all of these features in their current kitchen. The three participants that choose the pull-out drawer feature with raised toe kick in Task Fifteen as their preference over the other features, all commented that they liked that the feature was raised and therefore required less bending and easier access. The participants that choose the pull-out pantry feature in Task Eleven as their preference over the other features, noted that this feature allowed one to access it from both sides and that the feature seemed to utilize the most cabinet space. One participant noted that this feature would be useful in the bathroom and under his television in the family room. Many of the participants commented that they would like to incorporate many or all of the features present in the five tasks performed.

Universal Design Evaluation Task Sixteen

Directions

Open up the door in base cabinet “T16” and take a plate off the bottom shelf, place it on the counter, then put it back, and close the door. This cabinet does not have door handles. The door opens by pushing into the door (see Figure 37).

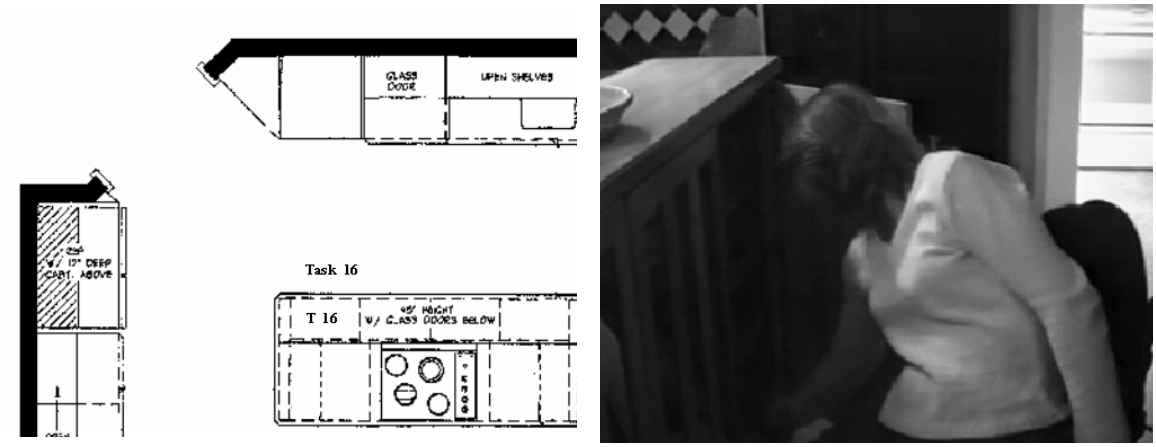

Figure 37. Task Sixteen Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the push button door latch on a 12” deep base cabinet with raised toe kick. Although all participants completed the task and scored a perfect score (10) on the universal design evaluation decision tree, this task had the most variety of comments surrounding the feature. Problems noted varied and included comments about the door mechanism, floor clearance, durability, and raised cabinetry (see Table 4.22).

Table 4.22

Ratings for Task Sixteen

	1	2	3	4	5
Ease of clearance and floor space to open cabinet door		1	3	3	2
Ease of opening cabinet door				5	4
Ease of taking something off the bottom shelf	1		2	2	4
Visual Appeal of Feature				5	4

Discussion

When asked if this feature, the push button door latch on a 12” deep base cabinet with raised toe kick, would make your kitchen preparation easier, 55 percent of the participants said yes. Many of the participants provided comments about this feature. Phil, who utilizes an electric wheelchair, rated the clearance and floor space to open cabinet door as a 2 out of 5 points and found it difficult to turn around in the space provided to complete the task. He noticed the cabinet next to the Task 16 feature that had doors with windows and loved the idea of having the windows on the base cabinets. He commented that the windows would make his kitchen preparation easier and would decrease the amount of times he would have to open a cabinet to see what was inside. In addition, he liked that the cabinets were raised higher off the floor and thought it increased the ease in which he could retrieve items off the bottom shelf.

Four participants commented that given the choice, they would not place this feature in their home. They noted that the push button latch on the door was ineffective and difficult to operate and that a handle would make the cabinet easier to open. One of the participants expressed concerns about constantly touching the cabinet door with greasy

hands and did not like the absence of a handle on the door. Kim commented that she did not have enough strength to push the door in for it to release and open.

Mary liked that this base cabinet feature was only 12 inches deep because items could not get hidden behind other items. She had difficulty grasping the plate because of her disability and rated the ease of taking something off the bottom shelf as a 3 out of 5. Jill did not like the overall height of the raised cabinet in the island because it made the counter too high and she could not see the counter top. In addition, she felt that raising the toe kick only wasted cabinet space and this area could be put to better use.

Kathy rated the ease of taking something off the bottom shelf as a 1 out of 5. As noted in Task Twelve, Kathy said prior to the study that she could not retrieve items from the floor and found retrieving items from her base cabinet to be a bit difficult.

Universal Design Evaluation Task Seventeen

Directions

Open up the oven door and take the casserole dish out of the oven and place it on the table. Move over to the table and pretend you are serving from the casserole dish (see Figure 38).

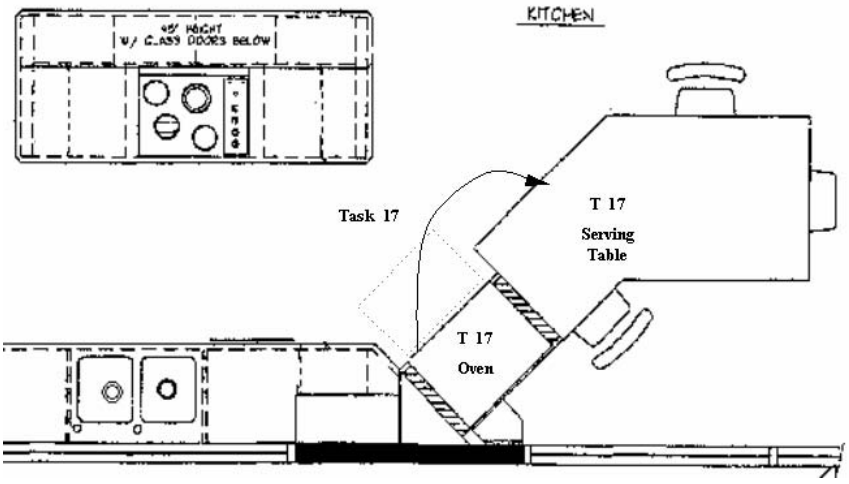

Figure 38. Task Seventeen Diagram and Participant Photograph

Evaluation

This task was trying to evaluate the raised oven feature with a serving table placed next to the oven. Every participant completed the task and scored a perfect score (10) on the universal design evaluation decision tree. Most of the problems noted were associated with removing the casserole dish from the oven (see Table 4.23).

Table 4.23

Ratings for Task Seventeen

	1	**2**	**3**	**4**	**5**
Ease of using the controls		1	2	2	4
Ease of clearance and floor space to open oven door				5	4
Ease of opening the oven door			1	6	2
Ease of removing the casserole dish from the oven	2		2	2	3
Ease of maneuvering to the table	1		2	1	5
Ease of serving at the table				3	6
Visual appeal of feature				1	8

Discussion

All of the participants thought having the table surface next to the oven was a convenient feature and would make their kitchen preparation easier. Lower ratings were noted for 3 of the 7 questions listed above in Table 4.23. When asked about the ease of the oven controls, a few participants who rated this feature lower commented that the controls were too high (2), that the font on the appliance was too small (1), and Harvey commented that he was color blind and could not tell the red on light was glowing. Many participants were concerned about removing the casserole dish from the oven. They noted that if the task required the removal of a hot casserole dish, then the task would be much more

difficult and dangerous. They felt that the oven was placed too high. Craig commented that with the oven this high, people in wheelchairs would get a "full face" of heat. In addition, many participants noted that their arms were positioned so that they had weakened strength to remove a casserole since their arms were practically parallel with the oven rack. Sixty-six percent of the participants noted that the oven should be a few inches lower. In addition, a couple (2) of participants suggested a side opening oven, and one participant felt that the island was too close to the oven. Many participants approached the oven like the participant in Figure 38 and found it a bit difficult to maneuver backwards to the table. A few commented that the next time their approach would be from the other direction and they would find maneuvering to the table easier.

Universal Design Evaluation Task Eighteen

Directions

Open up the folding doors under the cooktop. Try to reach all the controls and practice turning them on and off. Take the pot and spoon from the counter and pretend you are stirring the pot in all four burner locations (see Figure 39).

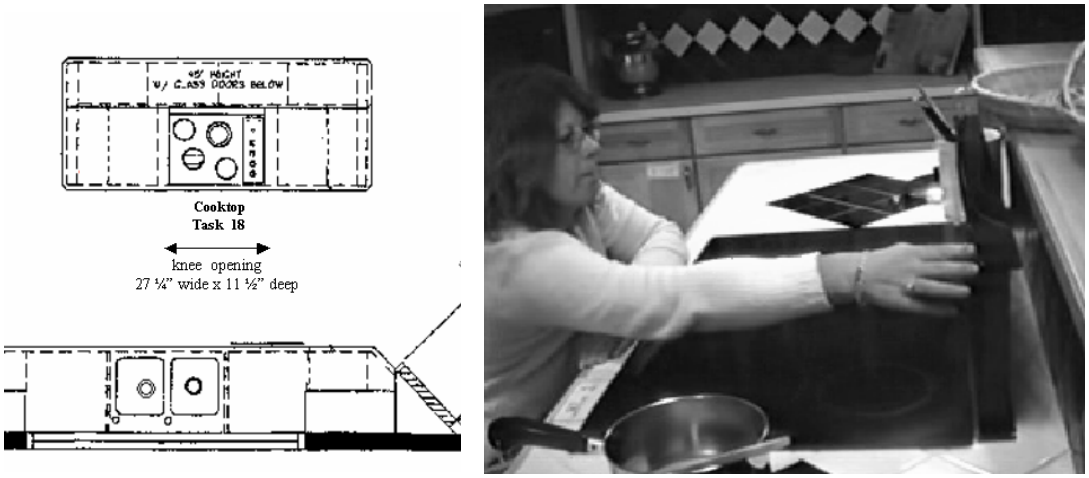

Figure 39. Task Eighteen Diagram and Participant Photograph

Evaluation

This feature was trying to evaluate the cabinet with folding doors that allowed for clear floor space under the cooktop. In addition, the participants evaluated the features of the cooktop appliance system. Although all participants completed the task, only seven of the participants scored a perfect score (10) on the universal design evaluation decision tree. The other two participants utilized a wooden spoon to flip the ventilation on/off switch and, therefore, scored an eight for utilizing an assistive device. The problems noted were associated with the folding doors and floor space clearance under the cooktop. Additional problems noted were related to the ventilation on/off switch and utilizing all four burners on the cooktop (see Table 4.24).

Table 4.24

Ratings for Task Eighteen

	1	**2**	**3**	**4**	**5**
Ease of use opening the folding doors			1	1	7
Ease of clearance and floor space to open folding doors	1	1		2	5
Ease of clearance and floor space under cooktop		2	2	2	3
Ease of using cooktop controls on cooktop surface				2	7
Ease of using ventilation on/off switch	2	3	3	1	
Ease of stirring pot from all burner locations		1	2	2	4
Ease of seeing into pot from all burner locations		3	3	3	
Visual appeal of feature			1	3	5

Discussion

Although this task received some low ratings, 88% said given the choice to have this feature, the folding cabinet doors, placed in their current kitchen they would. Mike, the one participant who said no to this feature, commented that he preferred to cook with gas and was comfortable with a sideways approach to cooking. The majority of the comments

regarding this task pertained to making the feature more user friendly. Many participants (4) noted that the folding doors under the cabinet did not fold back enough and were cumbersome. Three of those participants commented that the knee space provided was not deep enough and that their feet hit the back of the cabinet.

The on/off switch for the downdraft fan received the lowest rating for this task, and many participants commented that this switch was not very user friendly, especially for someone in a wheelchair. One participant noted that this feature was dangerous and that she could easily get burned or catch her clothing on fire. A few suggested that the on/off switch be mounted on the front of the cabinet with the ventilation switch or that the fan could turn on automatically when raised. Additionally, the ease of stirring and seeing into a pot from all four burner locations received low ratings as well. This was attributed to the fact that many of the participants had a difficult time maneuvering completely under the cooktop and the lack of depth in the kneehole space. One participant suggested the lowering of the cooktop area similar to the sink area in Task Five.

A few participants (3) commented on the glass top feature and how easy the controls were to use and that they liked the glasstop burners. One participant thought the controls should be more tactile to assist those users with aging eyes or glare problems. Overall, this feature was well received and the majority (88%) noted that they would like to have this feature placed in their current kitchen.

Summary of Universal Design Evaluation

Overall, the evaluation determined that the following seven universal design features located in the GE Real Life Design Kitchen were beneficial to the wheelchair user.

The following recommendations are suggested when designing a kitchen for a person in a wheelchair:

1.) The microwave oven should be placed at counter height and provide clear knee space underneath the oven (Task 1 & 2).

2.) An adjustable sink was determined to make meal preparation easier for a person in a wheelchair (Task 3). It was also determined that additional counter space next to the sink would be desireable.

3.) The dishwasher should be placed adjacent to sink (Task 4 & 5).

4.) A pull-out cutting surface was determined to make meal preparation easier (Task 8 & 9). This feature should be placed near the sink area.

5.) Some type of roll-out shelf, tray, or drawer for easy access to storage should be incorporated into the kitchen design and within close proximity of cooking and sink area (Task 11, 12, 13, 14, 15).

6.) The oven should be placed close to the serving area. A clear knee space should be provided below the serving area (Task 17).

7.) The controls on the cooktop surface should be easy to use and read, and placed at the front of the appliance (Task 18).

Results from a number of universal design features tested uncovered some discrepancies in regards to whether the universal design feature actually made meal preparation easier for people in wheelchairs. Further investigation is needed in the following areas: raised dishwasher, assistive rolling carts, pull-down shelving, push door mechanism, height of the oven, and knee space clearance requirements.

Observations from the Meal Preparation

After finishing the universal design evaluation portion of the study, each participant was then asked to prepare a meal with a set menu (see Appendix I) in the GE Real Life Kitchen Design Kitchen. Prior to preparing the meal, the researcher set up the kitchen for each participant. All utensils, food and ingredients, and cookware needed to complete the set menu preparation were placed on the table near the oven and each participant instructed the researcher as to where each item should be placed. Items were not allowed to be left on the countertop unless it was normally placed there in the participant's kitchen at home. Participants were instructed to feel free to have the researcher move anything within the kitchen to suit their needs. The participants were encouraged to move the rolling carts and the trash can placement during the kitchen set up. Although each kitchen set up was different, some patterns were noted. All the participants were methodical in deciding how to set up their kitchen and took this task very seriously. They were careful to try to minimize their meal preparation area in order to decrease the amount of traveling to ingredients, food, and cooking utensils. The majority of the participants (8) utilized the Task Eleven feature (a roll-out pantry cabinet) to hold ingredients and they normally either chose the left or right side of the cooktop or sink "A" when deciding where to place the majority of their meal preparation items. None of the participants asked to move or use a rolling cart.

The entire meal preparation activity was video taped and the researcher created behavior maps of each participant (see Appendix O). Behavioral maps recorded the meal preparation activity by diagramming the travel patterns within the GE Real Life Design

Kitchen. Each participant utilized the kitchen differently; however, when all the behavioral maps were placed on top of each other definite patterns emerged.

The observations made by the researcher during the meal preparation discovered that the participants worked efficiently, primarily with features that were rated high during the universal design evaluation and were within easy reach of the participant's cooking area. Most of the participants altered the meal preparation menu to either accommodate their personal tastes or to eliminate steps within the process. The following observations were noted:

1. Most participants tended to stay working within the sink and cooktop areas. They created their own mini work triangle that consisted of the sink, cooktop and counter.

2. The participants generally created only one meal preparation area and utilized only a small counter area in order to assemble ingredients. This occurred either to the left or the right of the sink or cooktop. The microwave oven and refrigerator seemed a bit far away from their work area. One participant, Mary, did the majority of her cutting and mixing of ingredients within the Task Nine cutting board and drawer feature located to the left of the dishwasher and sink "A".

3. Even though many of the participants rated certain features with high scores, they did not utilize them during the meal preparation. Task Eight, the cutting board next to sink "B" with the cut-out bowl feature, was never used by any of the participants. Microwave oven "B" was rarely used. No rolling carts were used by any of the participants.

Although, the decision tree matrix was not utilized during the meal preparation portion of the study, a few of the participants required assistance from the researcher or

family member. Four of the participants required assistance removing the hot casserole dish out of the oven and onto the table. A few of the other participants probably should have asked for assistance with this part of the meal preparation. Upon review of the video tapes, the researcher determined that some of the participants might have risked injury to themselves with this task. It was noted by many of the participants during Task Seventeen that the oven was placed at the wrong height and they had fears associated with removing hot items from the oven. Many felt that the oven should be a few inches lower. The racks within the oven made the casserole too high for them to lift out and the heat from the oven came directly at their face.

One participant forgot to turn on the downdraft vent on the cooktop. After she had chicken in the skillet, she realized that the vent needed to be turned on. She felt uncomfortable reaching across the hot burners to turn it on and asked for assistance. Two other participants utilized a wooden spoon to turn on the vent.

Many of the participants utilized their lap to carry things around the kitchen since they needed their hands to maneuver their wheelchair. Five of the participants used the cutting board on their lap to help with carrying items. Several times (3), participants placed items directly on their lap out of the microwave oven. This could potentially cause harm to the participants without their knowing.

None of the participants utilized the spray feature on the kitchen faucet located at the primarily utilized sink (sink "A"). Many of the participants varied the menu and took shortcuts during the meal preparation. Many commented that they often do this to save time and energy. Many commented that they normally utilize the microwave oven more and that they would normally not fix this extensive of a meal (except 2 participants who

commented that they would not make scalloped potatoes out of a box, but thought they were very good and now might consider it).

Many of the participants were not extremely diligent about cleaning up their mess after cooking. This could have been due to fatigue. Many of the participants seemed to have problems with clean up as the result of not having a disposer within the sink. Many commented that the need for a disposer was important and that they were willing to give up the adjustable sink in order to have a disposer in the sink. They realized that a disposer would take up some of their knee space and noted that they could get a sink with the disposer and drain near the back of the counter. The majority of the participants cleaned the counters and put away all left over ingredients and placed the dishes in the dishwasher. A few participants left the skillet and the casserole dish in the sink to soak. At the end of the cooking activity, all participants seemed proud of the meal they prepared.

Summary of Post Cooking Interview

After completing the cooking activity, the participants were asked a series of questions related to the features and layout of the GE Real Life Design Kitchen, preparing a meal in the GE Real Life Design Kitchen, and what features they would like to have in their kitchen at home. The majority of the participants were familiar with some of the features of the kitchen, but most (6) of the participants did not have any of the features they tested, in their kitchen at home. Only three participants had any of the GE Real Life Design Kitchen's features at home. Mike and Jill had both adapted their kitchen design to accommodate their wheelchair use. Harvey had pull-out trays for pots and pans in his kitchen at home.

When the researcher asked the participants which features from the GE Real Life Design Kitchen they found the most helpful, the participants noted the following.

1. The participants particularly liked the knee space under the sink. This enabled them to get under the sink and reach the faucet in the back. Many did note that they would pay extra for this feature, but not for the adjustable mechanism to move the sink up and down. Only one participant indicated that she would pay extra money for the adjustable mechanism.
2. Some of the participants liked the idea of having a knee space under the cooktop but did not like the doors that hid the space in the GE Real Life Design Kitchen. This could be due to the fact that the hinges on the door protruded into the knee space and made it difficult for participants to get under the cooktop. Although, they thought this feature was visually appealing, the attractiveness took away from the functionality of the feature.
3. Many of the participants thought the access to the table next to the oven was very helpful and would pay extra for this feature if they could fit it into their kitchen.
4. Several of the participants liked the Task Eleven pull-out base pantry feature. One participant, Frank, commented he would like them all over his kitchen and would pay extra money for this feature.
5. Several of the participants liked the pull-out trays and the cutting board, and said that they would pay extra money for this feature.
6. Two participants noted that the push button controls on the cooktop and oven were very easy to use. One said that she also liked the side-by-side

refrigerator and was excited that she could reach into the freezer without the use of a reacher.

When the researcher asked the participants which features from the GE Real Life Design Kitchen they found the least helpful, the participants noted the following:

1. Almost all the participants noted the Task 6 cart (the cart near sink "A") as being the least helpful and a waste of money. While they thought the idea was good, the execution of the feature did not make it very useable for someone in a wheelchair. The cart was rather large (24"x 24") and heavy. The casters did not roll very easily and possibly needed to be replaced.
2. Many of the participants commented that the doors to the cooktop were obtrusive and not needed.
3. The majority of the participants (5) commented that the oven was too high and needed to be lowered to be more useful to someone who is in a wheelchair.

When the researcher asked the participants about their likes and dislikes about the GE Real Life Design Kitchen layout, many of the participants felt they had already discussed these issues at great lengths. Some additional comments included that some of the participants (3) noted that the island was either too big or that they would remove it from the kitchen layout. Another commented that they would add a small sink in the island. One participant commented that the table in front of the microwave oven made it very difficult to use. The majority of the participants liked the GE Real Life Design Kitchen as a whole and made some additional favorable comments not noted previously. One comment included that the dish rack located near Task 8 was a very nice feature and was very accessible, but it could have been placed closer to the dishwasher. Another

participant thought everything was very convenient and that the kitchen allowed for ample turn around spaces within the work environment. Jill noted that it was nice to have a counter surface on both sides of the oven and wished she would have designed this feature into her kitchen. In addition, a few of the participants noted the good light within the kitchen and thought this was an important feature.

Overall, all participants seemed to enjoy the study and were very appreciative of being able to participate. Many of the participants noted that they may make some changes to their current kitchen. Most of the changes discussed involved adding roll out shelves to their base cabinets, adding handles to their existing cabinets, and removing upper cabinet doors for easier access and visual knowledge of item placement. Two participants noted that if they had the money they would like to add the downdraft exhaust which is less obtrusive than a traditional hood.

CHAPTER 5. SUMMARY

This chapter summarizes the study, presents observations and findings, discusses implications of the findings, and provides suggestions for further research. Although each section within this chapter is important to note, perhaps the most influential section regarding universal kitchen design is discussed within the implications section of this chapter and is divided into three parts: implications for appliance companies, cabinet manufacturers, and designers.

Summary of the Study

The purpose of the study was to evaluate the universal design features of the GE Real Life Design Kitchen by people in wheelchairs, and to examine how the GE Real Life Design Kitchen is used by people in wheelchairs as they prepare a meal in the space. This study was divided into four different sections/activities. First, in order to investigate the participant's food preparation patterns and cooking activities, a pre-cooking assessment interview occurred. This section also evaluated the participants' range of motion, strength, and handedness through an assessment of ADLs related to food preparation. Secondly, the participants evaluated specific universal design features of the GE Real Life Design Kitchen. In addition to the participants' evaluations, the participants were observed and rated on their ability to complete tasks based on a decision tree matrix. Third, participants were observed and evaluated on their cooking patterns while preparing a meal from a set menu. In the last section, in order to uncover any additional issues regarding meal preparation for a person in a wheelchair and to clarify the participants' experiences with the kitchen, a post-cooking interview occurred. This study was a step in understanding how

universal design features could benefit, assist, and/or hinder a person in a wheelchair as they prepare a meal.

To investigate how effective the GE Real Life Design Kitchen and its universal design features were for people in wheelchairs, three different person-behavior-environment models were employed in this research: the person-environment interaction model (Lawton & Nahemow, 1973), the work, worker, workplace model (Steidl & Bratton, 1968), and the human factors model or person-environment transaction model (Faletti, 1984). The research framework was set up based on these theoretical backgrounds.

Data were collected through a variety of methods during each section/activity of the study, including personal and videotaped observations and interviews. All portions of the study were videotaped except for the pre-cooking assessment interview that was taken prior to the cooking activity portion of the study. The videotape documented all activities that took place on the day of the study. This allowed the researcher to gain information and behavioral patterns of which the participant may be unaware or unable to verbalize.

Nine people participated in the study. All selected participants used a wheelchair on a daily basis for a variety of disabilities and prepared meals at home while in a wheelchair. Each participant was given the choice of either completing the study all in one day or separating the study into two sections on two different days. All but one participant completed the study in one day. Each participant had varying levels of grip, strength, and memory as a result of their disability. All participants completed the study. Each participant evaluated 18 universal design features by completing specific tasks and prepared a meal with the same menu in the GE Real Life Design Kitchen located in Wallace Hall on the Virginia Tech campus in Blacksburg, VA. Data collection procedures

were primarily qualitative in nature and relied largely on the participant's perception of ease, function, and visual aesthetics during the universal design evaluation, cooking activity, and post-cooking interview.

Observations and Findings

The participants consisted of 5 male and 4 females with ages ranging from 28 to 58 years old. The sample, cumulatively, had over 110 years of experience utilizing a wheelchair. The majority of the participants owned their own home (66%) and all (88%) but one participant lived in a single floor layout. All participants thought the GE Real Life Design Kitchen to be very aesthetically pleasing and attractive.

When participants were asked to test two different microwave oven placements within the GE Real Life Design Kitchen, participants noted that the most important factor for usability and placement of a countertop microwave oven was the ability of the user to get near the appliance. Suggestions included providing knee space under the counter area in which the microwave oven is placed or moving the microwave oven closer to the countertop edge.

Participants liked the idea of the adjustable sink. When asked if this feature would make kitchen preparation easier, 100 percent of the participants said yes. The sink height when adjusted ranged from 32.5 inches AFF to 35.5 inches AFF. Even though the participants believed that this feature would make their kitchen preparation easier, many of the participants did not believe that they would be willing to pay extra money for the adjustable sink mechanism and that providing ample knee clearance at a lowered sink height was sufficient enough to complete tasks involving the sink. Participants also noted

that having the faucet on the side of the sink, where it is easier to reach would make tasks requiring water much easier to perform.

All of the participants liked the dishwasher next to the sink. The design preference about the sink/dishwasher area that emerged from the study, would consist of a fixed lowered sink surface with counter space on both sides of the sink at the same lowered height, with a faucet on the side of the sink closer to the front of the counter, with a deep knee space under the sink, with a dishwasher with an easy to open and close mechanism. There were mixed results from the participants regarding the raising of the dishwasher.

The majority (66%) of the participants expressed a desire to have a cutting surface feature placed within a base cabinet next to the sink to make their meal preparation easier. A few of the participants utilized a portable cutting board located in the kitchen as a lap board and placed it in their lap as a tray surface to assist with carrying items and utensils around the kitchen.

All of the participants liked the idea of having some type of pull-out tray, shelf, or pantry feature added to their kitchen. Many of the participants indicated that they would add multiple pull-out units in their base cabinets if given the opportunity to do so. Comments surrounding this type of feature noted that the pull-out units allowed for easier access to items in the base cabinet and that it was also easier to see and find what was in that cabinet when the user opened the pull-out unit into the open area of the kitchen. This could be due to the fact that a pull-out tray or shelf moves items into the light and is no longer in the shadow of the base cabinet. The pull-out feature requires less strength and agility than bending over and reaching into a base cabinet. During the cooking portion of

the study, all of the participants utilized at least three or more pullout features within the GE Real Life Design Kitchen.

The study findings suggest that people in wheelchairs may utilize 12 inch deep base cabinets with windows to store dishes and smaller items not requiring a deep surface. One participant noted that the windows made it easier to see what was in the cabinet without having to open the doors to look inside.

All of the participants noted that the table surface next to the oven was a convenient feature and would make their kitchen preparation easier. Many of the participants commented that the oven placement was too high. This might be because oven height was almost even with the height of the participant's arms when extended horizontally. This body position of the participants' arms out straight forward, placed the participants at a weakened strength. During the cooking portion of the study, a few of the participants required assistance with removing the casserole out of the oven.

The majority (88%) of the participants liked the idea of having an open knee space under the cooktop surface. Participants noted that open knee space allowed for the user to get closer to the cooking surface and made their meal preparation easier. In addition, the participants liked the smooth cooktop surface and controls to be very easy to use and clean, especially for the participants with grip issues.

The analysis of the behavioral maps during the cooking activity, uncovered the concept that people who use a wheelchair while cooking are very efficient during meal preparation and do not require much counter space in order to prepare a meal. All of the participants placed the majority of the utensils and ingredients needed to prepare the meal within close proximity of the sink and cooktop. Each participant created a small work area

and only moved out of that area when necessary to do so. For example, the microwave oven and refrigerator within the GE Real Life Design Kitchen did not appear to be as convenient as it could have been if those appliances were located in closer proximity to the sink, cooktop and oven. A smaller work triangle may be needed for people who cook in wheelchairs.

Comments noted by the participants suggests that the FHAG and ANSI 117.1-1998 Standard 4.2.4.1 & 4.2.4.2 regarding clear floor space and approach needs to be further investigated in regards to optimal fit. The GE Real Life Design Kitchen exceeded the recommended minimum clear floor space requirement of 30 inches by 48 inches by at least 11 inches (41inches by 48+ inches) throughout the kitchen, yet some of the participants commented during a few of the universal design tasks tested that the floor space was tight or needed to be increased, especially when a drawer or cabinet door protruded in to the clear space. While any knee clearance depth that allows for person in a wheelchair to get closer to a task is desirable, the study discovered that a knee clearance depth of 11.5 inches is not ample enough for people in wheelchairs to get under the cooktop in order to see and utilize all four burners efficiently and safely.

Observation by the researcher, during the study and while reviewing the videotapes of the cooking activity, discovered that the orientation and approach to a design feature for a person in a wheelchair is very important for making meal preparation easier. For example, to remove something from the oven and place it on the table surface, it was much easier for the participant to use a side approach to the oven, facing the table area than to approach the oven facing sink “A” within the kitchen. In addition, it was noted that a 5’-0” turn around space in the oven area of the GE Real Life Design Kitchen would better

accommodate a person in a wheelchair and allow a person in a wheelchair the flexibility to change their orientation and approach to a design feature more readily. Within the design of the GE Real Life Design Kitchen, removing the base cabinet in the island directly across from the oven could easily accommodate this suggestion. This suggestion, if implemented would provide a 5'-0" turn around space within the work area without losing valuable counter surface on that side of the cooktop (see Figure 40). However, the addition of providing a 5'-0" turn around space clear of any countertops or overhangs might also benefit the kitchen that utilizes two cooks during meal preparation.

The study determined that the placement of a 5'-0" turnaround within the working area of any kitchen is desirable for a person who cooks while in a wheelchair. The ideal placement of the suggested turn around space would be dependant upon the kitchen arrangement and user preference but should be included in the kitchen design.

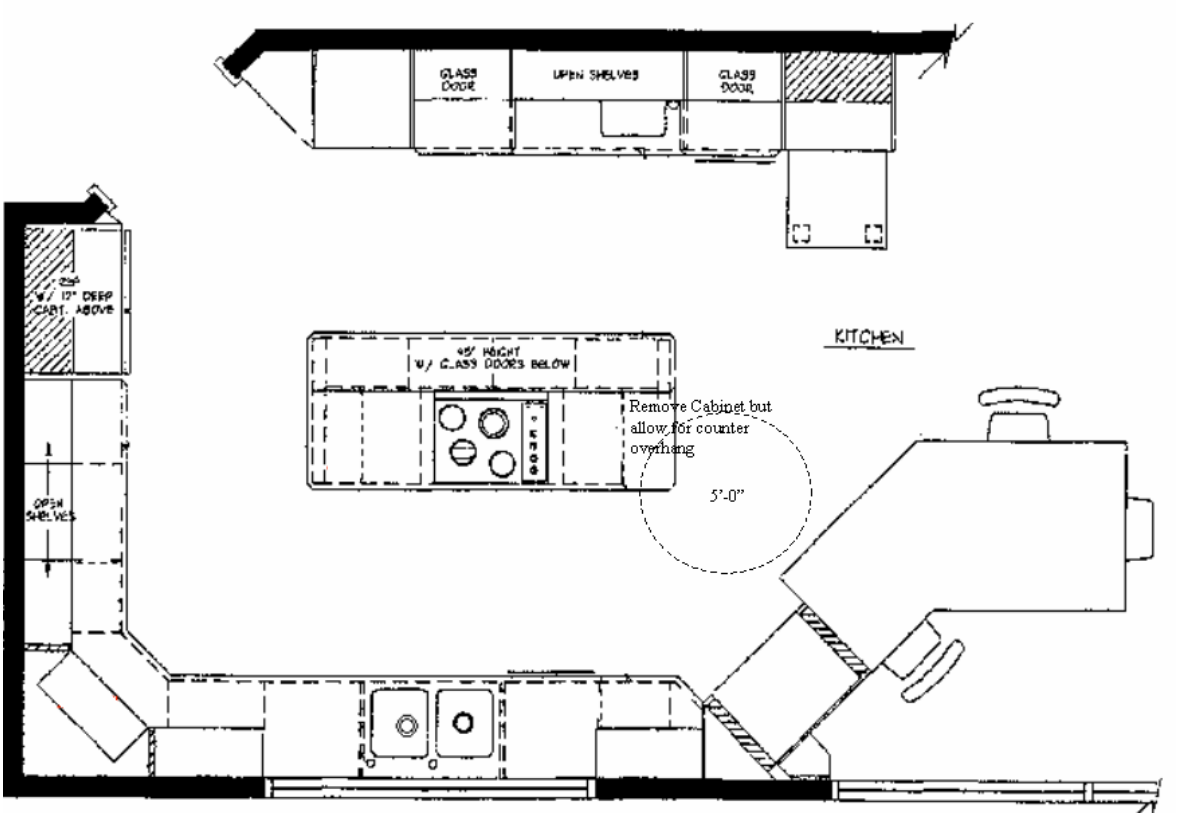

Figure 40. GE Real Life Design Kitchen with a 5'-0" turn around space (proposed)

In conclusion, the study determined that some universal design features are beneficial to people in wheelchairs; however, not all universal design features were beneficial. Universal design is an ideal. When designing a space within a home, the designer should consider specifically the needs of the users of that space and ideally incorporate design ideas that could be beneficial in the event that a disability, either temporary or permanent, should occur.

Implications and Recommendations

This study reinforces the importance of utilizing a person-behavior-environment framework when investigating and testing universal design features. The results of this

study have implications for appliance manufacturers, fixture companies, cabinet manufacturers, designers, builders, architects, and their clients.

Implications and Recommendations for Appliance and Fixture Companies

The results of the study found that easy to use appliance controls, that are cleanable, readable and intuitive to use, are desirable to people in wheelchairs. In addition, the study revealed that sinks with a shallow bowl to accommodate an open knee space underneath the sink area should be available. Developing sinks with the drain at the back of the sink would allow for better knee clearance under the sink. In addition, developing a sink with the hole placement for the faucet on the side of the sink would greatly reduce the forward or side reach required to access this feature, and would encourage small children to utilize the sink without assistance from an adult. In addition, the participants also reinforced the design recommendation of utilizing lever style handles for ease of turning off and on the water.

The results of this study revealed the need to develop a better oven solution. Many of the participants were intimidated by the amount of heat that escaped when the oven door was opened. In addition, some participants felt that the oven door was too large and cumbersome to maneuver around. One might simply specify a smaller oven. Possibilities exist to develop an oven that contains the heat of the oven inside the oven when the door is opened. The oven door could be compartmentalized into smaller door openings while still allowing for all doors to be open at the same time to remove large items placed in the oven or possibly developing a sliding oven door that slides vertically away allowing the user to get directly next to the oven cavity or an oven that has French doors attached (Eurostove, 2006). Dooraway (2006), is a company that is starting to address this issue and has

developed an oven where the oven door slides under the oven compartment and Siemens (2006) has designed an oven that lowers into reach via a push button, however; these are very expensive and they have not been tested by people in wheelchairs.

One participant in the study commented that he currently owns a refrigerator with a bottom freezer drawer. He said that this feature would be desirable to anyone who is in a wheelchair because it allows full access into the freezer and ample access into the refrigerator section. In addition, he noted that the bottom freezer drawer appeared to store more items and large casserole dishes that could not be accommodated with a side-by-side refrigerator. Most appliance manufacturers today offer this type of refrigerator.

The selection of an appropriate dishwasher for the person in wheelchair is an important factor in kitchen design. The results of the study revealed that appliance manufacturers might want to develop and design a dishwasher that is specifically made to be raised off the floor. This dishwasher might have low sides on the top rack in order to minimize the top rack height for people in wheelchairs. In addition, dishwasher developers could design a door mechanism for the dishwasher that would make it easy to open and close the door. This feature would appeal to people in a wheelchair and for those with loss of grip, allowing them to open and close the dishwasher door at the touch of a button. These suggestions, when implemented correctly, would be beneficial to all users and could be considered helpful universal design features.

Appliance manufactures, like the examples listed above, need to continue to research and develop products to enhance the lives of the consumer.

Implications and Recommendations for Cabinet Manufacturers

The results of the study found that heavy duty hardware utilized in cabinet construction is a sought-after and marketable feature to people in wheelchairs. Many participants, when testing specific cabinet features of GE Real Life Design Kitchen, expressed concern about the durability of specific features such as… the push button door latch, cutting board inserts, and the veggie bin pull-out. In many incidences, people in wheelchairs utilize their full body weight to stabilize or maneuver themselves in the kitchen. In addition, the heavy duty hardware needed to endure this type of stress would certainly assist in making cabinets more durable to withstand abuse from small children in the kitchen. Cabinet manufacturers might consider producing useful and durable cabinet accessories such as the following: pull-down shelf unit for the upper cabinet; revolving mechanical shelves in a pantry cabinet; rolling carts that are flexible, easy to maneuver and will not tip over; and better opening and closing door mechanisms for inside cabinets instead of relying on after market products.

Yearns, Patterson, and Bice's (2005) prototype cabinets allowed for adaptability before installing the cabinets; however, cabinet manufacturers might want to investigate the possibility of developing cabinetry modules that are adaptable after the cabinets are installed, not unlike corporate office furniture systems, that could provide well-designed adaptable cabinet solutions for a variety of users over a lifetime of use.

Implications and Recommendations for Designers, Builders, and Architects

Anyone who designs or builds spaces for people in wheelchairs should take into consideration some of the recommendations extracted from this study. There are a number of issues that are covered by this sample; limited reach, memory loss, fatigue and cognitive

stress to name a few. It is important to understand that when designing a space for a person in a wheelchair, there are more factors involved than just the physical measurements of the wheelchair. There could be a whole host of other physical symptoms one might need to consider. Prior to implementing universal design concepts and features to enhance the quality of living and make task completion easier for people in wheelchairs, specific testing of universal design features with the actual end user is recommended. In addition, a thorough evaluation of the person's anthropometric data in regards to reach, ability and limitations is needed to be more effective as a designer. While universal design suggestions and accessories can assist in making tasks for people in wheelchairs easier to perform, it is possible that certain suggestions and accessories could decrease or hinder a person's ability to complete a task. If available, it is desirable for end users to test a feature or a concept prior to design implementation. In addition, the designer, builder, or architect can uncover hidden concepts and gain further insight into their client's task performance and abilities by observing and conducting behavior mapping with a client within an existing environment.

In the kitchen, universal design features needed to make meal preparation easier for a person in a wheelchair include utilizing roll-out trays, pantries and shelves. When laying out the kitchen, make certain to provide open knee and clear floor space at the sink, microwave oven, and cooktop to make it easier for the person in a wheelchair to complete tasks in that area. The design should include a smaller work triangle to promote working efficiency and less fatigue. As the space allocations for today's kitchens keep growing in size, the need for creating *a kitchen within a kitchen* might exist. Creating one small work area that contains the essential working elements hidden within a larger kitchen that can

accommodate numerous users might be desirable. In addition, it is important to note that for universal design features to be effective, they must be located within a small convenient preparation area.

There are additional parameters to consider when designing a kitchen that were not covered by this study but impact the results of this research. All design projects must take into account the budget, overall space, space adjacencies, the products specified, the people who will use the space, and the overall intent of the project. In addition, it is important to note that even though a product specified might be supportive of the user, that product placement within an accessible location is crucial to the usability of that product or feature.

It is important to note that the recommendations suggested are specifically geared for those who design and build single-family homes. The results and recommendations from this study are important to know when working with multi-family and apartment structures, but it is not necessary to apply these concepts within those environments. However, some important design options to consider for multi-family and apartment environments might include: finishing the floor under the sink to allow for easy cabinet removal without replacing the entire floor to accommodate a person in a wheelchair, and providing pull-out drawers or trays in base cabinets. Even though the FHAG requires a 5'-0" turn-around space only in a U-shaped kitchen, it is desirable to provide one such area within all kitchen types. Often the 30" x 48" required clear space would not have been large enough to allow effective movement within the kitchen. More investigation is needed related to clear passage in general, especially as it relates to various mobility aids and the mobility impaired.

Conclusions

One must first recognize and understand that not all universal design features can accommodate all users. This concept contradicts the idea behind universal design. As stated earlier, universal design is an ideal. Universal design accounts for a variety of user types, ages, and cultures. This study focused only on persons who cook while in a wheelchair. The GE Real Life Design Kitchen was not designed specifically for a person in a wheelchair. It was designed for multiple users. In order to accommodate the user profile established (see Chapter 2, p.44 for user profile), Peterson, included some features that might not be supportive of a person in a wheelchair. For example, the pull-down shelf feature might be appropriate and useful to a shorter standing individual. However, as long as the design does not create barricades for the person in a wheelchair, the design might be providing supportive deign features for other family members who might need to utilize the kitchen as well. If the kitchen is solely designed for a person in a wheelchair, it could possibly exclude others within the household, for example a son who is 6'-4" tall. Universal design is not 100% achievable. Not all features can be supportive to everyone. "Even though advocates of universal design recognize that it is nearly impossible to design all things for all people, the ultimate objective is to be as inclusive as possible" (Weisman, 2001, p.69.5). The results of this study revealed the need to investigate and discover additional universal design features that are supportive of people in wheelchairs and that can also accommodate a variety of other users with a variety of limitations.

Suggestions for Further Research

These recommendations for further study and research are formulated as follows:

1. *Similar research on a larger sample of people in wheelchairs to determine if the findings from this study are applicable to a larger population.*

Enlarging the study sample would contribute to making the results more generalizable.

2. *Similar research in a variety of kitchen environments to determine if the findings from this study are applicable to a wider variety of kitchen environments.*

Enlarging the study would contribute to making the results more generalizable.

3. *A study to compare clearance needs for a manual wheelchair versus clearance needs for an electric wheelchair or scooter.*

The researcher observed a few differences between wheelchair users of manual wheelchairs and electric wheelchairs in relation to turning radius and maneuverability. However; nothing definitive was discovered. The use of a scooter or a walker is becoming increasingly common and while no participant utilized one of these devices for this study, these type of mobility aids should be included in a future study as well. A study of this type could uncover if or when design concepts need to be differentiated based on the type of wheelchair present in the home.

4. *A study to investigate people with flexibility, strength and grip issues who prepare a meal.*

The researcher observed a few difference between the participants who had regular physical strength and flexibility with those participants who had limited grip, strength, and

flexibility. Further investigation is needed to determine possible strategies for designing for people with these limitations.

5. *A study to compare clearance needs between optimum accessibility and accessibility requirements mandated by law.*

It was not the intent of this study to test all the accessibility requirements mandated by law, therefore, the results of this study suggests that further research is needed in this area. The federal guidelines regarding accessibility need to be further investigated to determine if the majority of people with disabilities are actually being accommodated. A study of this type may contribute to important information about clearance needs and could possibly change guidelines and accessibility requirements.

6. *A study to examine how and why people in wheelchairs utilize open knee space.*

The results of this study suggest that further investigation into knee space would be beneficial to gaining additional insight into how a person in a wheelchair utilizes and needs this space.

7. *A study that further investigates the role of an island in kitchen design and which users benefit from this feature.*

The results of this study indicate that the island may have acted as more of a hindrance in the GE Real Life Design Kitchen. Further research with flexible spaces that would allow the researcher to adapt the environment with many different scenarios could further investigate this issue.

8. *A study that further investigates the concentrated work zone for a person in a wheelchair*

It was not the intent of this study to determine a concentrated work zone/area for the person in a wheelchair, however; the results of this study indicate that a concentrated work zone would be beneficial for the person who cooks while in a wheelchair. Further investigation is needed to determine the appropriate size and features to be included within this kitchen preparation zone.

9. *A study that further investigates specific aspects of the universal design features that were tested within the GE Real Life Design Kitchen.*

Although the participants tested 18 different features located within the GE Real Life Design Kitchen, some of the results contradicted various universal design recommendations. Further investigation of these features is needed to determine their usefulness to people in wheelchairs. The following are a few examples of the discrepancies found.

Two different carts were designed to make kitchen preparation easier. Even though a few of the participants thought this feature might be useful, further research is needed to determine if this is a feature that would be useful to a person who cooks while in a wheelchair. The majority of the participants for this study utilized a manual wheelchair that requires both hands to maneuver around the kitchen, this might be an explanation of why many of the participants did not find this feature helpful and that none of the participants chose to use this feature during the cooking activity.

Although the participants tested a pull-down shelf in an upper cabinet designed to make kitchen storage more accessible, further investigation of this type of design feature is needed to determine if this is a feature that would be useful to a person who cooks while in a wheelchair. It was noted that the tension on the mechanism was very tight which

increased the difficulty of the feature. Five of the participants in the study had disabilities that affected their reach and strength. This might be an explanation of why many of the participants did not find this feature helpful and that only one of the participants chose to use this feature during the cooking activity. Of all the universal design features tested, this feature received the lowest ratings.

Some of the participants did not notice the difference between the raised toe kick section and the normal toe kick section of the kitchen. Further investigation is needed to determine the usefulness of raised toe kick for kitchen users in wheelchairs.

The height of the oven door was determined to be too high for a person in a wheelchair to safely use. Further investigation to the appropriate oven height and type, including oven size, is needed for optimal fit and safety reasons.

10. *A study that compares like products and appliance types with people who have disabilities to determine which products and appliances should be recommended for a variety of personal physical limitations.*

The results of this study indicate that specific features of a particular product or appliance could enhance or hinder the ease in which a person could utilize that product. For example, one participant noted that the raised dishwasher (dishwasher "B") had higher sides on the top rack than was present in the dishwasher that remained on the floor (dishwasher "A"). Therefore, participants might not have rated this feature favorably due to the combination or the raised appliance and the actual design of the appliance. Appliances and products should be compared within the same placement within an environment to determine a true comparison of the product type. This type of study would highlight appliances and their features that are specifically designed for special populations. In addition, this study could

classify and recommend appliances and features by physical limitations. For example, a certain type of control is recommended for people with loss of grip.

11. *A study that tests and evaluates universal design features with all people to determine if there are any design features that are truly universal.*

Enlarging the sample to include people of different ages and with different abilities would contribute to making the results more generalizable.

12. *Similar research on a larger sample of people in wheelchairs with a wider array of disabilities to determine if the findings from this study are applicable to a larger population of wheelchair users.*

Enlarging the study sample would contribute to making the results more generalizable.

13. *Expand the research study to include the same set menu meal preparation at the current home of the participant in a wheelchair to determine if the findings from this study are applicable to a home setting rather than a fixed environment.*

By investigating how the participants prepare a meal at their current home, the study would contribute to making the results more generalizable and may uncover additional concepts not discovered in this study.

14. *Expand the research study to observe the meal preparation by utilizing Steinfeld and Danford's (1999) decision tree instrument to determine if the GE Real Life Design Kitchen environment creates situations of non-fit for the person in a wheelchair.*

The researcher observed that some participants potentially placed themselves at risk while taking the food out of the microwave oven and the wall oven and noted that some

participants could have used some assistance during the meal preparation activity but the researcher did not employ any instrument to assist with the evaluation of fit between the participants and the environment.

15. *Replicate previous kitchen studies that observed kitchen activities, with people in wheelchairs and utilize Steinfeld and Danford's (1999) decision tree instrument to determine if optimal fit is achieved.*

Examining what design decisions and factors increase the likelihood of optimal fit for a person in a wheelchair might uncover design concepts that could be considered good universal design practices.

16. *Test kitchen utensils and accessories made specifically for a person in a wheelchair to see if they could be considered a universal design feature.*

It was the intent of this study to evaluate universal design features located in the GE Real Life Design Kitchen to see if they were helpful to people in wheelchairs; however, the reverse could be investigated. Many people benefit from design alterations made specifically for people in wheelchairs, so it only seems logical that those accessories should be investigated by others to discover their possible usefulness to all people, hence, universal design.

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APPENDIX A
IRB

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Institutional Review Board
Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice President for Research Compliance
CVM Phase II- Undepond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
email: moored@vt.edu

DATE: February 11, 2005

MEMORANDUM

TO: Julia O. Beamish Apparel, Housing & Resource Mgt 0410
Holly Cline

FROM: David Moore

SUBJECT: **IRB Expedited Approval:** "Evaluation Universal Design Features in Kitchens by people in wheelchairs" IRB # 05-092

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective February 10, 2005.

Virginia Tech has an approved Federal Wide Assurance (FWA00000572, exp. 7/20/07) on file with OHRP, and its IRB Registration Number is IRB00000667.

cc: File
Department Reviewer LuAnn Gaskill NE 0410

APPENDIX B
Informational Flyer

Are you interested in trying out kitchen design features?

Graduate Student is seeking volunteers
who use a wheelchair
to evaluate kitchen design

Purpose:
The purpose of this study is to evaluate and test the universal design features of the GE "Real Life Design" Kitchen, by people using wheelchairs. The kitchen is located in the Center for Real Life Kitchen Design, in Wallace Hall on Virginia Tech's campus by wheelchair users. The study will determine if the universal design features are beneficial to users in wheelchairs.

Criteria:
To be eligible to participate, you must meet the following criteria:

- Cook or prepare at least one meal a week in your kitchen
- Agree to cook a meal in the GE Kitchen on Virginia Tech's campus
- Use a wheelchair while preparing meals
- Agree to be videotaped and/or photographed while participating in study
- Provide your own transportation to and from Wallace Hall on the Virginia Tech's campus

Benefit to Participant:
Participants might discover new technologies and features in kitchen design that would benefit them in preparing meals.

Compensation:
Participants may be reimbursed for gas and travel arrangements.

Research Location:
An interview assessment will be conducted either over the phone prior to coming to campus for the cooking activity or on the same day as the cooking activity.
(approx. 20 minutes)

The cooking activity will take place in Room 247 of Wallace Hall, in the Center for Real Life Design. (approx. 3.5 hours)

Time Commitment:
The interview assessment should take 20 minutes.
The cooking activity should take no longer than 3.5 hours.

If interested please call: Holly Cline at 239-3559 (local call for Blacksburg) or e-mail: hcline@radford.edu

APPENDIX C
Criteria of Sample and Participation
Sign Up Sheet

Criteria of Sample and Participation Sign Up Sheet

Thank you so much for agreeing to participate in this study. The purpose of the study is to test the universal design features of the GE Real Life Design Kitchen located in Wallace Hall on Virginia Tech's campus. This kitchen has several universal design features that were planned to make the kitchen easier to use for everyone no matter what their abilities. I am particularly interested in how people in wheelchairs use the features in this kitchen and would like you to participate if you can.

First, let me make certain you meet the criteria established to participate in the study.

Do you cook or prepare at least one meal a week in your kitchen?	__ yes ___ no
When you cook in your kitchen, do you do so in a wheelchair?	__ yes ___ no
Do you have transportation available to get to and from Wallace Hall on VA Tech's campus?	__ yes ___ no
The study will take approximately 4 hours, can you participate for that amount of time?	__ yes ___ no
Are you a willing participant for the study, which includes cooking a meal in the GE Kitchen?	__ yes ___ no
Do you agree to be videotaped and/or photographed while participating in the study, and will you agree to sign a photographic release form?	__ yes ___ no

If participant answers **no** to any of the above questions. ↓

I would like to thank you for your time but unfortunately, you do not qualify to participate in this study. Do you have any additional questions for me at this time? If you know of anyone who may qualify for this study could you please have them contact me at 239-3559 or by e-mail at hcline@radford.edu. Thank you again and have a wonderful day.

If participant answers yes to all questions. ↓

Code Number _____

Thank you again for agreeing to participate in the study, your information is very valuable to us. The study is separated into 4 different parts: a pre-cooking interview; a universal design feature evaluation; a cooking activity, where you will prepare a meal; and a post-interview after you've completed all other portions of the study. You may choose a few different ways to proceed with the study.

You may either choose to participate in the study all in one day and that will take approximately 4 hours. OR

You may choose to separate the study into two parts. Participating in the pre-cooking interview and universal design evaluation on one day (approximately 1.5 hrs) and returning to perform the cooking activity and post-cooking interview on another day (approximately 2 hours).

Which method do you think you would prefer? _____

Let's schedule the day(s) and time(s) for you to come to the kitchen and participate in the study.

Day and Time _____ Day and Time _____

When you come to Wallace Hall to participate in the study, I will have you sign two forms that are required by the University. The first form is an informed consent form that explains the purpose of the study and procedures involved. The second form gives me the permission to videotape and photograph you while you are participating in the study.

After signing the forms, I will take some basic measurements of your body while sitting in your wheelchair. I will then have you test certain universal design features of the GE Kitchen and ask for your feedback. After that, I will have you perform the cooking activity assigned to you and then afterward I will ask you a few questions about your experience and ask for your feedback.

Are you a vegetarian? _____ yes _____ no

The meal you will be making will consist of curry or garlic chicken (or vegetarian alternative), scalloped potatoes and a salad. Do you have any allergies or food preferences that make this menu unacceptable? _____ yes _____ no (if yes,) How can I modify the menu? _____.

After you are finished cooking the meal, you will clean up the kitchen. You are more than welcome to eat your meal in the GE Kitchen. You may invite a friend to eat the meal with you, if you would like, or you can always take your meal home with you.

If you use any assistive devices in your everyday cooking you may want to bring those with you or we may have that device in the GE Kitchen. Do you have any assistive devices that you plan to bring or need? _____

Does anyone normally help you with your cooking? _____ yes _____ no
(if yes, who? Will you need that person to come with you for the cooking activity)
_____

If you could bring me a sketch of your kitchen as it exists in your current living situation I would greatly appreciate it. In addition, if you have any photos or documents pertaining to your kitchen layout and design, I would love to see those too.

I will be mailing you a parking pass and directions to Wallace Hall and the GE Kitchen. Can I please have you address in order to mail these items to you?
_____
_____
_____
Do you have an e-mail address and do you check your mail regularly? _____ yes _____ no
If yes, may I have your e-mail address in order to e-mail you further information?_____

May I have your telephone number? _____

Do you have any other questions?

If you need to get in touch with me for any reason please call me on my cell phone at 239-3559.

Thank you again for your time and patience and I look forward to meeting you on _____ day at _____ time.

APPENDIX D
Pre-Cooking Assessment Interview Sheet

Pre-Cooking Assessment Interview Sheet

Thank you so much for agreeing to participate in this study. The purpose of the study is to test the universal design features of the GE Real Life Design Kitchen located in Wallace Hall on Virginia Tech's campus. This kitchen has several universal design features that were planned to make the kitchen easier to use for everyone no matter what their abilities.

As I discussed with you on the phone, some portions of this study will be video taped. In addition to signing the informed consent sheet, I will also need you to sign a Photographic release form stating that you will allow me to video tape and photograph your participation in the study.
_____ (check once the participants has filled out informed consent form and photographic release form)

I hope you remembered to bring a sketch of your kitchen. I will take your sketch now if you brought it with you. _____ (check that you received sketch and staple it to the back of this assessment sheet)

As I discussed with you over the phone I have a few set of question I would like to ask you about your current kitchen at home. These questions should take approximately 25 minutes. Here is a copy of the questions I am going to ask so you can read along with me if you would like.

The first set of questions is about your current living arrangements and your ability to prepare a meal.

How many people, including yourself are present in your current living situation?

# Participant	Age	Gender	Participating
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Do you have a pet(s) (if yes, what type?)_____

Is your pet a special animal to assist with your activities of daily living?
(if yes, what type of activities and what type of pet(s)?)
_____

Do you have any additional disabilities that affect how you operate in the kitchen? (if yes, what type?)
_____
_____

Besides the wheelchair, do you use an assistive device(s) when you cook? _____ yes _____ no
(if yes, please describe) (if yes, please ask them if they can bring it with them for the cooking activity in Wallace Hall)
_____
_____

The use of an assistive device is
_____ not difficult _____ a bit difficult _____ very difficult _____ not necessary

Do you need or prefer to use one side of your body more than the other when you prepare a meal? (if yes, please describe)

_____

_____

When you prepare a meal in your home, do you tire easily? (if yes, please describe)

_____

_____

When preparing a dish that comes in a prepackaged box, would your ability to read the directions be classified as average, below average or above average?

_____

When handling groceries, would you classify your strength as average, below average or above average?

_____

Which of the following, best describes your current living situation?

a.	_____	apartment	_____	townhouse/condo	_____ house
b.	_____	single floor layout	_____	multi-floor	
c.	_____	rent	_____	own	

How many bedrooms? _____

What is the approximate square footage of your home? _____

1. For the purpose of this study, the kitchen is defined as the primary food preparation area. In your current living situation, what types of activities take place in your kitchen on a regular basis among you and your household members? (check all that apply)

_____	cooking	_____	school work	_____	conversation on phone
_____	entertaining	_____	reading the newspaper	_____	TV watching
_____	supervising children	_____	hobby creation	_____	serving food/buffet
_____	sewing	_____	doing laundry/folding	_____	meal planning
_____	pet food/bed	_____	computer work	_____	bookkeeping/paying bills
_____	listening to music	_____	eating	_____	conversing with others
_____	other activities _____				

I am going to ask you a series of questions about how you utilize your kitchen. When I say "you" I mean only yourself. These questions are about your cooking patterns.

2. How often do you prepare a complete meal in your current living situation? A complete meal consists of two or more food items and a beverage (select one).

_____	5 or more times per week	_____	1-2 times per week
_____	3-4 times per week	_____	never

3. Which meal(s) do you prepare on a regular basis? (check all that apply)

____ breakfast ____ lunch (noon) ____ dinner (p.m.)

4. I am going to ask you how often you do certain activities. The answers you can select from are:
   (A) Never (B) 1-2 times per month or less (C) 1-2 times per week (D) 3 or more times per week

   On average, how often do you…

   _____ Prepare a complete meal using recipes and basic ingredients
   _____ Prepare a complete meal using the combination of convenience foods and food using a recipe
   _____ Prepare a quick meal using only convenience foods
   _____ Bring in carryout food
   _____ Eat Out
   _____ Eat with other people and friends in the kitchen

5. Do you prepare quantity meals that are frozen for later use? _____ yes (if yes how often?) _____ no

6. Do you do any specialty cooking? Such as:
   _____ gourmet foods _____ canning _____ grilling outdoors _____ quantity freezing
   _____ ethnic foods _____ stir fry _____ microwave meals _____ baking (cookies, bread, etc)

7. On a regular basis, do you prepare items that need rolling (rolled cookies, pie crusts, etc.)? ____ yes ____ no

   On a regular basis, do you prepare items that need chopping (vegetables, nuts, etc.)? ____ yes ____ no

8. In terms of fruits, which of the following do you use most often? (select one)
   _____ fresh _____ canned _____ frozen _____ use all equally

9. In terms of vegetables, which of the following do you use most often? (select one)
   _____ fresh _____ canned _____ frozen _____ use all equally

10. Do you use more boxed or frozen convenience foods? ____ boxed ____ frozen ____ about the same

11. Do you have an eating area in your kitchen in your current living situation?
    ____ yes ____ no (if yes, how many?) _____

12. Is it important to have an eating area in the kitchen? _____ yes _____ no (if yes, how many?) _____

If participant has additional people living in his/her home please ask the following question.

The next question refers to your household. When I say household I mean everyone else in your current living situation but yourself. _____ (NA) no additional people living in home

13. How often does someone in your household other than you prepare a complete meal in your current living situation? A complete meal consists of two or more food items and a beverage (select one).
    _____ 5 or more times per week _____ 1-2 times per week
    _____ 3-4 times per week _____ never

The next set of questions will be about the appliances you have in your home.

14. Which major kitchen appliances do you have in your kitchen? (check all that apply)
    _____ range _____ refrigerator _____ dishwasher _____ wall oven ___ other
    _____ cooktop _____ microwave _____ trash compactor _____ freezer _____

15. Which major kitchen appliances do you have located in other parts of the home? (check all that apply)

_____ range _____ refrigerator _____ dishwasher _____ wall oven ___ other
_____ cooktop _____ microwave _____ trash compactor _____ freezer _____

16. What major kitchen appliance would you like to add to your kitchen?

_____

17. How many times per week do you hand wash all of the meal's dishes? _____ Only select items? _____

18. During an average week, which cooking method do you use most often to prepare meals? (select one)

_____ range top/cooktop _____ microwave oven _____ oven _____ small appliances

19. Do you use the microwave oven for: _____ (NA does not have MW, skip question 30.)

_____ reheating leftovers _____ heating small quantities of water
_____ partial preparation _____ preparing convenience foods (microwaveable lasagna, chicken, TV dinners)
_____ popping popcorn _____ complete preparation from scratch

20. Do you use the microwave oven:

_____ never _____ less than the range _____ the same as the range _____ more than range

21. Which small appliances do you regularly keep on your kitchen counter? (check all that apply)

_____ blender _____ coffee maker _____ mixer _____ food processor
_____ toaster _____ toaster oven _____ can opener _____ microwave
_____ TV _____ iced tea pot _____ deep fat fryer _____ electric fry pan
_____ bread machine _____ others _____

22. I am going to ask you about other items on or near your kitchen counter. The answers you can select from are: **C.** on the countertop, **B.** on the back splash, or **H.** hung under the wall cabinets (code accordingly beside items)

_____ canisters _____ cookbooks _____ radio _____ food (eg bananas)
_____ knife block _____ plants _____ lotion _____ decorator item
_____ soap pump _____ telephone _____ utensil holder _____ mug rack
_____ spice rack _____ recipe box _____ medicines _____ dishes
_____ paper towels _____ salt and pepper _____ napkin holder _____ dish rack/drain board
_____ bills _____ others _____

I would also like to ask you some questions about the storage of items you use in your kitchen.

23. How many sets of dishes do you have? _____ Where are they stored?

_____ kitchen above counter _____ dining room other _____
_____ kitchen below counter _____ breakfast area

24. Do you store any other kitchen items outside the kitchen? ___ yes ___ no? (if yes, what types, where & why)

Types of items _____ Where? _____ Why? _____
Types of items _____ Where? _____ Why? _____
Types of items _____ Where? _____ Why? _____

25. Do you recycle? ___ yes ___ no Do you prefer to store recycling items in the kitchen? ___ yes ___ no

26. In which parts of the kitchen would you like to have additional storage/space? (check all that apply)
_____ wall cabinets _____ at the sink _____ at the range _____ a pantry
_____ base cabinets _____ counter top _____ at the refrigerator _____ in all areas

27. How many drawers do you have in your kitchen? _____

28. Would you like to have more drawers available in the kitchen? _____ yes _____ no

29. In your current situation, what do you store in your drawers?
____ silverware ____ cooking utensils ____ baggies ____ junk drawer (pens, phone book, etc)
____ plastic ware ____ tin foil/ wax paper ____ spices ____ tools (screw driver, hammer, etc.)
____ dishes ____ pots and pans ____ other (be specific) _____
_____

30. Do you have enough counter space for mixing and preparing food? _____ yes _____ no

31. Do you have enough counter space for storing the things you need in your kitchen? _____ yes _____ no

32. Do you have enough knee space for mixing and preparing food? _____ yes _____ no

The next set of questions will ask you about kitchen modification that you have made or would like to make to your kitchen.

33. Did you have any input into the design of your kitchen? _____ yes _____ no

34. Has your kitchen ever been renovated or remodeled? _____ yes _____ no

35. Have you made any modifications to your current kitchen to make it easier for you to use the space while you are in a wheelchair (lowering cabinets, removing doors, removing cabinets, etc.)?
_____ yes _____ no (if yes, please describe).
_____
_____

36. Have you made any changes concerning storage in your current kitchen? _____ yes _____ no
(if yes, please describe) _____
_____

37. Is there anything about your current kitchen layout that makes cooking preparation, cooking and cleaning difficult? _____ yes _____ no (if yes, please describe) _____
_____

38. If you could improve one thing about how your kitchen is arranged, what would it be?
_____
_____

39. Is there anything about your current kitchen layout that makes storage and retrieval difficult?
(for example: food storage, appliances, pots and pans, etc.) _____ yes _____ no (if yes, please describe)
_____
_____

40. If you could improve one thing about your kitchen's storage, what would it be?
_____
_____

41. What changes to your current kitchen would you make if you had the money? (list in order of preference)
_____
_____

Now I am going to ask you questions concerning your mobility, range of motion and strength in performing various activities. I would like to know if you find the activity: not difficult, a bit difficult, very difficult, something you can't do or as something you do not do.

The first series of questions discuss range of motion, mobility, and handedness.

Range of Motion/Mobility/Handedness

42. Raising arms straight above your head is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

43. Using your arm strength to lift and move things is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

44. Using your hands to grip things is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

45. Moving your head and neck from side to side/ up and down is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

46. Bending over to retrieve things is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

47. Transferring from your wheelchair to a chair is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

48. Opening a door to a room is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

49. Using buttons or hooks in dressing yourself is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

The next series of questions is about your mobility, range of motion and handedness in the kitchen.

50. Cutting vegetables is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

51. Putting filled pots on the cooktop is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

52. Stirring food is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

53. Pulling out and removing items from your wall cabinets is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

54. Pulling out and removing items from your base cabinets is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

55. Pulling out and removing items from a cabinet drawer is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

56. Opening spice containers is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

57. Opening food jars is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

58. Opening canned food items is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

59. Lifting items out of the oven is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

60. Sweeping is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

61. Loading the dishwasher is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

62. Reaching the back of the sink to turn on the faucet is _____ something you do not do
_____ not difficult _____ a bit difficult _____ very difficult _____ something you can't do

Thank you so much for your patience in answering all of the questions. Do you have any additional comments you would like to add?

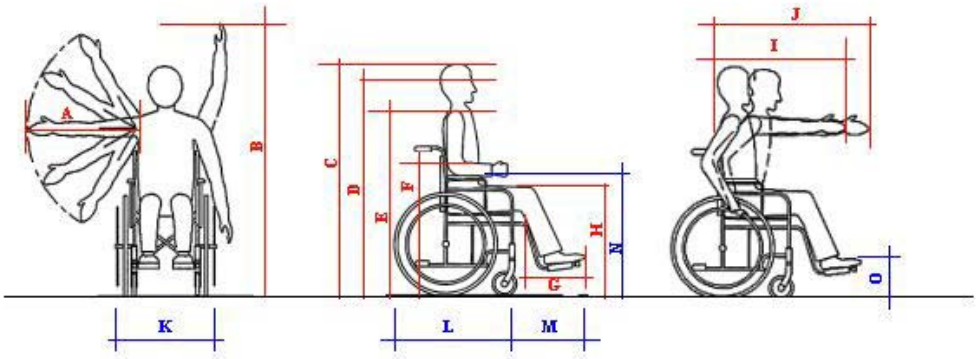
APPENDIX E
Universal Design Evaluation Form

Universal Design Evaluation Form

Code Number _____ Male/ Female _____

Thank you so much for agreeing to participate in this study. The purpose of the study is to test the universal design features of the GE Kitchen to see if the features in the kitchen are beneficial a person in a wheelchair. As I discussed with you on the phone, this portion of the study will be video taped.

I would first like to take some measurements of you in your wheelchair.



Measurements *A, B, I, & J measurements taken with 16 oz. Bag of rice in hand.

A. * Side Approach Horizontal Reach Sitting			
B. * Vertical Reach Height Sitting		I. * Horizontal Forward Reach	
C. Sitting Height		J. * Horizontal Forward Reach Stretching	
D. Eye Height Sitting		K. Wheelchair Width	
E. Shoulder Height Sitting		L. Wheelchair Depth	
F. Top of Arm Height Sitting		M. Foot Rest Extension Depth	
G. Under Knee to Toe Length		N. Wheelchair Arm Height	
H. Thigh to Floor		O. Floor to top of Toe in Footrest	

Note wheel chair type: Manual, Electric or Scooter

_____

Does your wheelchair have any special features that you normally utilize during your meal preparation?
_____ yes _____ no (if yes, please have participant demonstrate and describe) _____
_____

Did you bring with you any assistive devices? _____ yes _____ no (if yes, have participant explain what the device(s) is (are) and demonstrate how he/she uses it (them))

_____
_____

The first part of this exercise is to have you test certain design features and standards present in the GE Kitchen. I will have you perform a task and then answer a few questions related to the task. This will also help you get familiar with the kitchen before you start the cooking activity.
If you have questions at any time or need to take a break, please feel free to ask. I will read each task and indicate the location where the task is to take place. (refer to diagram for task orientation)

Task 1 Take the box labeled “A” out of freezer, open the box and place the container in microwave “A”. Take container out of microwave “A” and place it on the counter.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of opening Freezer door	1	2	3	4	5
Ease of clearance and movement from Freezer to Microwave	1	2	3	4	5
Ease of opening Microwave door	1	2	3	4	5
Ease of placing container on counter	1	2	3	4	5
Visual Appeal of Features	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 2 Take the box labeled “B” out of freezer, open the box and place the container in microwave “B”. Take container out of microwave “B” and place it on the pull out table.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of opening Freezer door	1	2	3	4	5
Ease of clearance and movement from Freezer to Microwave	1	2	3	4	5
Ease of opening Microwave door	1	2	3	4	5
Ease of placing container on pull out table	1	2	3	4	5
Visual Appeal of Features	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Which task was easier to perform? Task 1 or 2
Which Microwave placement is easier to utilize? “A” or “ B”
Which Microwave is easier to utilize? “A” or “ B”
Which placement made it easier to place container on counter or table? “A” or “B”

Do you have any additional comments you would like to add? Would you change anything?
_____

Task 3 Adjust sink “A” utilizing the adjustability mechanism of the sink. Place the sink at the appropriate height for your greatest ease of use and get water out of the faucet in the glass provided and place it on the counter.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space under sink	1	2	3	4	5
Ease of adjusting the sink	1	2	3	4	5
Ease of turning on faucet	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Measure the sink height _____
Is there enough counter space at the appropriate height next to the sink? _____

Do you have any additional comments you would like to add? Would you change anything?
_____

Task 4 Take a mug and a plate out of the sink "A" and place them into dishwasher "A". Place the mug in the top rack of the dishwasher and place the plate on the bottom rack of the dishwasher.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and movement from Sink to Dishwasher	1	2	3	4	5
Ease of opening Dishwasher door	1	2	3	4	5
Ease of taking glass out of sink	1	2	3	4	5
Ease of taking plate out of sink	1	2	3	4	5
Ease of placing glass in Dishwasher	1	2	3	4	5
Ease of placing plate in Dishwasher	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 5 Take a mug and a plate out of the sink "B" and place them into dishwasher "B". Place the mug in the top rack of the dishwasher and place the plate on the bottom rack of the dishwasher.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space under sink	1	2	3	4	5
Ease of clearance and movement from Sink to Dishwasher	1	2	3	4	5
Ease of opening Dishwasher door	1	2	3	4	5
Ease of taking glass out of sink	1	2	3	4	5
Ease of taking plate out of sink	1	2	3	4	5
Ease of placing glass in Dishwasher	1	2	3	4	5
Ease of placing plate in Dishwasher	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Which task was easier to perform? Task 4 or 5
Which Dishwasher placement is easier to utilize? "A" or " B"
Do you have any additional comments you would like to add?
_____

Task 6 Pull out the cart labeled "T6" and place it near sink "A". Utilize the cart surface to slice a cucumber, with the cutting board, knife and cucumber provided.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to move roll out cart	1	2	3	4	5
Ease of moving roll out cart	1	2	3	4	5
Ease of slicing cucumber near sink	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 7 Pull out cart labeled “T7” and place it near sink “B”. Utilize the cart surface to slice a cucumber, with the cutting board, knife and cucumber provided.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to move roll out cart	1	2	3	4	5
Ease of moving roll out cart	1	2	3	4	5
Ease of slicing cucumber near sink on cutting board	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 8 Pull out cutting surface labeled “T8” and slice a cucumber, with the knife provided. Place bowl in slot provided and place cucumber slices in bowl.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cutting surface	1	2	3	4	5
Ease of moving cutting surface	1	2	3	4	5
Ease of slicing cucumber near sink on cutting board	1	2	3	4	5
Ease of placing bowl in slot	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 9 Pull out cutting surface “T9” and slice a cucumber, with the knife provided.
On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cutting surface	1	2	3	4	5
Ease of moving cutting surface	1	2	3	4	5
Ease of slicing cucumber near sink	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Compare Tasks 6, 7, 8 and 9 for the following questions.

Which surface was the easiest to utilize?	T6	T7	T8	T9
Which surface had the best visual appeal?	T6	T7	T8	T9
Which roll cart was easier to utilize?	T6	T7		
Which cutting surface was easier to open?			T8	T9
Given your choice to place any of the following features anywhere in your current kitchen, which would you choose to have in your home?	T6	T7	T8	T9

Where would you place the feature? _____
Why did you choose the feature you did?_____
Do you have any additional comments you would like to add?
_____

Task 10 Open door in cabinet "T10" and use the pull-down shelf to get out a container and place it on the counter.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of using the pull down shelf	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Given the choice to have this feature placed in your current kitchen would you have this feature added? _____ yes _____ no Why? _____
Do you have any additional comments you would like to add?
_____

The next 5 tasks are all related, I will be asking you to open up various cabinets and retrieving an item from the bottom tray or drawer, placing it on the counter and then retuning it back to it's original position in the cabinet.

Task 11 Pull out the door in base cabinet "T11" and take the bag of rice off the bottom shelf and place it on the counter and then put it back and close the door.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of using the pull-out door	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 12 Open the bottom drawer in base cabinet "T12" and take the bag of rice out and place it on the counter. Then put it back and close the drawer.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open pull-out drawer	1	2	3	4	5
Ease of using the pull-out drawer	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 13 Open door in base cabinet "T13" and pull out the bottom veggie bin drawer. Take the bag of rice and place it on the counter. Then put it back and close the drawer.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of using the veggie bin drawer	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 14 Open door in base cabinet "T14" and pull out the bottom tray. Take the bag of rice out of the tray and place it on the counter. Then put it back and close the drawer.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of using the pull-out tray drawer	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Task 15 Open the door in base cabinet "T15" and pull out the bottom tray. Take the bag of rice out of the tray and place it on the counter. Then put it back and close the drawer.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of using the pull-out tray drawer	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Compare Tasks 11, 12, 13, 14, and 15 for the following questions.

Which cabinet was the easiest to take something off the bottom shelf, tray or drawer?	T11	T12	T13	T14	T15
Which cabinet had the best visual appeal? (undecided)	T11	T12	T13	T14	T15
Given your choice to place any of the following features anywhere in your current kitchen, which roll-out feature would you choose to have in your home.	T11	T12	T13	T14	T15

Where would you place the feature? _____
Why did you choose the feature you did?_____
Do you have any additional comments you would like to add?
_____

Task 16 Open the door in base cabinet "T16" and take a plate off of the bottom shelf. Place it on the counter and then put it back and close the door. This cabinet does not have door handles. The door opens by pushing into the door.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of clearance and floor space to open cabinet door	1	2	3	4	5
Ease of opening cabinet door	1	2	3	4	5
Ease of taking something off the bottom shelf	1	2	3	4	5
Visual Appeal of Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Given the choice to have this feature placed in your current kitchen would you have this feature added? _____ yes _____ no Why? _____
Do you have any additional comments you would like to add?
_____

Task 17 Turn the oven on and try using the controls, then turn the oven off. Open the oven door and take the casserole dish out of the oven and place it on the table next to the oven. Move over to the table and pretend you are serving from the casserole dish.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of using the controls	1	2	3	4	5
Ease of clearance and floor space to open oven door	1	2	3	4	5
Ease of opening the oven door	1	2	3	4	5
Ease of removing the casserole dish from the oven	1	2	3	4	5
Ease of maneuvering to the table	1	2	3	4	5
Ease of serving at the table	1	2	3	4	5
Visual Appeal of the Table Feature	1	2	3	4	5

Would this feature make your kitchen preparation easier?_____

Would you prefer the oven 1) at the height it is now 2) lower 3) higher
(if answer 2 or 3 have participant show where they would prefer the height and measure and record) _____

Do you have any additional comments you would like to add? Would you change anything?
_____

Task 18 Open up the folding doors under the cooktop. Try to reach all the controls of the cooktop and practice turning them on and off. Turn on the ventilation fan. Take the pot and spoon from the counter and place it on the cooking surface. Pretend you are stirring the pot in all four burner locations.

On a scale from 1 to 5 (1 being poor & 5 being excellent), rate the following:

	poor				excellent
Ease of use opening the folding doors	1	2	3	4	5
Ease of clearance and floor space to open folding doors	1	2	3	4	5
Ease of clearance and floor space under cooktop	1	2	3	4	5
Ease of using cooktop controls on cooktop surface	1	2	3	4	5
Ease of using ventilation controls to raise the fan	1	2	3	4	5
Ease of using ventilation on/off switch	1	2	3	4	5
Ease of stirring pot from all burner locations	1	2	3	4	5
Ease of seeing into pot from all burner locations	1	2	3	4	5
Visual Appeal of Features	1	2	3	4	5

Would this type of folding cabinet doors with floor space underneath for cooking make your kitchen preparation easier?

_____

Would this type of cooktop and ventilation system make your kitchen preparation easier?

_____

Given the choice to have this feature placed in your current kitchen would you have this feature added? _____ yes _____ no WHY? _____

Do you have any additional comments you would like to add? Would you change anything?

_____

Based upon your experiences from testing the universal design features in the GE Kitchen, please respond to the following questions.

Did you notice any difference when utilizing cabinets with the raised toekick height versus the standard toekick height cabinets??

_____ yes _____ no (if yes, please describe)

_____
_____
_____
_____

Did any of the features need more clear floor space to assist in making that feature more user friendly?

_____ yes _____ no (if yes, please describe)

_____
_____
_____
_____

Were there any features you really liked and would pay additional money to get those features in your home? _____ yes _____ no (if yes, please describe)

_____
_____
_____
_____

Were there any features you really disliked and consider those to be a wasted effort?

_____ yes _____ no (if yes, please describe)

_____

If separating the study into two different days.

Thank you for your cooperation so far. All we have left for today is to set up the kitchen how you would like to use it for the cooking activity. Would you like to take a break before we set up the kitchen? After setting up kitchen:

Thank you again for your help with the study. I have you scheduled to return to complete the rest of the study on

_____

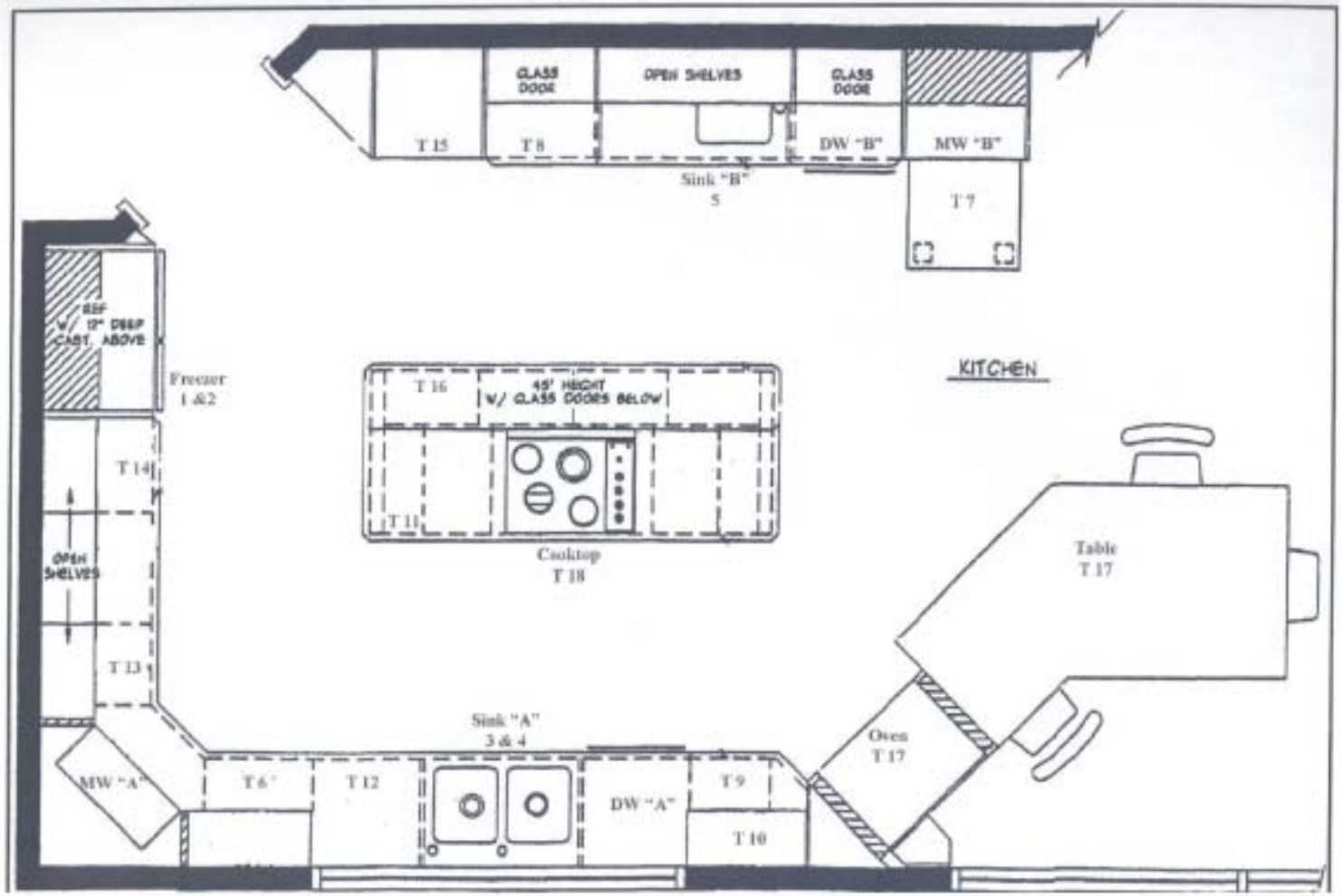
If conducting the study all in one day.

Thank you for your cooperation so far. Would you like to take a break before we set up the kitchen and get started with the cooking activity?

APPENDIX F
Diagram for Task Orientation

Diagram for Task Orientation

GE "Real Life Design" Kitchen

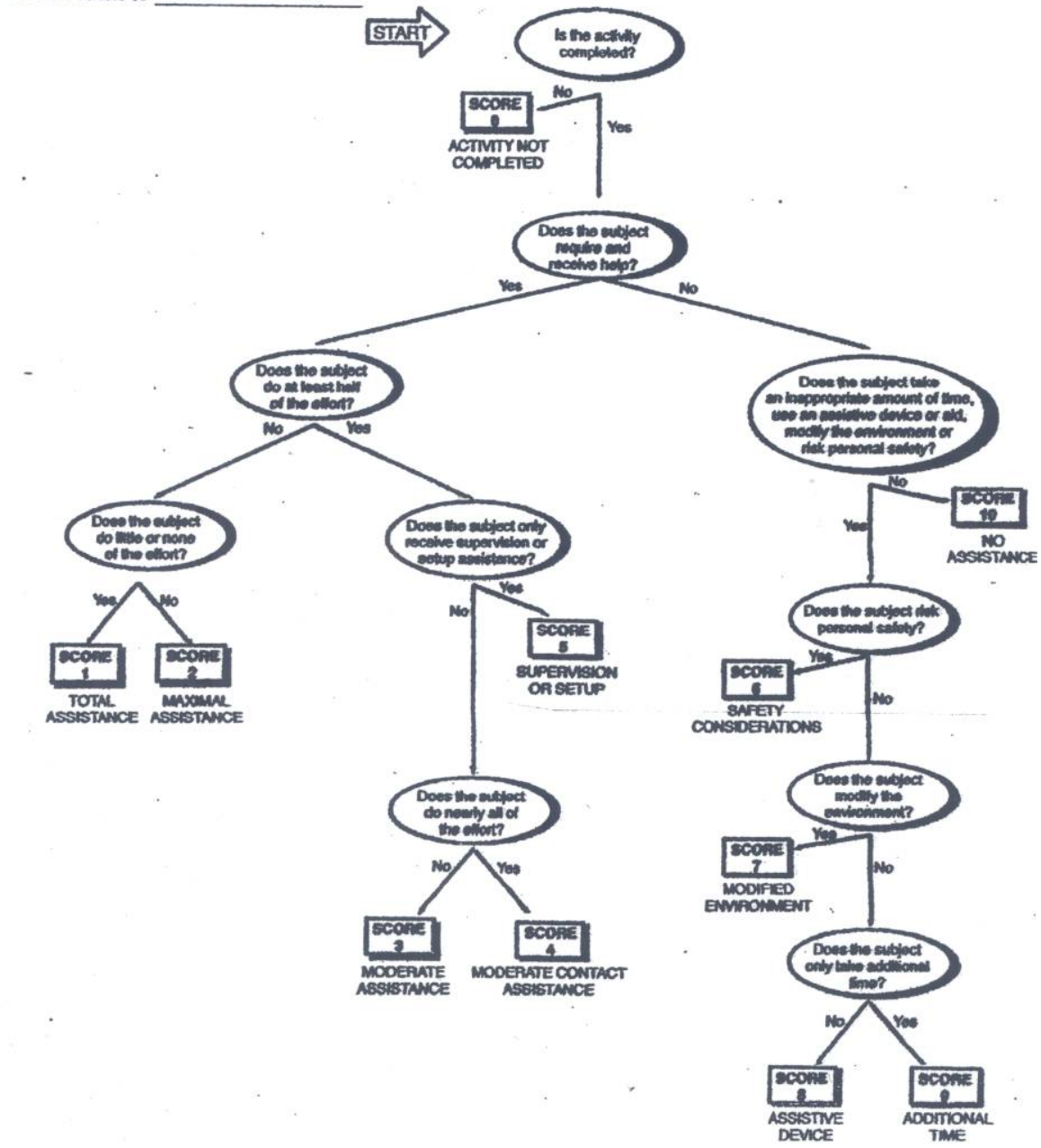


APPENDIX G
Universal Design Evaluation Decision Tree

Universal Design Evaluation Decision Tree

Decision tree for the Environmental Functional Independence Measure (adapted from Steinfeld & Danford,1999,p.122.)

Code Number _____



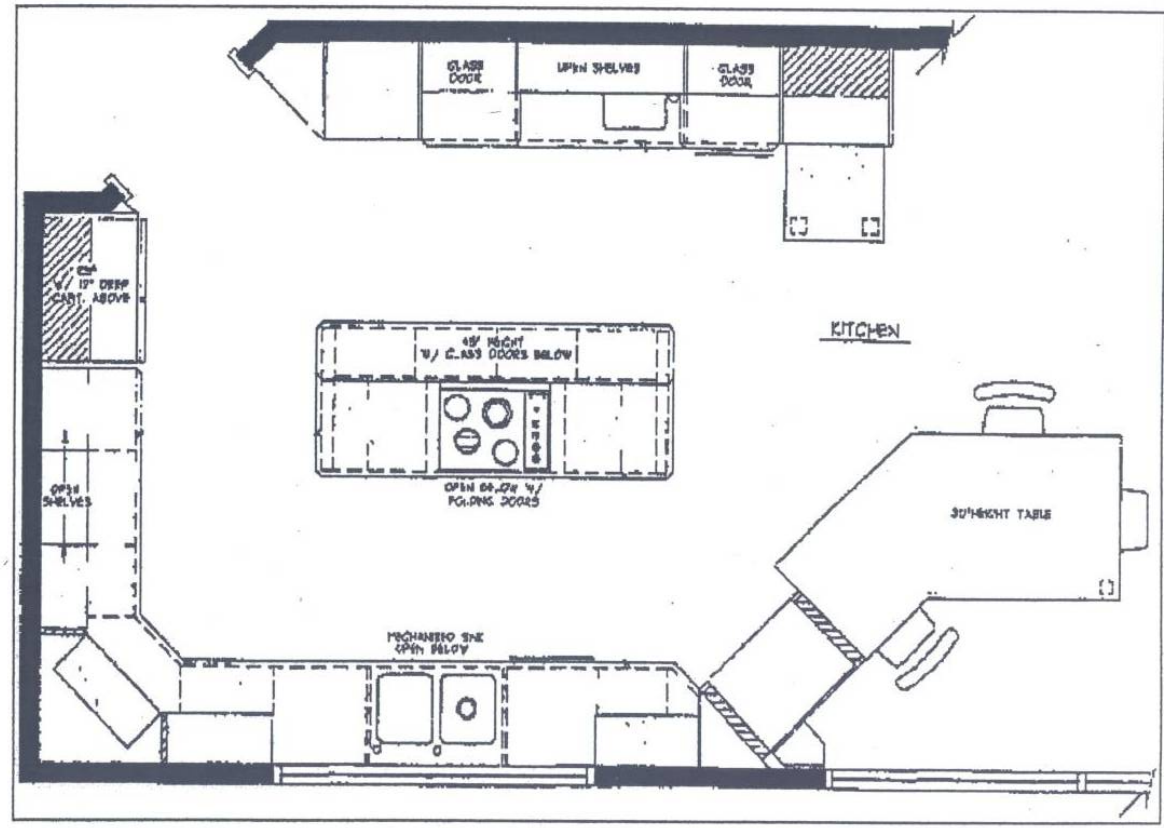
APPENDIX H
Diagram for Kitchen Set Up

Diagram for Kitchen Set Up

GE "Real Life Design" Kitchen

Code Number _____

Item	Code
* ask trash can placement	



APPENDIX I
Cooking Activity Menu

Cooking Activity Menu

Curried Chicken, Scalloped Potatoes and Green Salad

Before you begin your cooking activity, I have placed all the ingredients (except frozen or refrigerated items) and cooking tools you should need to prepare this meal on the counter top. I would like for you to tell me where you would have these items placed if this was your kitchen. Everything cannot remain on the counter but I want to set up the kitchen as you see appropriate.

I will place the items where you tell me and make any adjustments to the kitchen you may need before you begin cooking (for example: pull out roll out cart so you can use counter area, move trash can, etc.).

Now that the kitchen is organized to your liking, it is time to begin the cooking activity. If you have any questions please do not hesitate to ask.

Questions?_____
_____
_____

After your finished cooking you may choose to eat the food immediately and then clean up the kitchen or you can clean the kitchen and then eat or you may take the food home with you if you like. Here is your menu.

Menu

Chicken Breasts with Curried Peppers

2 Frozen Chicken Breasts
1 tablespoon margarine
½ clove garlic, crushed
½ teaspoon curry powder (you may substitute garlic seasoning blend)
2 tablespoons dry white cooking wine
Dash Pepper
¼ green pepper, ¼ yellow pepper, & ¼ red pepper cut into thin strips

Defrost chicken in Pyrex dish. Wash & pat dry. Melt margarine in a large skillet. Stir in garlic and curry powder. Add chicken. Cook 5 minutes on each side (medium heat). Add wine & pepper. Cover & simmer 15 to 20 minutes. Remove chicken serving platter and keep warm. Add peppers to skillet. Cook 3-4 minutes until crisp/tender. Spoon peppers over chicken in serving platter and serve.

Scalloped Potatoes

Follow directions from box and serve.

Green Salad

Green Salad Bag in Refrigerator
Cucumber
Salad Dressing

Use cucumber from pre-cooking assessment activity and add to green salad from bag in refrigerator. Select salad dressing and pour onto salad and serve.

APPENDIX J
Menu Task Matrix

MENU TASK MATRIX

GE "Real Life Design" Kitchen

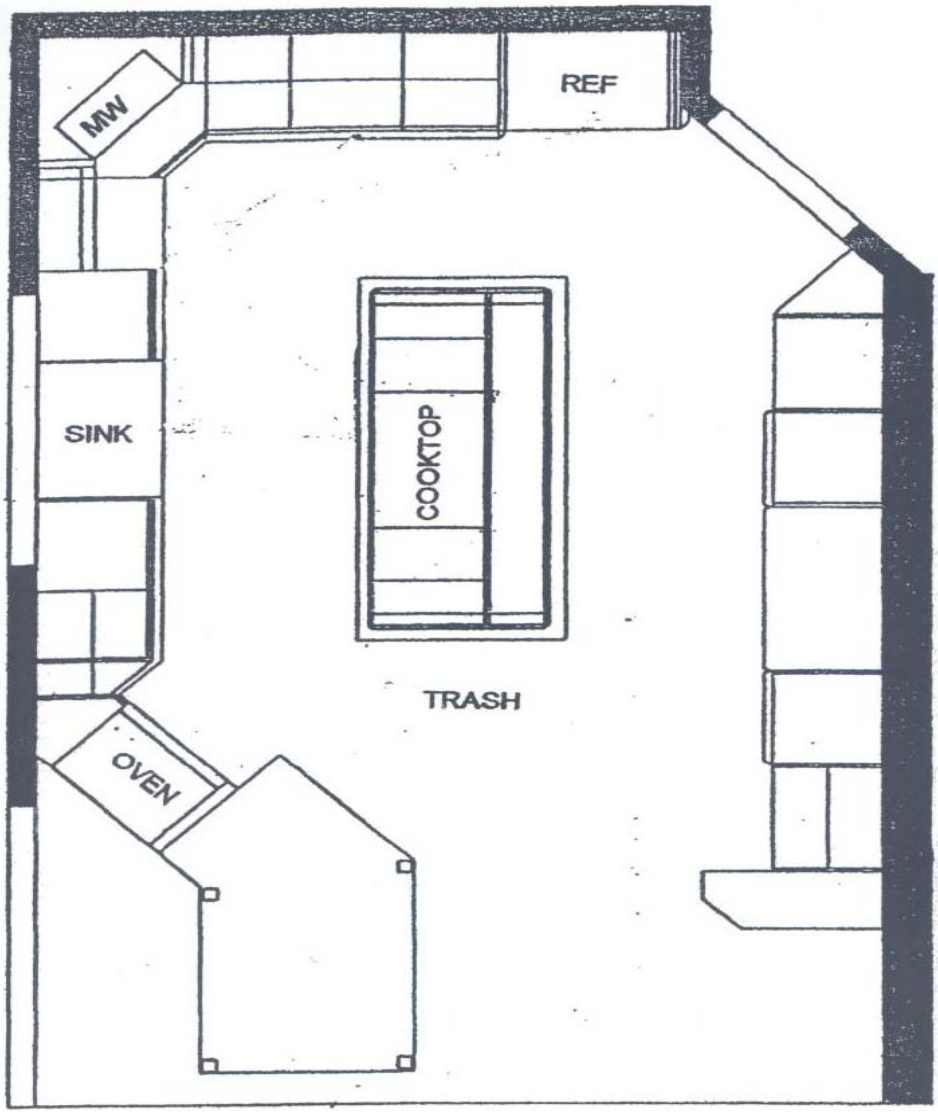
Code Number

	Chicken Preparation	Scalloped Potatoes	Salad	Remarks, Comments, Notes & Observations
Getting Ingredients From Storage				
Assembling & Measuring Ingredients				
Mixing				
Surface Cooking				
Microwave Cooking				
Bake in Oven				
Removing Items from Ref. or Freezer				
Cutting or Chopping				
Washing Vegetables				
Use of Counter				
Use of Roll Out Cart				
Use of Table surface				
Load Dishwasher				
Hand wash in sink				

APPENDIX K
Behavior Map of Cooking Patterns

Behavior Map of Cooking Patterns

Code Number_____



APPENDIX L
Post-Cooking Interview Guide

Post-Cooking Interview Guide

Code Number _____

Thank you so much for agreeing to participate in this study. We are almost finished with the study. I know it has been a long day and if you will just hang in there a little longer we will be finished.

1. Were you familiar with any of the design features in the GE Kitchen prior to the study?
   - → What features were you familiar with?
     Do you have any of these features in your current kitchen?
     Did you have any of these features in a previous kitchen?

2. Now that you have used the features to prepare a meal, which did you find the most helpful?
   - → Why?
   - Would you be willing to pay extra money for the feature?
     - → Least helpful? → Why?

3. What did you think about the layout of the GE Kitchen?
   - → What did you like? → Why?
     What would you change? → Why?

4. Was there something you really liked about working in this kitchen?

5. Was there something you really disliked about working in this kitchen?

6. What features did not work?

7. What did you think about the appliances you used?

8. If you were going to design a kitchen for yourself what features would it have in it? This can be features from the GE Kitchen and/or any additional features you know about and would want?

9. After cooking in this kitchen, do you think you will make any changes to your current cooking situation? (changes to work surfaces, access to storage, removal of doors,etc)
   _____

9. If given the choice, would you prefer to prepare a meal in the GE kitchen or your kitchen at home?
   _____ why? (please describe)

10. Given the chance, what changes would you make to the GE Kitchen to make it work more efficiently for you? (please be specific, such as: lighting, clearances, appliances, appliance height, counter height, eliminate base cabinets, raised dish washer, oven ht. etc.)

_____
_____
_____
_____

11. Do you have any additional comments or suggestions?

Thank you for your participation with the study. Would you mind if I called you in a few weeks for a possible conference call with some other participants or to ask you a few more questions? _____

In addition, I may want to visit a few of the homes to see the kitchens of some of the participants. Would you be willing to let me visit your home? _____

If so, give me your phone number, address, and driving directions.

_____
_____

I would call and set up an appointment before coming to your home. Thank you again for participating in the study.

APPENDIX M
Informed Consent

Informed Consent for Participants

Virginia Polytechnic Institute and State University

Title of Project: Evaluating Universal Design Features in Kitchens by People in Wheelchairs

Principal Investigator: Holly L. Cline (Graduate Student) & Dr. Julia Beamish (Committee Chair)

I. THE PURPOSE OF THIS RESEARCH/PROJECT

The purpose of the study is to evaluate the universal design features of the GE "Real Life Design" Kitchen by people using wheelchairs and to see if these features are beneficial to the user. The specific objectives are:

1. To describe the demographic and housing characteristics of the participants who use wheelchairs, including anthropometric, demographic, and housing characteristics; meal preparation activities; and kitchen design.

2. To evaluate the universal design features of the GE "Real Life Design" Kitchen by people using wheelchairs.

3. To examine how the GE "Real Life Design" Kitchen is used by people in wheelchairs as they prepare a meal in the space.

II. PROCEDURES

Several steps will be involved in completing your part of the study:

1) You will be asked questions from an interview schedule about the activities that you do in your kitchen and about the arrangement of your kitchen.

2) Your body measurements as pertaining to reach and cooking activities in addition to your wheelchair will be measured and recorded. You will be video recorded during this portion of the study and throughout the remaining portions of the study.

3) You will be asked to evaluate and compare specific features in the GE "Real Life Design" Kitchen. You will receive a brief tour of this kitchen and its appliances to familiarize yourself with the space.

4) You will be given a short menu of foods (with recipes when needed) to prepare in the GE "Real Life Design" Kitchen. You will then prepare the food items in the manner that you would normally use in your home, while following the recipes. You may eat the food in the test facility or take it home with you. This will not be recorded. You will clean up the kitchen after you cook. This activity will be recorded.

5) After you have completed the menu preparation, you will be asked a few questions about your experience. This will be video and audio recorded.

III. RISKS

The few risks associated with the project are the same as those associated with food preparation in your home. Knives, cooking appliances, hot water, breakage, and spills could cause harm, if used improperly or recklessly. To minimize these risks, you will receive a tour and orientation to the kitchen that you will cook in. In addition, the researcher will place the items that you will use in your food preparation activity in the locations of your choosing and instruct you in the use of appliances (if needed).

Food used in the menus has been recently purchased from a local grocery store. It is fresh, frozen, refrigerated properly, and/or stored appropriately. You should make sure that the food you prepare is cooked according to the recipe, so that the food item is cooked completely.

The study facility is cleaned regularly. A fire extinguisher and a first aid kit are in the facility. A research associate will be in the facility as you prepare the food to assist with questions or emergencies.

You are allowed to withdraw from the study at any time without penalty.

IV. BENEFITS OF THIS PROJECT

The information that is learned from this study will help the researchers to better understand how people in wheelchairs use their kitchens today. Current guidelines that are used in the design of kitchens will be reviewed and recommendations will be made to the National Kitchen and Bath Association an organization of kitchen designers, and the American National Standards Institute, and affiliated industries.

You are requested to refrain from discussing the evaluation with other people who might be in the candidate pool from which other participants might be drawn.

V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

Your identity in the project will be protected. A code number will be assigned to you and used on the interview schedule and video taping. A master list of participants will be kept in the facility to be used for contacting participants about scheduling appointments. This will be destroyed after the data has been analyzed.

Video tapes will be secured in the study facility and viewed by the researchers and research associates for coding purposes only. For the analysis and review of tapes, only code numbers will be used. Tapes or photographs will not be shared with other persons or agencies unless specific written permission is given. The tapes will be destroyed after one year.

Your signature on this form does not give the researcher permission to show your videotape to anyone else. If the researchers wishes to use a portion of your videotape for any other purpose, they will get your written permission on the Photographic Release Form before using your video.

VI. COMPENSATION

You may be reimbursed for travel expenses. You will be able to eat and/or take home any food items you prepare.

VII. FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time for any reason. You do not have to answer any question you do not want to answer or be involved with any portion of the study that you do not wish to be involved with.

VIII. APPROVAL OF RESEARCH

This research has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University, and by the Department of Housing.

IX. SUBJECT'S RESPONSIBILITIES AND PERMISSION

I voluntarily agree to participate in this study, and I know of no reason I cannot participate. I have read and understand the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project

_____ _____

Signature Date

Should I have any questions about this research or its conduct, I may contact:

_____	Holly Cline, graduate student	Phone (540) 231-2058
_____	Dr. Julia Beamish	Phone (540) 231-2058
IRB Review Board: Office of Research Compliance	David M. Moore	Phone (540) 231-4991

APPENDIX N
Photographic Release Form

Photographic Release Form

Virginia Polytechnic Institute and State University

Title of Project: Evaluating Universal Design Features in Kitchens by People in Wheelchairs

Principal Investigator: Holly L. Cline (Graduate Student) & Dr. Julia Beamish (Committee Chair)

I give permission for photographic images of me taken during my participation in this study to be used in the presentation of the results of this study. Images and /or video tapes may be used to illustrate the methods of the study or to highlight the findings of the study. The may be used in presentations, reports, or on web sites.

_____ _____

Signature Date

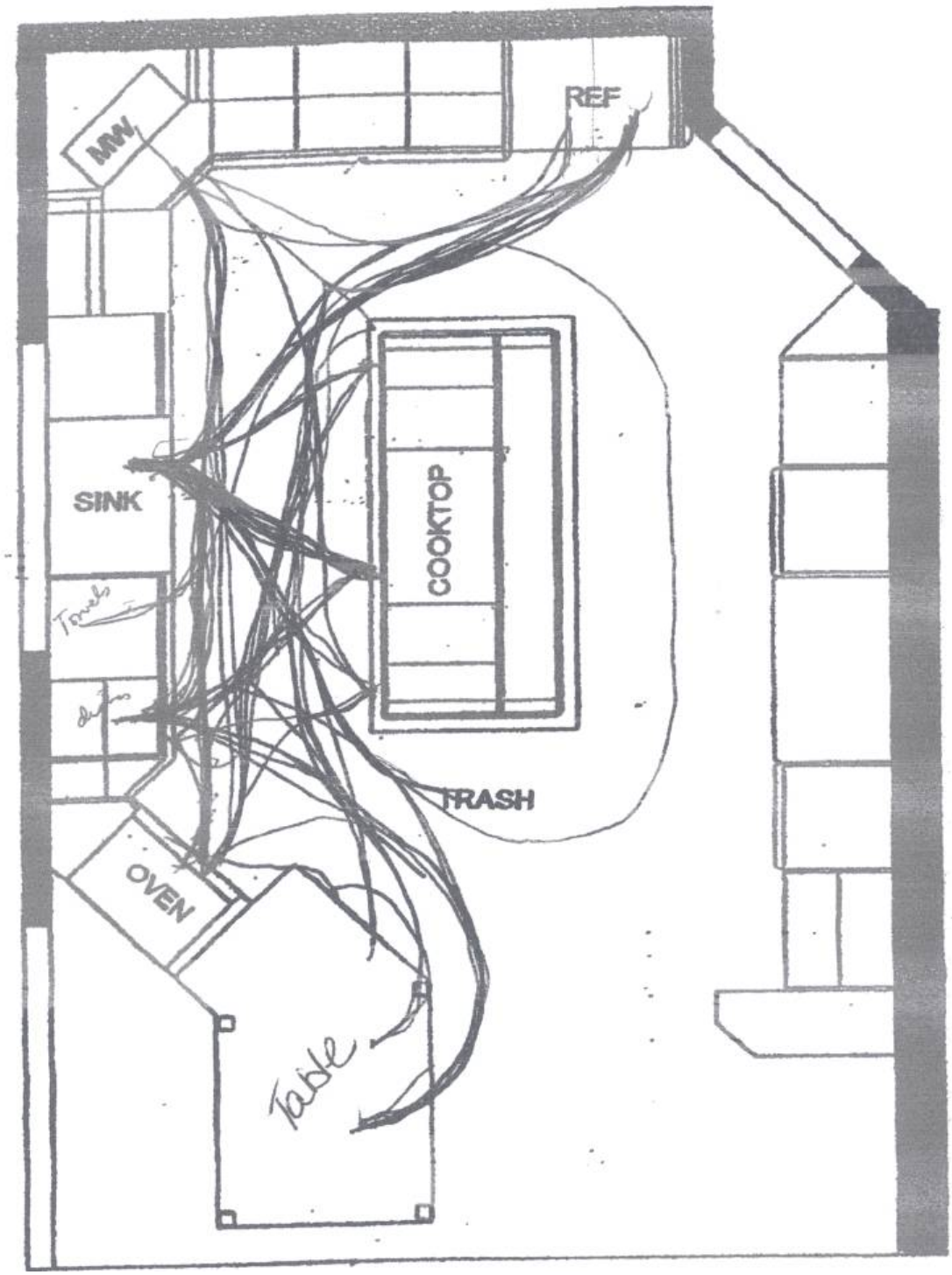
_____

Please print name

APPENDIX O
Participants Behavioral Maps

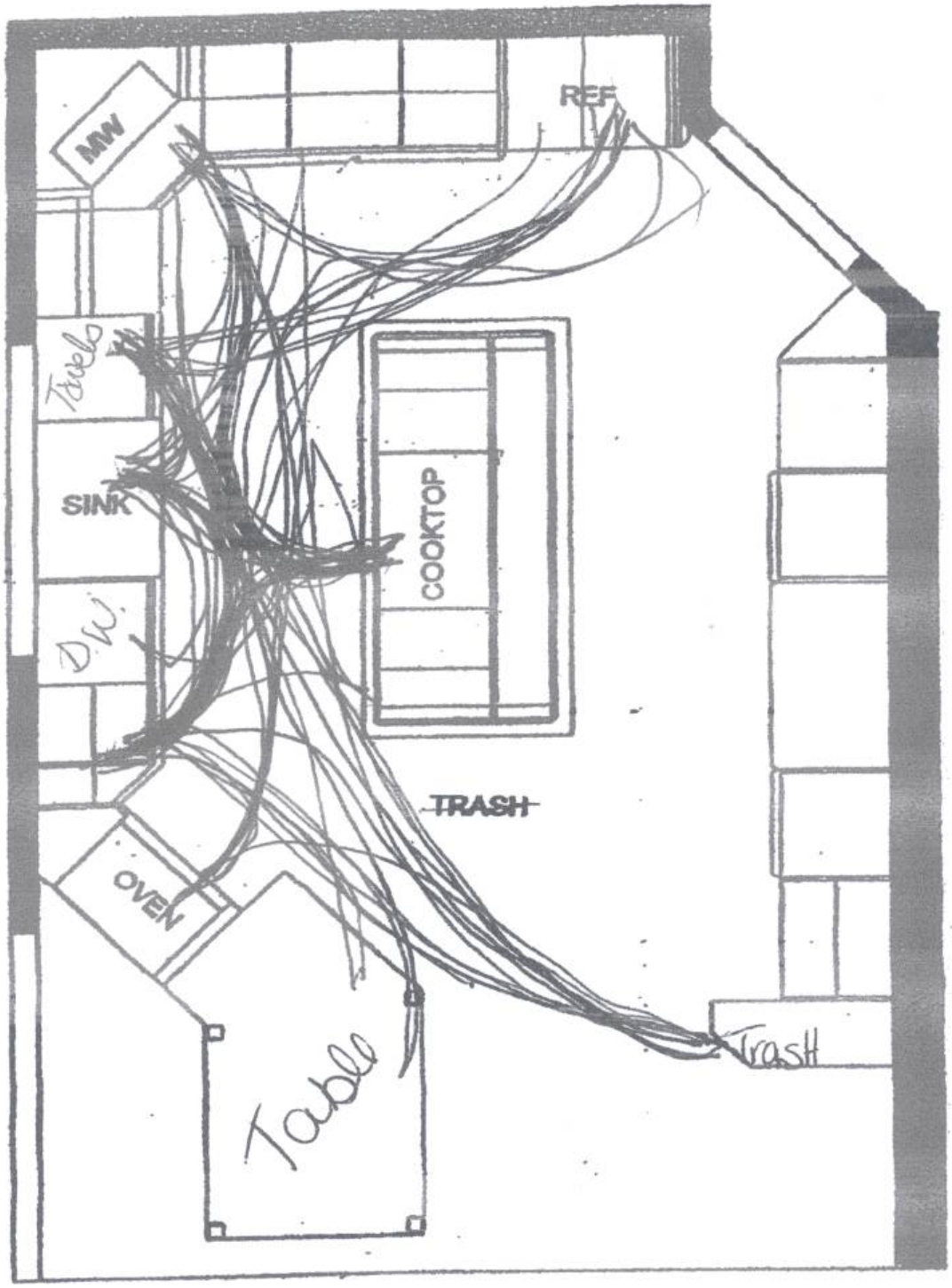
Behavior Map of Cooking Patterns

er ~~1001~~ FRANK



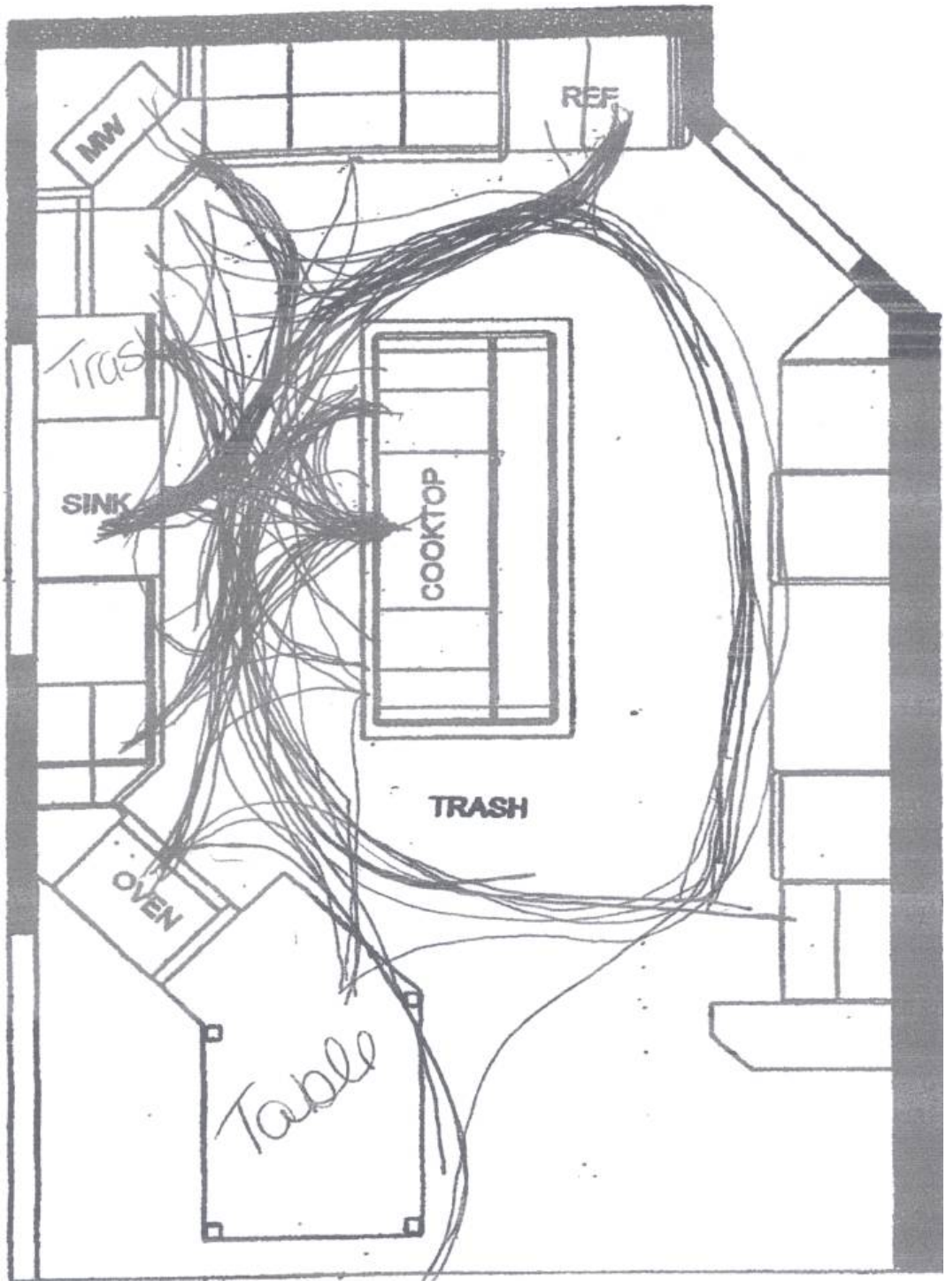
Behavior Map of Cooking Patterns

er [redacted] 002 MARY



Behavior Map of Cooking Patterns

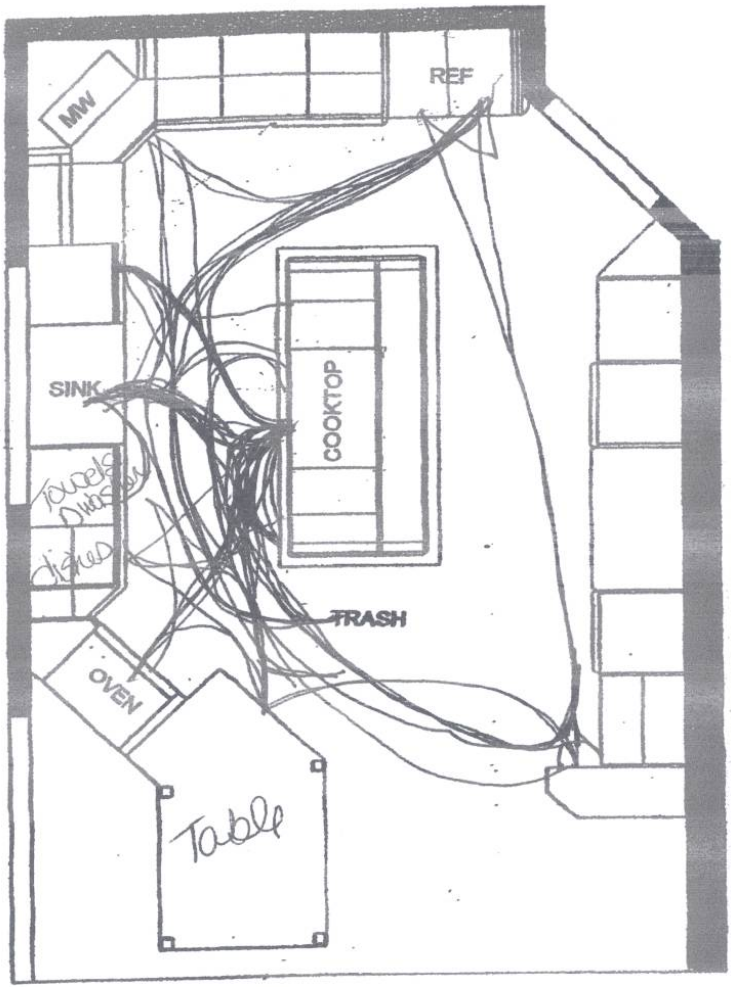
IT 003 PHIL



CRAIG

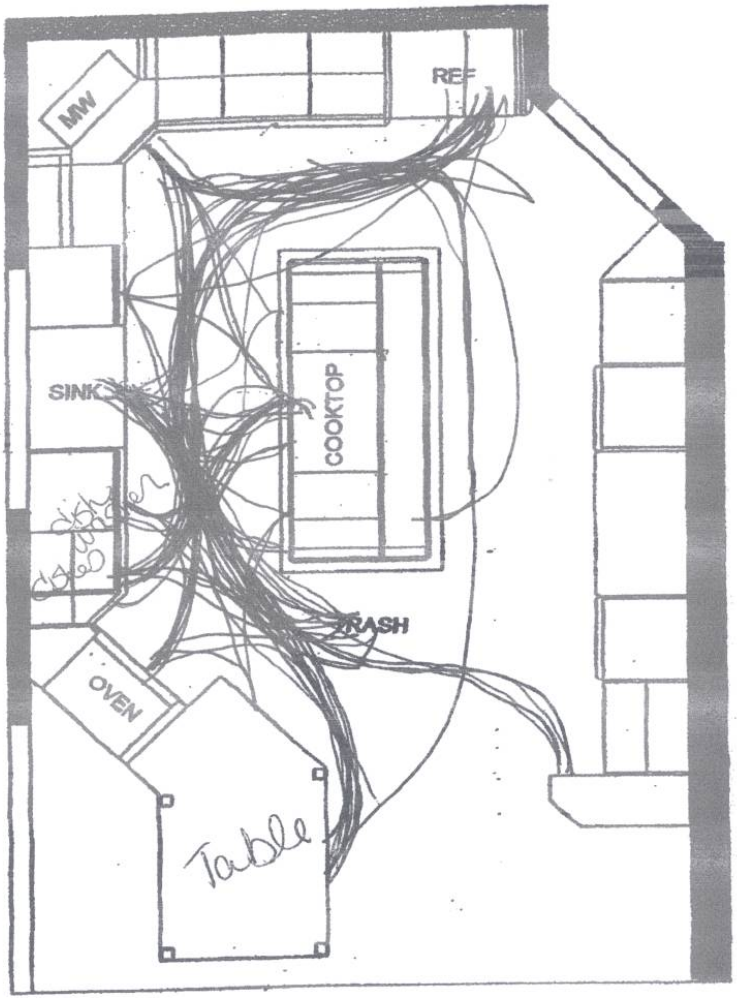
Behavior Map of Cooking Patterns

Code Number ~~ST~~ 004 CRAIG



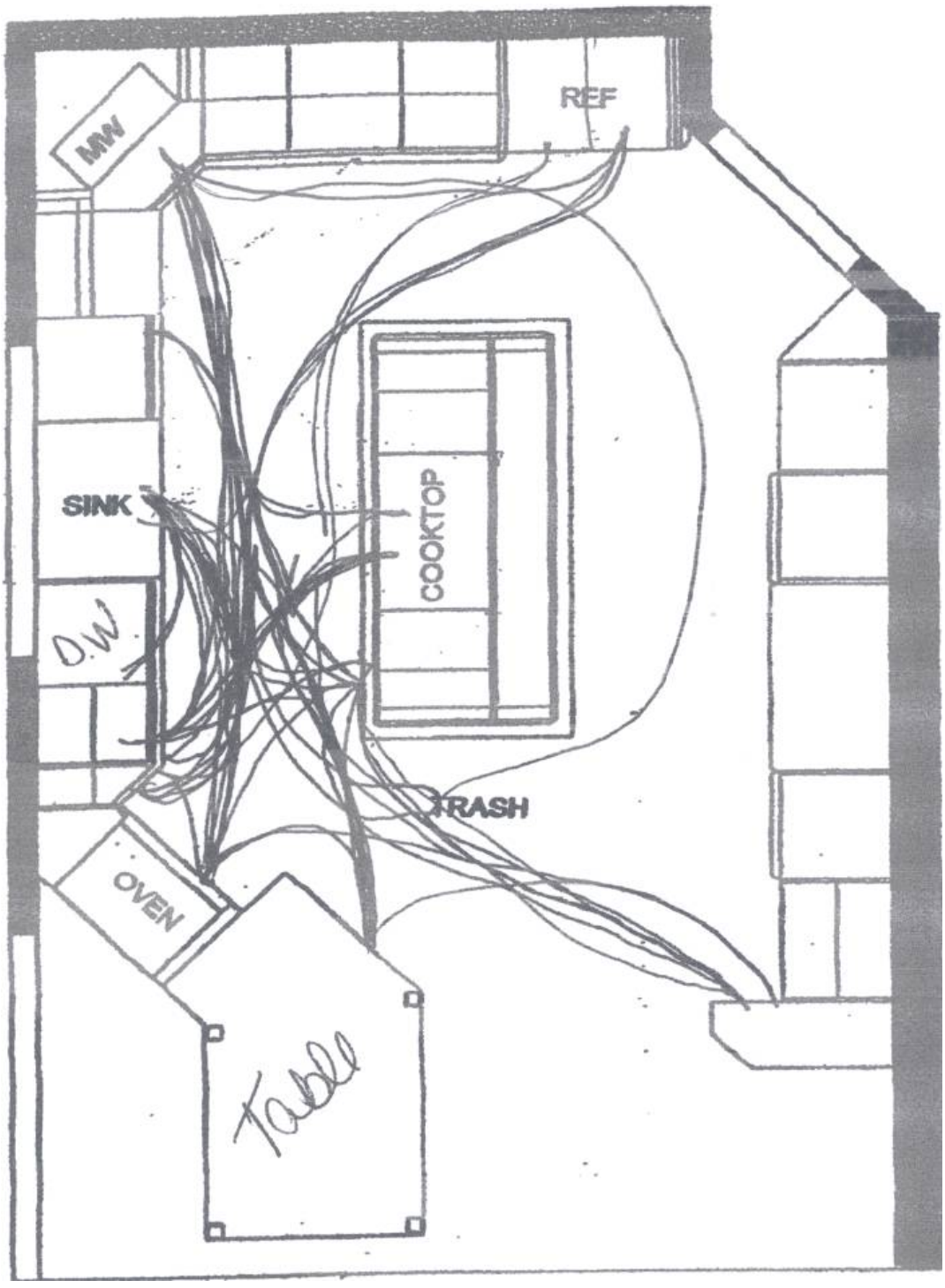
Behavior Map of Cooking Patterns

Code Number ~~007~~ 005 Jill



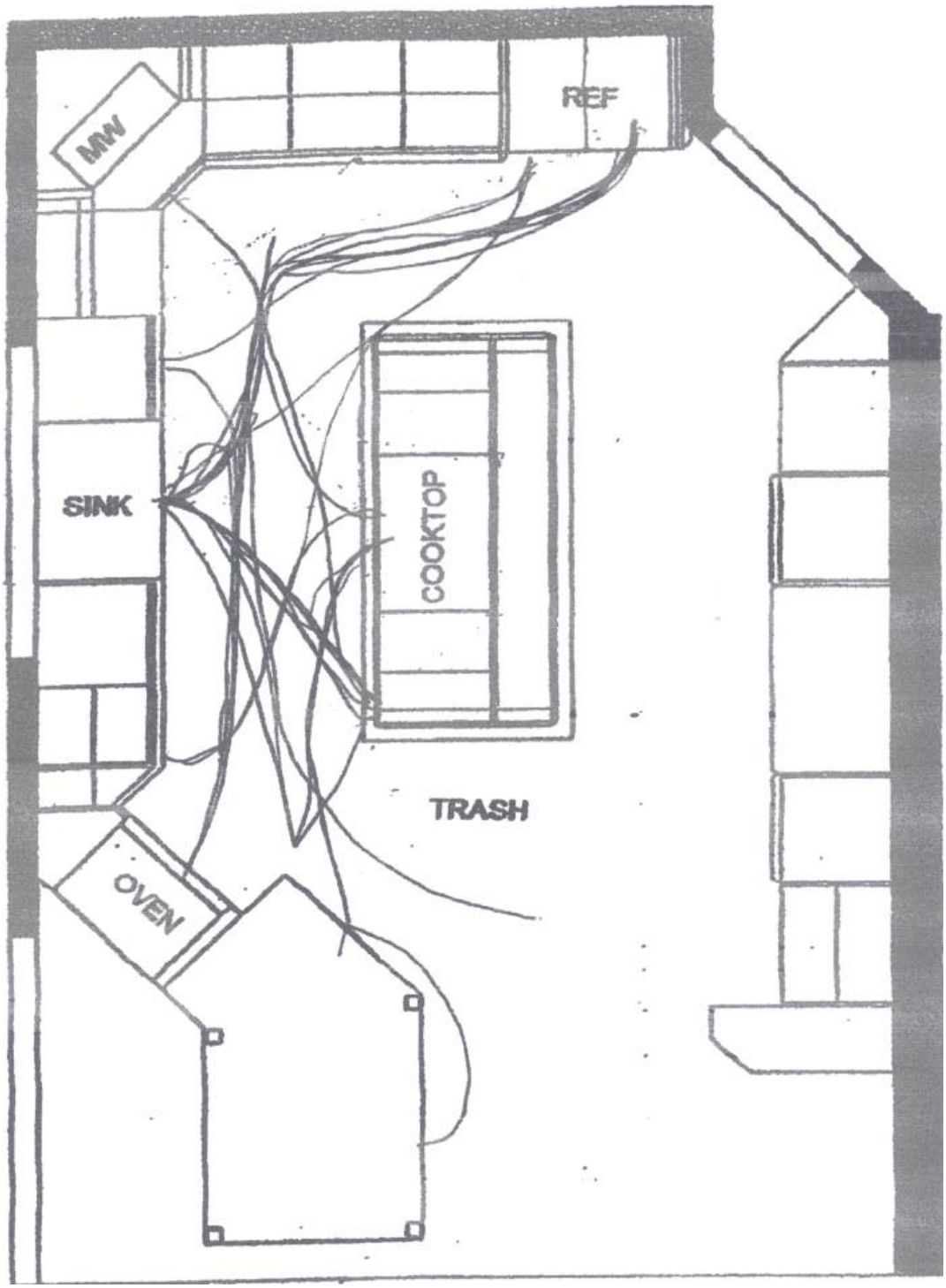
Behavior Map of Cooking Patterns

~~37~~ 006 MIKE



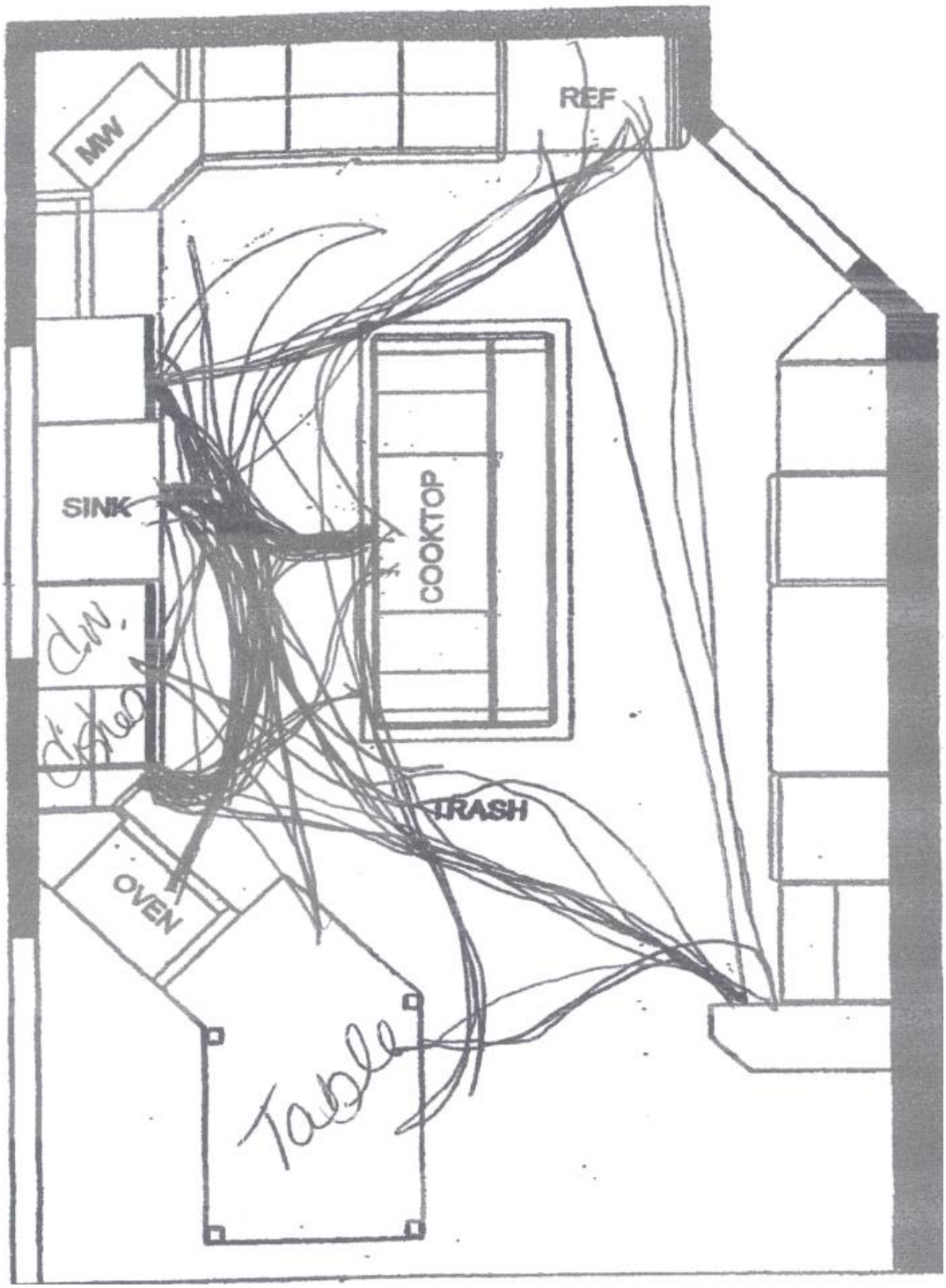
Behavior Map of Cooking Patterns

~~007~~ 007 HARVEY



Behavior Map of Cooking Patterns

r ~~007~~ 008 KATHY



Behavior Map of Cooking Patterns

~~003~~ 009 KIM