

UNIVERSAL DESIGN IN RESIDENTIAL SPACES

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Abstract

The purpose of this paper is to identify features for universal design recommendations that are appropriate for residential design. The recommendations are based on previously developed criteria for people with disabilities and for the elderly, as well as traditional space-planning standards. Specific recommendations are categorized as the following: exterior, general interior, kitchen, bathroom, laundry/utility, living/dining, and bedroom/storage. Some items are more universal by their placement, while some features can be made more universally usable by being made adjustable. The recommendations presented herein would be useful to educators and designers who work with the concept of universal design.

Introduction

Universal design is a relatively new concept which holds that design of all spaces and products can be made useable by people of all ages and abilities. The focus on universality has a greater applicability than designs that are labeled barrier-free or accessible. For many years designers have either ignored the special needs of people with disabilities, or they have embraced this as a specialized field of design that required special attention to individual user's needs (Cheever, 1992a, 1992b; Mace, Hardie, & Place, n.d.; Raschko, 1991). Research has been conducted that has begun to identify and explain special needs in relation to design. Guidelines for designing spaces for the elderly and for people with various disabilities are available (American National Standards Institute [ANSI], 1986; Casto & Day, 1977; Raschko, 1991; U.S. Architectural & Transportation Barriers Compliance Board [ATBCB], 1991; U.S. Department of Housing and Urban Development [HUD], 1991). However, complete guidelines for universally designed spaces, particularly residential spaces, are not available in concise formats. Many educators wishing to encourage universal design, and designers trying to apply the concept in practice, must rely on a variety of barrier-free design recommendations

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and fill in the blanks with other recommendations and ideas that have been gleaned from reading and experience.

The purpose of this paper is to identify features for universal design recommendations that are appropriate for residential design. These recommendations are based on readings, research publications, and published design standards that were reviewed and categorized into exterior and interior spaces.

Background

Universally designed products and environments are usable by most people regardless of their level of ability or disability (Center for Accessible Housing, n.d.). If universal design can be achieved it will no longer be necessary to examine design recommendations in light of special guidelines or codes, e.g., if all houses were constructed with wide doorways as standard practice, then compliance with an accessibility code would not be an extra step in the design process. The concept of universal design implies that design recommendations should consider four basic categories of people: adults, children, older adults experiencing age-related changes, and people of all ages with disabilities. These groups provide a starting place for exploration into recommendations for universal design for residential spaces.

The average adult does not exist; however, the anthropometric measures for the average male and female were the basis for many space standards that have been used historically in planning residential spaces (McCullough, Philson, Smith, Wood, & Woolrich, 1962; Small Homes Council, 1953). Most notable are the studies of the kitchen area (McCullough, 1949; Ranney, 1949). These early reports were influential in the development of space standards sanctioned by the Minimum Property Standards (MPS), which were used for many years as the basis for homes that were insured by Federal Housing Administration (Beamish & Day, 1988). Current kitchen and bath industry guidelines continue to identify the space needs of average-sized adults in relation to these areas (Cheever, 1992a, 1992b).

The space needs of children were also considered to some extent by these early researchers and have been considered in the design of some residential spaces and products, but for the most part the needs of children have been ignored. Children grow and change and their physical capabilities evolve fairly quickly in relation to the life of a house and a family. Because of the transitory nature of their status, many special considerations for their needs may be ignored. The role of universal design in meeting children's needs could be significant, since it would address needs that have been largely overlooked in the past.

The relation of the elderly to their physical environment has been widely explored and documented (Hiatt, 1986; Null, 1988; Raschko, 1991; Regnier & Pynoos, 1987). Many of these recommendations are based on age-related changes, such as sensory losses and energy declines, as well as changes caused by disease, such as arthritis and heart problems. The recommendations have focused on designing new housing situations to meet the needs of the elderly (Cranz, 1987; Hiatt, 1986) and on adapting existing housing to the changes that the elderly person is experiencing (Pynoos, Cohen,

Davis, & Bernhardt, 1987; Steinfield, 1987). Both of these types of recommendations provide many applications that are suitable for a universally designed residence. Many elderly would live at home longer if their homes were universally designed.

The development and expansion of design guidelines for the disabled have helped to identify and explain solutions that are suitable for special needs populations. In 1961, the American National Standards Institute (ANSI) issued ANSI 117.1, a short document that presented minimum requirements for designing and constructing public buildings. Enforcement of these standards in federally financed buildings occurred when the Architectural Barriers Act was passed in 1968. Full access to federal programs was to occur when the Rehabilitation Act passed in 1973, but many regulations to insure enforcement were delayed years before they were released. The Rehabilitation Act created the Architecture and Transportation Barriers Compliance Board (ATBCB) to investigate noncompliance. In 1982, ATBCB developed the Minimum Guidelines and Requirements for Accessibility Design (MGRAD) for use by federal agencies. The Uniform Federal Accessibility Standards (UFAS) were developed in 1984 to be consistent with the MGRAD and have been the federal standard since that time. ANSI 117.1 was completely revised in 1980 to reflect research on accessibility and was upgraded in 1986 (Wilkoff & Abed, 1994). The most recent legislation to address building accessibility was the Americans with Disabilities Act (ADA), passed in 1990. The ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) were issued in 1991. These guidelines cover all public accommodations.

Although rental offices of multifamily housing developments are covered by ADA, most housing in the United States is not covered by this act or by any federal legislation. The Fair Housing Act was amended in 1988 to include people with disabilities as a special category that cannot be discriminated against in the housing market. The most direct application of this act to design occurred with the issue of the Fair Housing Accessibility Guidelines (FHAG). These guidelines apply to multifamily housing with four or more units built after March, 1991 (HUD, 1991). They include many accessible features and mandates that owners will “adapt” units for someone with a disability who requests adaptation and is willing to pay to restore the unit to its original condition. The unit should include such features as wider doorways, accessible routes into/throughout the dwelling, and switches/controls mounted in accessible locations (Davies & Beasley, 1992). Adaptations might include the installation of grab bars in the bathroom and/or the lowering of cabinets in the kitchen. Most of the criteria specified in the FHAG comply with the current ANSI A117.1 standards for accessible buildings and facilities (ANSI, 1986; Davies & Beasley, 1992). New and existing rental housing that is federally subsidized or built with federal funds must comply with UFAS guidelines according to Section 504 of the Rehabilitation Act. Section 504 guidelines for subsidized housing, issued in 1988, require that the owner make accessibility changes to a unit if a resident requests such changes.

FHAG and ADAAG provide criteria for designing accessible and/or adaptable spaces suitable for people with a variety of disabilities. Although designing to the standards does not assure a universally acceptable space or environment, many of the FHAG and

ADAHG criteria should be incorporated into universal design recommendations or environments. Most residential spaces (especially single-family housing) are not regulated by the design guidelines specified in any of the above-mentioned documents. FHAG covers multi-family housing with four or more units. Single- and two-family housing, which compose the vast majority of housing stock, are not covered. Designers are not legally obligated to incorporate any of these standards into plans for housing that is not covered by these regulations. However, consumers may (and should) be aware of the changes that can occur throughout their lives and thus seek houses that are universally designed.

Residential Universal Design Characteristics

The universal home includes thoughtful and well-planned features that make the residence more usable by all family members. Universal homes incorporate universal design principles, resulting in a living environment that can, with little difficulty and expense, be adapted to virtually any user's long-term comfort, safety, and ease. According to Lusher (1988),

universal design succeeds because it goes beyond specialization. The concept promotes designing every product and building so that everyone can use them to the greatest extent possible - every faucet, light fixture, shower stall, public phone, or entrance. Universal design is a revolutionary but practical leap forward in the evolution of building and designing procedures (p. 5).

The recommendations presented here are primarily based on the review of the following publications: Barrier Free Environment, Inc., 1981; Cheever, 1992a, 1992b; Excell Homes Inc., n.d.; HUD, 1988, 1991; Leibrock & Behar, 1993; Leibrock & Rowe, 1981; Lusher, 1988; Maytag, n.d.; Orleans, 1981; Peterson, 1995; Pirkl, 1994; Raschko, 1991; Whirlpool, 1986a, 1986b, n.d.). These references were used because they tend to be comprehensive, yet concise; other references are mentioned where appropriate. Although many of the references relate to barrier-free design, only features that were universal were included. Since several design ideas may be appropriate the recommendations are not intended to be prescriptive. This paper will describe options currently available for design of a universal residential space. Further solutions will need to be developed and considered. Figure 1 summarizes the list of features presented in the text.

Exterior

Attention to detail during design, construction, and site planning is essential to the construction of a convenient and flexible living environment. Level walks, entrances without steps, and wider doorways make it easier for everyone to approach and enter the home, e.g., movers, children, a parent with groceries. Other features are available that could be included in a residence for someone with specific limitations or conditions. A covered door stoop provides protection for everyone from the outside elements. A front door package shelf is a feature that could be provided for added convenience, while security wiring system can provide protection/warning from intruders. A

Table 1. Residential Universal Design Summary List

Exterior

Level walks
Entrance without steps
Wide doorway
Covered stoop
Front door package shelf (outside)
Security wiring system
Full-length sidelight panel beside the door
1/2 in. maximum vertical edge at threshold

General Interior

32 in. minimum door width
24 in. space on latch side of doors
32 in. wide circulation path
42 in. clearance in hallway
5' X 5' turning radius in activity areas
Power casement windows
Light switches 38 in. above the floor
Electric outlets 18 in. above the floor
Thermostat controls 44 in. above the floor
Lever handles on doors or doors without latches
Rocker or touch switches
Non-slip carpet or vinyl floor surface
Carpet pile height - less than .15 in. and carpet pad - maximum 3/16 in.
Carpet yarn weight - if 3-ply, greater than 10 oz.; if 2-ply, greater than 15 oz.

Kitchen

L or U shaped kitchen
Ample clear floor space
Eat-at counter with knee space
Variable or multi-level counter heights, including sink and cooktop (at least two work-center heights)
Adjustable height countertop and sink
Removable sink cabinet for knee space
Removable cooktop cabinet for knee space
Variable intensity task lighting on counter surface
Accessible storage, i.e., pantry with pull-out racks
Full extension drawers
"D" handle on cabinets
Lever handle faucet

(table continues)

Table 1. (continued)

Shallow sink (e.g., 4 in.)
Shower spray at sink
Anti-scald valve
Elevate dishwasher 6-18 in.
Recycling and waste receptacles should have a 36 in. max. ht.
Side by side refrigerator/freezer
Top-mount refrigerator with 50% of freezer, all of the fresh food compartment and controls within 54 in. accessible reach range
Microwave oven bottom should be 24 - 48 in. above the floor
Easy to clean range top, i.e., glass ceramic cooktop
Built-in oven with wire racks to pull out at shelf height
30 in. clear floor space beside the oven
Pull out shelf to transfer food to and from oven
Self-cleaning oven
Auto-defrost refrigerator
Range controls front or side mounted
Appliance controls 1.5 - 3 in. diameter
Appliance controls turn clockwise
Avoid controls that can be turned on accidentally
Appliances with push bars rather than pull-out buttons
Appliances with touch controls rather than dials
Appliances with horizontal levers that require less force to operate than vertical levers

Bathroom

Ample clear floor space for maneuvering at fixtures
Tub with fold-up seat or integral transfer surface, or
Whirlpool tub, or
3' X 3' shower with transfer seat, or
5' X 5' roll-in shower with an accessible threshold
Reinforced walls to accommodate grab bars as needed
Offset tub/shower controls to allow operation outside the fixture
Lever handle faucets
Anti-scald faucets
Access to lavatory, i.e., wall-mounted, pedestal, adjustable

Laundry/Utility

Storage on utility closet doors
Accessible storage
Broom and mop rack

(table continues)

Table 1. (continued)

Doors swing fully open for access to clothes washer and dryer
 Front loading washer with door hinged on one side
 Elevate dryer height by 12 in.
 Dryer with door hinged on one side
 Controls, lint filters, and soap dispensers located on the front of appliances

Living/Dining

Avoid reclining chairs that require excessive strength or coordination to operate
 Chair should have firm back support at the correct angle
 Chair arms should not extend more than 1 in. beyond the chair for stability
 Upholstery fabric should be durable, flame retardant, and easily cleanable
 Removable cushions and without welts, ridges, or tufts make maintenance easier, and prevent irritation
 Table height and angles (folding leaves) adjustable
 Round or octagonal tables are more sociable
 Lazy susan improves reach across wide tables
 Anti- or low-glare table surfaces

Bedroom/Storage

Flexibility of storage
 Adjustable open shelves
 Adjustable height clothes rod
 Wardrobes with an adjustable hanging bar no more than 54 in. from the floor
 4-6 in. wire or D type pull on furniture drawers
 Lights in closets
 Shallow (e.g., 12 in.) shelves used in storage where appropriate

full-length side light panel beside the front door allows everyone, including children and users of wheelchairs, to observe visitors before opening the door; however, it may provide a security risk by making break-ins easier.

General Interior

Clearances throughout the house are important. An open floor plan and wider doors and halls add flexibility in the arrangement of furnishings, provide opportunity for maneuvering a wheelchair within the space, allow for plenty of space for children to play, and provide a spacious feeling for everyone. Door clearances should be at least 32 in. wide (ANSI, 1986). This requirement often means a 34 in. door is being specified and/or an easier-to-find 36 in. wide door. Hall clearances and pathways of 42 in. enable

an ambulatory person to walk beside or around a non-ambulatory person. To make maneuvering in/outside the house easier, a 24 in. space on the latch side of the door is an option. A 32 in. wide circulation path throughout the house allows a person to circulate, even in a wheelchair. Likewise, turning spaces of a 60 in. diameter in activity areas allow people in wheelchairs to maneuver in a space and are more comfortable for everyone when more than one person is using the area.

Planning one-level housing is a consideration that should be examined for universal residences. Multi-level residences are a possibility and are not prohibited in FHAG for adaptable units, but for long-term use the home should have a bedroom and bath on the main living level. When stairs are used, the riser and treads should be consistent. Straight staircases require a safe stopping place midway between floor levels (Leibrock & Behar, 1993). People with mobility limitations have difficulty negotiating spiral/curved staircases (Leibrock & Behar, 1993).

Casement and power casement window operations ensure independence by allowing people to open a window when needed. The hand crank on casement windows and power casement window operators enable people to open the window without utilizing the body to push up. Light switches 38 in. off the floor, electric outlets 18 in. above the floor, and thermostat controls 44 in. off the floor are examples of items that are made more universally usable through their placement. The placement of items within reach of users of wheelchairs and children, but not too low for ambulatory users, is helpful for everyone. Accessibility guidelines have indicated that this range is 15-48 in. (HUD, 1991).

Lever handles on doors are solutions that help anyone whose hands are full. Small children and people with arthritis or other physical disabilities that limit a full range of movement or grip strength can use lever handles more easily. Rocker or touch switches allow people with limitations and children to operate switches without grasping or pinching. Safety features for all family members may include easy-care, non-slip floor surface, such as low-pile carpet and vinyl flooring.

Kitchen

The kitchen is the most expensive room in the house to construct. The permanent nature of countertops, cabinets, and appliances makes this space difficult to adapt to lifespan challenges. Therefore, it is important to consider initially how to make these spaces universal. A universally designed kitchen has invisible solutions that enable family members to be self-sufficient within this living environment.

L- or U-shaped kitchens are often recommended since they tend to provide ample floor space and uninterrupted multiple work areas. Features such as, variable counter heights, pull-out shelves, convenient storage, and a dining section at the end of the kitchen which allow the entire family to help with meal preparation. An eat-in-counter with knee space enables all family members to use the space for eating, studying, and visiting.

Variable counter heights throughout the kitchen work areas make it possible to prepare food while seated, make kitchen work safer and more comfortable for people who are short or who tire easily from standing. The counter sections can be mounted at variable heights from 30 to 36 in., i.e., they can be made manually or mechanically adjustable. A lower counter section, sink, or cooktop may be installed with either base cabinets beneath or an appearance/protection panel below to provide knee space. Variable-intensity task lighting under wall-mounted cabinets reduces shadows and creates a safer work area on counters, particularly for people with low vision.

All family members need easily accessible ample storage spaces. A storage pantry with pull-out racks is one idea that helps organize food and equipment, and places more storage within the reach of a variety of users. Other storage accessories such as lazy susans and pull-down shelves allow hard-to-reach areas to be accessible to a wider range of users. A rolling cart that can be stored under a counter is another storage option. For safety and durability, drawers should be equipped with full-extension hardware. Handles on the cabinetry should be easy to grip, e.g., have a "D" shaped pull.

Kitchens have three primary work centers: cleaning, preparation, and cooking/serving areas (Cheever, 1992b). With multiple cooks and a variety of users, many kitchens will duplicate these centers and provide specialized task areas. At the cleaning center the sink may be shallow for ease of reach, and have a lever handle faucet with an anti-scald valve and shower spray attachment. The dishwasher should be located close by and should be elevated six to 18 in. off the floor to decrease the need to bend or stoop. Other conveniences at the sink would be a hot water dispenser and a food waste disposer. In addition, the environmentally conscious kitchen requires recycling as well as waste receptacles that have a maximum height of 36 in.

The preparation area in the kitchen should be located next to the sink and should include ample counter for food preparation. This area is often located next to the refrigerator as well. The universal design kitchen's refrigerator is all automatic defrost, side-by-side, or top-mount refrigerator with a minimum of 50% of the frozen food compartment and all of the fresh food compartment, and all controls within an accessible reach (54 in. off the floor). There should be counter space on the same side as the refrigerator door the handle (L or R side).

The cooking/serving center includes a range and counter space. A cooktop that is easy to clean is essential and a glass ceramic top meets this requirement. The oven should be self-cleaning. The oven within a universally designed kitchen is built-in, with wire racks that pull out at shelf height. A 30 in. clear floor space enables the user to get closer to the oven. A cart may be used to fill the space when the open floor space is not needed. A pull-out board is a feature that allows the user to have landing space beside the conventional built-in oven and the microwave oven. The microwave oven should be located so that the bottom of the appliance is 24 to 28 in. off the floor.

Placement of controls on appliances is an important consideration. For example, range controls should be placed to the side or front of the appliance to prevent users from reaching over hot heating elements and pots. Side placement may prevent small children from inadvertently turning on the appliance. Control design can make the

appliance easier to use. The diameter of appliance controls should be 1.5 in. to 3 in. (Eastman Kodak Company, 1983). They should turn clockwise and not turn accidentally, have push bars rather than pull-out buttons, have touch controls rather than dials, and if levers, be horizontal rather than vertical (Leibrock & Rowe, 1981).

Bathroom

The bathroom is the second area of the home with permanently installed features that make it less adaptable. Universally planning the space will create a safer space for all users. Ample clear floor space (e.g., 5' X 5' turning radius) is a must for universally designed bathrooms to ensure maneuverability at lavatories, toilets, and tubs/showers. While this space may require a room slightly larger than a traditional bathroom, it reflects a trend for more spacious bathing areas that can be used by more than one person at a time. The space will also add flexibility to the home throughout the lifespan.

Bathing options to satisfy both universal and personal preferences include (a) standard tub with a fold-up seat, (b) tub with a transfer seat, (c) whirlpool tub, (d) 3' X 3' transfer shower, and (e) 5' X 5' roll-in shower. Each of these have benefits for certain needs and bathing preferences. Further research and product development may be needed to identify a bathing option that is universal in its safety, comfort, and convenience. Features at the tub or shower to enhance safety and universal use include a hand-held shower head, lever handle faucets, and off-set controls. Off-set controls make it easy to turn on water and regulate water temperature from outside the shower or tub.

According to the American Association of Retired Persons (AARP) (Cheever, 1992a), showers and bathtubs rank third among products associated with accidental death of people age 50 or older. The main causes of accidents are falls during showers/bathing or when getting into/out of the tub/shower. Proper installation of grab bars and/or hand-rails would help prevent falls during bathing. The bathroom walls must be reinforced so that grab bars can be installed more easily and inexpensively, if and when the need arises. FHAG (HUD, 1991) specifically requires this reinforcement in adaptable multifamily housing.

Elderly people and small children have very sensitive skin. In 1988, the National Safe Kids Campaign determined that as many as 150,000 people in the United States experience scalding injuries each year and as many as 37,000 of the victims were children (Cheever, 1992b). Scalding accidents can be eliminated by using scald protection devices which are now included in some building codes. Scald protection devices include pressure balance valves, thermostatic valves, combination valves, and temperature-limiting valves. These can be used at the tub/shower and at the lavatory.

Users should be able to approach and use the lavatory and toilet. A wall-mounted or pedestal sink might enhance access for some users. Adjustable height lavatories are currently available, and might be helpful to families with children, as well as to people in wheelchairs. Lever-handle faucets are recommended for ease of use at the lavatory.

Laundry/Utility

In the laundry area, closet door storage racks for small items, brooms, and mops allow all users easy access to the storage space. Doors that swing fully open are necessary for complete access to an enclosed washer and dryer, as well as for repairs and installation and/or removal of the equipment. How appliances are placed within the space, as well as the controls and features on the equipment, determine the universally designed laundry area's design. A front-loading washer with a side-hinged door is recommended for its ease of access for people across the life cycle. Top-loading washers require bending to remove items. Raising the dryer height 12 in. above the floor enables users to reduce bending and stooping, and makes the appliance accessible to people who use wheelchairs. Bottom-hinged doors impede the user from accessing the washer or dryer, because the user must reach over the door and down into the equipment. Side-hinged doors allow the user to get closer, to reach down inside. Controls, lint filters, and soap dispensers located on the front of the appliance are easier to reach by all users. Laundry and utility equipment can be made universal by their placement within the space, or by the adaptation or placement of the features on the equipment itself.

Living and Dining

If general interior design features have been well planned throughout the house, then the design of the living and dining areas may be limited to the selection of furnishings. But one should always select furnishings with requirements in mind. For example, selection of a comfortable chair is important, especially if the user will spend a great deal of time in the chair. If a chair supports correct posture, it can reduce fatigue. Reclining chairs are adjustable, although, reclining chairs that require great strength or coordination to adjust should be avoided. As an option, an electrically controlled chair can be used. Chairs should have firm back support at the correct angle. Chair arm extensions permit ease in rising, but should not extend more than one inch beyond the chair to increase stability. Upholstery fabric should be durable, flame retardant, and easily cleanable, especially with small children around. Chairs with removable cushions, without welts, ridges, or tufts, are more comfortable and easier to maintain.

Tables with adjustable heights and angles, or with folding leaves, increase the flexibility of the design of the space. Some pedestal tables should be avoided since they can be easily tipped, and if a pedestal dining table is used, a depth of 24 in. is needed to allow clearance for a person using a wheelchair. Round or octangular tables create a more sociable environment than do rectangular tables. A lazy susan is an option available to reduce reaching across wide tables. Table surfaces should be anti- or low-glare. Universally designed living and dining rooms are universal because of the nature of the items selected and because of the arrangement of the items within the space. Adjustable chairs and tables enable a variety of people to use the space.

Bedroom and Storage

The bedroom is a personal space that all individuals need to be able to control. An open space with flexible storage and appropriate furnishings enables people of different ages and abilities to be independent within their personal space.

Universally designed storage areas have flexibility built-in, enabling the closet/storage area to change with the individual. One difference between the traditional storage area and a universally designed storage area is the way the rods are mounted. Notched mounting blocks on the wall is one option that allows the rods to be lowered or raised to accommodate peoples' changing needs (Lusher, 1988). Adjustable, open shelves allow the user to store and remove items without opening or closing doors, allows the user to manage changing needs. Open shallow bookshelves at appropriate heights make books and other items easy to reach. Additional bedroom and storage options include 4-6 in. wire or D type pulls on furniture drawers, lights in closets, and shallow (e.g., 12 in.) storage shelves where appropriate.

Monetary Cost of Universal Design

Mace, Hardie, & Place (n.d.) addressed the topics of the economic cost of lost opportunities and the cost to society when universal design is not implemented. The intent of the universal design concept is to simplify life for everyone across the life cycle, by making housing usable by more people with little or no extra cost. However, builders and designers often believe universal design and barrier-free design will significantly increase costs and perceive that people will not pay for it (John Hopkins Injury Prevention Center, n.d.). Steve Winter Associates (HDR Current Development, 1993) concluded that incorporating the FHAG increased building costs by 0.3 percent. Robert Scharf Associates (1981) estimates additional cost should not exceed one-half of one percent to five percent of the total construction cost.

Many universal design features are no-cost options. They may only require different product choices or design decisions. Other low-cost solutions can become no-cost options with wide-spread use. Because mass production of universally designed products would help to reduce costs, further research and development of innovative products that meet universal design criteria is needed to assure effective living environments for all people.

The alternative to universal design is retrofitting a house to meet users' needs through the life cycle. Retrofitting the home to adapt the structure to meet the specific needs of the user or occupants is a more expensive alternative than using universal design features during the initial construction. Retrofitting may also require more thought and design expertise to incorporate design features that do not appear to be simple add-ons.

Specifying different features for different groups of people will always cost more and require massive coordination and selective judgment about who should be accommodated and where. All of these impossible issues are eliminated by the universal design concept (E. Steinfield, as quoted in Lusher, 1988, p.14).

Conclusion

Universal design includes items that are usable by most people regardless of their level of ability or disability. Some items are more universal by their placement, while some features are made more universally usable by making them adjustable. Universal and adaptable features generally are no more expensive than conventional features if incorporated by the designer at the programming and conceptual stages (Mace, Hardie, & Place, n.d.). Cost-conscious designers must consider and advise clients concerning not only construction costs related to accessibility, but also the long-term hidden costs incurred by future needs. The monetary cost to individuals, families, and society must be considered. The average life expectancy of products must be considered in relation to the current and long-term life cycle stage of the family and their needs and goals.

As housing and design educators investigate housing options and family life, they need to start to consider universal design features as standard practice in residential design. Decreased long-term costs and a safer environment for all ages and stages of the life cycle are reasons to consider universal design features. The summary list of features that should be included in a universally designed residence reflects design solutions, practices, and products that are currently available and have been recommended by a variety of sources to meet the needs of all. The list may not be complete and may not be consistent with everyone's understanding of universal design. Many "special" solutions have been developed for barrier-free design that apply universally; however, these solutions may still have an image of being barrier-free. Further reflection and exploration of the concept and application of universal design is needed to define its scope and limitations, particularly as it applies to residences.

In the meantime, residential designers may use the summary list presented here when designing a home for those interested in meeting present and future needs. Owners and designers may also use the summary list when considering improvements or repairs to their own homes. As society ages, as health care costs increase, grown children boomerang back to their original family home, and frail aging parents move to their children's homes, universal design features help people stay in their homes longer and live with other family members more comfortably. Universal design enables families with small children, parents, and grandparents to share the same living space, by allowing individual members to be independent users of the space.

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