Preface

On June 20, 1995, a Special Interest Forum (SIF) was held in Washington DC, on the topic of "Accessible Cabinetry." Its purpose was to promote innovation in cabinet design to help make kitchens and bathrooms more accessible and usable by a diverse population, including people with disabilities. This report is based on the presentations made during the Forum. It captures the main points raised by the presenters and elaborates on many of the issues. Credit is given to the presenters where appropriate.

The SIF was organized by the Association of Safe and Accessible Products (ASAP) with the assistance of the Center for Accessible Housing and the National Kitchen and Bath Association. Funding was provided by the Center for Inclusive Design and Environmental Access, State University of New York at Buffalo, as part of a grant from the U. S. Department of Urban Development entitled "Fair Housing Means Universal Design."

Introduction

In the early 1900's, Ellen Richards, one of the first home economists, began to study the application of scientific principles of work design to the home. Her objective was to reduce the burden of domestic work on women. She was one of many social critics, both before and since, who believed that the new technology of the industrial age could have a positive impact on the quality of domestic life, particularly the life of women. Since Richards began her work, the household products industry has gone farther than she ever could have imagined to make domestic chores more safe and efficient. We have almost eliminated the necessity of any work at all for some tasks. For example, the development of frozen foods and the microwave oven have reduced the time it takes to cook a meal from the better part of a day to a few minutes. But social changes and advances in civil rights demand that we engage a new agenda for design of domestic space, an agenda that clearly has its roots in the work of the early feminist pioneers.

There are many people in our society that find it very difficult, if not impossible, to use a kitchen or bathroom without assistance and their numbers are rapidly growing. The new agenda is access

and usability for people who have functional limitations. We now recognize that the design of the home environment can be just as discriminatory and handicapping as prejudice against hiring a person with a disability.

In the US, as in many other countries, the goal of independent living for people with disabilities has led to new norms for design. These norms have been incorporated into the Fair Housing Amendments Act of 1988, the Americans with Disabilities Act (ADA) and other laws. They recognize that conventional design practices are excessively restrictive and discriminatory. In the course of implementing the laws, it has become clear that accessibility benefits everyone, not just people with disabilities. In fact, there is a trend developing to rethink the concept of accessibility. The new buzzword is "universal design."

This report will examine accessibility to one set of home products: kitchen and bath cabinetry. Our objective is to stimulate and support innovation in cabinetry design. We will outline reasons for the need to make cabinetry more accessible and typical features of accessible cabinetry. Examples of accessible products and several case studies will be presented. We will analyze the barriers to innovation and present some principles for universal design of cabinetry. We will conclude with a summary of the state of the art in this area and some recommendations for improving the pace of innovation.

Toward Universal Design

Three federal laws require accessibility to cabinets in housing. Two of them, the Architectural Barriers Act and the ADA only apply to housing that is built with public funds or that is operated by public programs. The Architectural Barriers Act covers all buildings built in whole or in part with federal funds. Most states also have complementary laws that apply to buildings constructed with state and local funding. Under the ADA, Title III, "Public Accommodations," does not apply to housing but Title II, "State and Local Government Programs," does. Title II applies to all publicly supported housing and strengthens Section 504 of the Rehabilitation Act. Unlike the first two laws, the amendments to the Fair Housing Act, passed in 1988, applies to *all* multi-family housing, including privately financed construction and housing built for sale as well as for purchase.

Whereas the regulations for the two former laws require only a small number of accessible units in each project, the Fair Housing Accessibility Guidelines (FHAG) require all dwelling units in elevator equipped buildings and, generally speaking, all ground floor apartments, to be accessible. Although the Fair Housing requirements are not as extensive as other accessibility regulations, they apply to a much wider range of dwelling units.

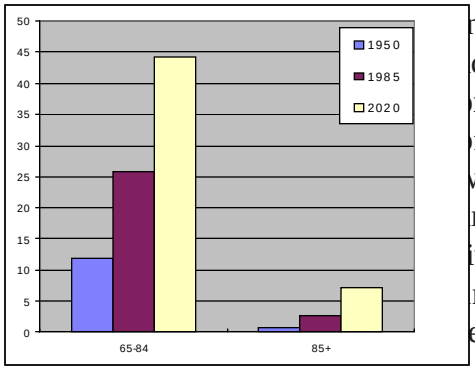
Since earlier accessibility regulations applied only to a limited number of units, custom cabinetry or special "handicapped" product lines have generally been used to meet them. Now, with a much wider number of units covered by the Fair Housing Act, there is a market developing for accessibility to products that are part of general product lines. Because of economies of scale, such products should be less expensive and more widely available than special product lines. Demand for such products is likely to increase in the near future.

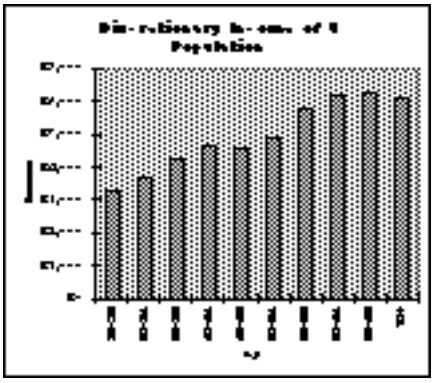
One source of demand will be improved enforcement of the law. The Fair Housing Act is administered by a complaint-driven process. There is no official review of plans prior to construction. But, the National Council of State Building Codes and Standards recently requested the ANSI A117 Committee to develop code language for the Fair Housing Accessibility Guidelines. Currently under development, they should be available next year for adoption by code authorities. Local building departments will then complete design reviews as part of the code approval process. This will protect designers and builders from unwitting violation of the law by insuring an official design review.

A second source of increased demand will be social change. John Salmen traces the origin of a concern with accessibility to the growth of the population of individuals with disabilities. This increase occurred because of three reasons: 1) a large number of people were disabled by the polio epidemic in the late '40s and early '50s; 2) advances in medical technology have saved a larger proportion of people injured in wars and accidents, and 3) the population is aging and older people have more disabilities than younger people (Salmen, presentation at SIF).

Arising directly from this demographic shift, the growth of the independent living movement and the policy of de-

institutionalization brought a large number of people with disabilities into the housing market. They are not only living alone but also with their families. Additionally, children with disabilities do not remain isolated at home in dependent situations. They are learning how to live independent lives ntegrated into the community. Thus, families need greater ccessibility in their homes. Institutions, re-organized as service roviders, now provide support for these families in the form f cash grants to make home modifications. There is also a whole new class of shared living arrangements. Adolescents nd adults who used to live in residential institutions are now iving in many types of community residences like group homes nd supervised apartments. These include both new and emodeled construction.





Figs. 1 and 2 Older people are gowing in both numbers and buying power

Demographic projections show that the older population not only is increasing rapidly but their purchasing power is becoming a major force in the marketplace (see Fig 1 and 2). The success of commercial ventures that cater to this group is a demonstration of their economic power. An example is the mail order pharmaceutical service run by the American Association of Retired People. With policy shifts, even older people without the economic resources will have more access to third party sources to purchase more accessible housing. It is clear that keeping people in their own homes is less costly and more desirable than relocation to nursing homes.

The regulatory trend toward more accessibility and the social trends go hand in hand. The regulations can be viewed as a response to the social changes. The need for regulations simply means that the marketplace has not adjusted fast enough to the changes taking place in society. Once one recognizes the significance of these changes, a different approach to accessibility becomes evident. In fact, several new concepts have been proposed that extend the idea of accessible design from a regulatory approach to a more inclusive design approach, one that will benefit everyone not just people with disabilities. There have been many concepts proposed that address the new needs. Here is a list that compares the new concepts to the original accessible or “barrier free” design concept:

- Accessible Design - accessible and usable by people with disabilities,

- Adaptable Design - for the general public but can be modified or adapted for use by people with special needs,
- Life Span Design - designed for everyone and accommodates the changes in functional ability associated with the aging process,
- Universal Design - design for access by all people, including those with disabilities, throughout the life span.

  (Adapted from a typology proposed by Pirkl, in *Transgenerational Design*, 1994.)

John Salmen proposes that universal design includes a number of different attributes:

1. Choice in method of use which can be provided by adjustability, alternative methods or redundant systems.
2. Inclusion and respect for diversity.
3. A search for meaningfulness (*sic* added value) in the design.
4. Rejection of the idea that "one size fits all."
5. Properties of accessibility are invisible (i.e., inherent to the design).
6. An emphasis on the process of design as opposed to product.

   (Salmen, presentation at SIF)

Proponents of universal design accept the limitation that it may be impossible to accommodate each and every person on this earth. The evolutionary process of seeking universal design is more important than reaching the ideal at any one point in time. Moreover, universal design practitioners downplay the importance of regulations. They argue that regulations tend to make designers think in terms of problems to be solved rather than opportunities for good design (Steinfeld, 1991). Truly creative design is therefore stifled by a regulatory mentality. Regulations still have a role to play because they insure that a bottom-line level of accessibility will be achieved. But products and designs should exceed these minimums if they wish to address the larger social changes taking place.

A review of regulations is useful to understand the difference between accessible and universal design. It highlights the limited scope of accessibility regulations; they simply do not address the full range of consumer needs. It also identifies how design to regulations alone will not lead to products that are desirable to the broader population. The regulations are only a point of departure, not the solution.

The existing technical provisions of state and local accessibility codes and the ADA Accessibility Guidelines are based on ANSI A117.1, the consensus standard for accessible design. ANSI and most of these regulations have several requirements that apply to cabinetry:

- clear knee space under kitchen sinks, bathroom lavatories and one kitchen work counter or removable base cabinets,
- bottom shelf of upper cabinets no higher than 48 in.,
- lower kitchen counters or adjustable height counters,
- bottom edges of mirrors on medicine cabinets no higher than 40 in.,
- hardware usable by people with limitations of grip,
- clearances between cabinets and counters that allow wheelchair access.

The provision of knee space and lower counters presents problems for marketing dwelling units. Most housing consumers prefer the space under sinks and lavatories to be enclosed and filled with useful storage areas. Lower counters may be good for people who use wheelchairs and those of short stature, but they are uncomfortable and unsafe for those of average height and above. Thus, the ANSI Standard allows “adaptable cabinetry” as an option. Cabinets can be constructed so that the front frames, doors and bases can be removed and counters lowered as long as these adaptations can be accomplished with little effort and cost.

The FHAG actually have no explicit requirements that apply directly to cabinet design. However, requirements for accessible circulation and access to fixtures and appliances introduce constraints on design that result in larger floor areas if accessible cabinet designs are not used. In fact, the FHAG has built-in

incentives for accessible cabinetry like in ANSI. For example, in bathrooms there must be enough space for wheelchair clearance inside the room beyond the swing of a door. If knee clearance is provided under the lavatory, most of that space can be counted as part of the required bathroom clearance (see Fig. 3). Thus, if an owner wants to build minimum sized bathrooms and kitchens, accessible cabinetry would be necessary.

This discussion demonstrates the benefit of the universal design approach over "accessible design." While providing knee clearance and a lower counter may be "accessible" according to code, it will be unacceptable to a broad range of users. The adaptable cabinetry concept embodies the universal design attitude. First, it allows convenient and safe use by people without disabilities. Second, there is no value lost, i.e., extra floor area, storage space or appearance. Third, it can more effectively accommodate a range of special needs, e.g., knee space but high counter for a tall person in a wheelchair.

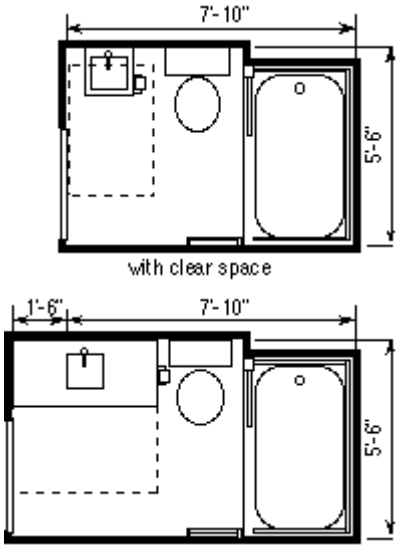


Fig. 3 Knee space under the sink increases accessibility and reduces required bathroom size

There are clearly more design issues covered by ANSI than the FHAG, but even ANSI does not cover several issues that would make cabinetry more accessible to the broad population, particularly older people and children. Most noteworthy, there are no requirements for the amount of storage space that must be within reach. Other gaps include lack of attention to the following issues:

- cabinet doors,
- drawers and shelves,
- medicine cabinet location,
- "dead" space in corners,
- storage for frequently used items,
- garbage and recyclable storage,
- location of hardware,
- special features like cutting boards.

We are not arguing here that the regulations should cover these items. Rather, these gaps illustrate that there are a lot of design decisions not covered by codes that affect the usability of kitchen cabinets. The domain of universal design includes the code mandated issues, although it may re-interpret them, and many

more issues besides. Universal design is, pure and simple, commonsense design. It rejects simplistic constraining approaches and seeks the intelligent responsive solution by careful analysis and creative problem solving.

Fig. 4 Pull out shelves improve access to storage
(photo courtesy of Hafele America)

Fig. 5 The EZ Shelf helps those with reach limitations
(photo courtesy of Hafele America)

Fig. 6 Lazy susan cabinets help to maximize space
(photo courtesy of Hafele America)

Example Products

Several manufacturers are already making cabinet products that have universal design features. A review of some examples highlights how universal design can be achieved in practice.

Hafele, a manufacturer and distributor of cabinet hardware and accessories, has focused on the development of an extensive line from which manufacturers and designers can select products to make cabinets more usable. Their line includes many interesting accessories that enhance the usability of cabinets for everyone. They are continually adding new products that address new needs in the market place.

Many of Hafele's products increase accessibility by bringing the stored items in cabinets closer to the user (see Fig. 4). These include:

- half circle pull-out shelves,
- pull out pantry units,
- full extension slides for baskets, drawers and shelves,
- baskets on the back of doors,
- components that can be arranged to get optimal access.

The company has recently started to distribute a Canadian product in the US called EZ Shelf. This device allows access to upper shelves by pulling down a gliding shelf unit (see Fig. 5). The Canadian government has made this a standard specification in accessible housing units.

Another group focuses on maximizing access to "dead space" like corner Lazy-Susan baskets and blind corner shelves that are attached to doors (see Fig. 6).

Hafele has recently addressed the increased importance of waste management in contemporary households. Many of their products make it easier for everyone to store waste efficiently.

As an example, one device opens a container lid as the cabinet door is opened; products like these increase accessibility and usability by reducing the number of necessary movements to complete a task (see Fig. 7). They also have a device for sliding shelves so that they slide out when a door is open.

Fig. 7 Automated parts save time and improve usability
(photo courtesy of Hafele America)

A number of companies are now offering products that allow instantly adjustable counter top heights. Such devices eliminate the conflict caused by fixed counter shelves. When more than one member of a household wants to prepare food and participate in cleaning up, it is often impossible to find an effective compromise height. Some older people who normally would use a high counter may need to have lower heights some days, when they're not feeling well and have to sit down while working. Hafele and AD/AS offer counter lifts with a manual crank (see Fig. 8). The lift has a range of 12 in. Both companies make an electro-mechanical lift that can be operated by touch switch or even remote control. AD/AS also makes a lifting device that provide instant access to upper cabinets (see Fig. 9). These systems include fail-safe switches that stop the cabinet if it encounters an obstacle.

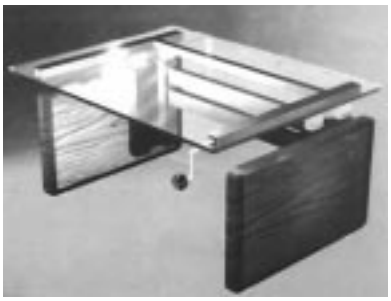


Fig. 8 A manual hand crank provides adjustable height counters
(photo courtesy of Hafele America)

Fig. 9 Motorized adjustable counters and shelves provide choice and flexibility
(photos courtesy of GE Appliance and ADAS)

Kiwi Connection distributes a product imported from New Zealand. The Ezyfold Hinge that allows bi-fold doors to be hung so that they lie flat against the cabinet when opened and give full accessibility to the inside. Bi-fold doors increase wheelchair circulation space in any small space because they have much smaller arcs compared to standard hinged doors. The hinge can be attached to either the underside of a shelf or the back of a cabinet. It also eliminates the need for a track at either the top or bottom. This hinge is a simple solution to providing knee space under counters without exposing unattractive under cabinet space (see Fig. 10). It can also be used in corner locations.

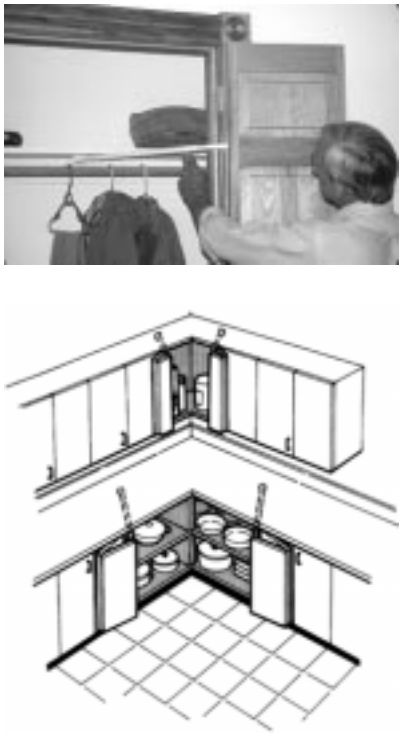


Fig. 10 The Ezyfold hinge increases usable clear space without the need for tracks (photos courtesy of the Kiwi Connection)

All these examples demonstrate how cabinet design can address a full range of accessibility needs. Accessible products do not have to look special or cost a lot. In some cases, like the Ezyfold hinge, they may even save money over conventional products. What is most important, however, is that as universal designs, these products are desirable by most consumers not just people with disabilities. They generally make cabinetry more useful and convenient.

Corporate Strategies

Yorktowne Cabinets

Yorktowne Cabinets has evolved an accessible product line over a long period of time. This evolution was marked by four phases. Phase One was driven by a "get the job done mentality." In general, the company produced accessible cabinets to meet the mandate for a percentage of accessible dwelling units in government funded projects. These cabinets were initially produced as special items for those jobs. Eventually, the company standardized the toe kick and base cabinet designs. This ushered in the second phase where accessible cabinets were offered as part of the product line but not marketed. By the late 1980's, Yorktowne was offering accessible cabinets in selected low end lines. These were available only in a limited number of sizes. Existing parts were used wherever possible. Several non-standard parts were added to provide the accessibility features including special front frames, toe kicks, end panels and interior components. In the 1990's the company began to see growth potential in this line. The third phase began when the company sought a market niche in this field. There was

more accessible housing being constructed and their customers were making requests for more availability in different styles. In response to the social changes described above, Yorktowne has now embarked on the fourth phase, a universal design approach. They now see accessible cabinetry as more than just a response to regulations.

The Yorktowne "Universal Access Cabinetry" concept is available in all product series and most styles. It comes in all woods and in selected laminates. The components needed for accessibility focus on the base cabinets and include:

- base cabinets with built in trays,
- base cabinets with cutting boards,
- drawer bases,
- revolving corner bases,
- sink fronts,
- pantry (tall) cabinets with sliding trays,
- oven cabinets,
- valences and fillers.

In addition, these components can be combined with a range of standard wall cabinet types to address different needs like tambour cabinets, open shelves and bookcase units. They can also be combined with an assortment of accessories and decorative trims. To market the universal access approach, the company has redesigned their product literature and specification book and developed a publicity campaign around the concept (see Fig. 11). A key feature of Yorktowne's philosophy is to offer the universal access products at standard prices but the accessible base cabinets do cost about 20% more than the standard cabinet prices of the same lines.

Fig. 11 Yorktowne has developed marketing materials specifically for people with disabilities (photo courtesy of Yorktowne)

General Electric Appliances

General Electric Appliances does not make cabinets but the company takes a "systems approach" to design. They recognize that appliances are only part of the total kitchen. In marketing their products to homebuilders, their strategy is to educate builders on a total concept and how their products fit into it. GE recently unveiled a universal design approach to kitchen

design they call “Real Life Design.” In developing this campaign, they considered the name carefully. The Real Life Design brochure explains:

> Some people call it Universal Design. Others call it Lifespan Design. We think a better, more accurate description is Real Life Design by GE. Real Life Design is simply good design. It can be appreciated by everybody because it makes so much sense to everybody’s life. It takes into account that most people don’t fit the stereotypical norm. Baby boomers in huge numbers are finding out that they aren’t as spry or sure-sighted as they used to be. Along with the usual problems faced by an aging population, Real Life Design also acknowledges a wide range of physical and mental abilities impairments. It even acknowledges that a great many of our most worthy citizens are children!
>
> (GE Appliances, 1995)

The emphasis on real life removes any stigma associated with “design for the handicapped.” The decision to use the universal design approach was based on economics. Through a careful study of demographics, GE discovered that the largest growth in household formation is among people between the ages of 45 to 65 and over 75. In addition, the number of households with two workers, latch key children and multiple generations

Fig. 12 The GE Real Life Kitchen incorporates universal design features to improve access for everyone
(photo courtesy of GE Appliance)

is increasing. Surveys of people over 65 demonstrate that most want to remain in their own homes. These trends mean that usability for people with a wide range of abilities will be an important aspect of consumer decision making.

GE decided to take a pro-active approach rather than ignoring the developing market and waiting until competitors respond first. Their strategy is to link "intelligent design" to "smart choices" by consumers. In this way, builders can be more responsive to consumer needs. As the center piece of their campaign, GE designed and built a demonstration kitchen that was exhibited at the National Association of Home Builders' 1995 Convention.

The kitchen was designed by Mary Jo Peterson and included many cabinetry products that exemplify universal design including several discussed above (see Figs. 12-13). Some of the features are:

- Automated sink with contrasting color faucet and retractable nozzle.
- Rolling cart that can be positioned to assist in different tasks like unloading a dishwasher.
- Roll out shelves to reach small items often lost at the rear of cabinets.
- Door mounted step stool to reach items on upper cabinets.
- Counter with a raised insert in a contrasting color to both contain spills and help people with poor vision identify the edge of the counter.
- Counters at multiple heights to support specific tasks, including heights above 36 in.
- Areas that can be adapted for seated work.
- Space planning for wheelchair clearances.

The Real Life Design kitchen demonstrates the interrelationship of cabinet design and appliances. For example, Fig. 13 demonstrates how a retractable surface under an oven can assist in loading and unloading at a dangerous location. "Spacesaver" appliances can make use of space that is often out of reach for many people. A dishwasher can be made more usable by raising it off the floor. The kick space can then be carried through for

Fig. 13 Pull out shelves make using appliances easier and safer (photo courtesy of GE Appliance)

adjacent cabinets, improving wheelchair access. The appliances used in the kitchen emphasize convenience and built in intelligence. For example, the microwave oven includes touch controls, sensor cooking, automatic completion reminder and word prompt display. As a complete kitchen, the theme of convenience and usability for everyone is reinforced by every feature including the appliances, the space design, the appearance and the cabinetry.

GE recognizes that implementation of the Real Life Design concept must go further than constructing and exhibiting a model kitchen. The kitchen will travel to trade shows but they have also produced a book about it, a video and alternative media for people with visual impairments. These media are educational tools that can be used by their sales force, professional designers, contractors and consumers themselves. Perhaps more significant, however, is that the company has developed a consumer information system that is integrated with the new campaign. In the past, when a consumer called the GE "Answer Center" toll free number and asked for information on appliances that were usable for people with disabilities, the response would be something like "Sorry, we don't have anything for the handicapped." Now, the Answer Center staff is trained to ask more questions, identify exactly what the consumer needs and identify products that might be helpful. In turn, the results of this dialogue will become part of a database that the company can "feed forward" into product development efforts.

The Real Life Design concept was not created simply as a public relations effort. GE realized that accessibility features for people with disabilities are usually convenience features for everyone else. These features are usually found on the more profitable appliance lines because the pricing of the lowest cost basic lines is highly competitive. Thus, by promoting universal design, GE expects to reap a return through increased profit margins on the appliances they sell. They believe that the consumer is willing to pay for convenience features if builders and designers can communicate their "real life" value.

Research and Development Case Study

Earlier in this report we discussed the value of adaptable cabinetry. In this section we will expand that discussion and describe a research and development effort completed in

conjunction with a major manufacturer.

The adaptable cabinetry idea has been around a long time. The concept originated with the Focus Society in Sweden in the early 1970's. The Focus Society was a voluntary association founded to construct accessible housing throughout the country. Their intent was to develop dwelling units for people with severe disabilities that were integrated into standard housing estates. In their research and development work, they discovered that many individuals would be living in family situations and others would have full time attendants. While people who use wheelchairs needed low counter tops and storage units, other family members and attendants preferred standard heights. Moreover, many accessories were needed to accommodate individual needs but were not necessary for everyone. Thus, the Society developed a kitchen cabinetry system with adaptable features that could be installed and then adjusted to meet the specific needs of each household. In a research study directed by this author in the late 70's, the adaptable concept was validated as a more sensible approach than fixed "accessible" cabinetry (Steinfeld, et al, 1979).

Fig. 14 Tracks on the walls make these cabinets easily adjustable (photo courtesy of Granberg)

Adaptable design concepts were then introduced into ANSI A117.1 in 1980. Unfortunately, only specialty manufacturers in the cabinet industry have adopted the adaptable cabinetry idea. The products on the market tend to be used for custom projects, not mass produced housing. Perhaps the best example of adaptable cabinetry is made by Granberg, a Danish manufacturer whose products are produced under license in North America by a Canadian company (see Fig. 14). All the parts of the system are hung off a wall mounted track so that heights can be adjustable. The base units come in two pieces, a lower cabinet and a drawer unit. The counter top can be mounted on top of the two base components, only the cabinet, or without the cabinet, in order to achieve different heights. A full line of accessories is available including a motorized countertop/ cabinet lifting system.

When specifying cabinetry for a project, most builders and designers want to specify a complete line of stock products from one manufacturer. Quality, availability and affordability are the three key factors in product selection. Adaptable cabinetry concepts like those in the Granberg system have not been adopted by the major manufacturers in the United States.

Importing products results in uncertainty about delivery and higher costs. Moreover, complete systems like Granberg's are not available in the wide variety of styles and quality levels needed to meet the requirements of a diverse market.

As part of the Fair Housing Means Universal Design Project, we decided to implement a small research and development effort to examine the barriers to innovation in adaptable cabinetry. We contacted KraftMaid, a major cabinet maker whose products were used in the Real Life Design kitchen. Their experience with that project had convinced them that universal design was an important area for further product development. They agreed to work with us to produce and evaluate an adaptable cabinet prototype from our design.

We started by developing a preliminary design for an adaptable bathroom lavatory and sending it for review to the KraftMaid designers. We discussed the design with them and made some modifications to fit with their construction and engineering approach. They then constructed the prototype and shipped it to the Special Interest Forum for presentation and evaluation. In the process of construction, they made some additional changes.

Fig. 15 The adaptable vanity adjusts to meet the needs of different users
(IDEA Center/KraftMaid)

The design utilizes a core unit consisting of a counter braced by side pieces. Bolts or screws can be installed anywhere in the back panel so that studs do not have to be located in specific places. The sides and front of the unit are attached to the core and the base is removable. The prototype design originally had three levels of adaptability. The first utilizes Ezyfold doors and a removable base to provide access underneath for a wheelchair or seated person. The knee space can be hidden behind the bi-fold doors. The second level is achieved through removal of the sides and doors and the installation of a shroud in front of the drain. This provides enough knee clearance to turn a wheelchair underneath. The third level is achieved by adjusting the height of the counter top. The unit would be detached from the wall and re-re-installed at a different height. All the dimensions meet the ANSI A117.1 and ADAAG requirements (see Fig. 15).

The KraftMaid designers felt that the wall hung approach was risky. Thus, in the constructed version, the core unit was extended and supported on the floor. To adjust the height, the legs would have to be trimmed off. This eliminates the possibility of increasing the height.

KraftMaid's marketing department evaluated the prototype as a potential new product. They used a series of 10 questions that help them to analyze the profit potential of the product:

1. Is this product needed/desired by an identifiable market segment?
2. How large is the market for this kind of product?
3. How great is the incentive for the consumer to actually purchase this product?
4. What price range will the market bear?
5. Have we designed and engineered the idea so that it fills the need and is attractive to the consumer?
6. Can the product be produced using equipment and labor sources we already have? Do we have space for the production or will capital investment be required? How much?
7. Can we produce the product using materials we already keep in stock or will new materials be necessary?

8. If new materials must be stocked, how much will the material cost? How much space will be required and what will the space cost?
9. What media will be required to promote the product and how much will it cost?
10. What is the projected cost of the warranty for this product?

On the positive side, they concluded that there certainly is a market for accessible cabinets. Moreover, the prototype was successful in providing a high level of adaptability and accessibility. They were convinced that the product could be made attractive although they were not happy with some of the details. It could be manufactured in both framed and frameless cabinet types to offer the broadest possible style choices. They liked the slide out base and saw a potential enhancement by using it as a step for children. This would reduce the need for storing a step in the bathroom; it could be safer than an unstable step and it would be an attractive feature for families with small children. The design was strong enough to support an adult when using it for stability or to pull oneself up from a seated position, even when the front and sides were removed. Installation would be easy although special instructions would have to be included. The doors opened very easily. The durability of the cabinet was judged better than the average vanity. Finally, the cabinet could be stored and shipped either in a knock-down form or fully assembled.

On the negative side they also identified a number of problems with the design. First, the interior shelf (un-adapted version) was not a standard size for the company. Their drilling equipment would have to be readjusted every time a run of shelves was to be produced. This would add substantially to the cost. The standard size shelf they have available would not provide enough storage to meet consumer needs. Moreover, it did not fit well within the unit as designed. Most people want drawers in the vanity and the prototype did not provide any. Most importantly, the retail cost of the prototype would be approximately $225 compared to $150 for the average vanity. The added value for the consumer is questionable. Would the consumer put enough value on the adaptability features? The cabinet may be viewed simply as camouflage for plumbing. There are less expensive ways to provide countertop support.

The reason for the cost difference was the added materials and labor required for the two layers of wood at the side and top front and the rear panel which is usually not provided. At the Special Interest Forum it was concluded that further development of the idea should focus on developing a less expensive way to make the supporting system for the core unit. Other improvements include the development of a drawer option, the sliding step idea and a more effective storage system for the interior.

This small R&D exercise was a useful way to illustrate how a cabinet company approaches innovation. We all know that the bottom line for a business firm is profitability, but it is difficult for outsiders to understand the many variables that the manufacturer has to consider in evaluating profit potential. Each company undoubtedly does things a bit differently and would see different problems. For example, another cabinet manufacturer might already make a standard shelf that would fit in the prototype. Yet, that company may have difficulty with another feature. In general, however, we learned that the basic problem with producing adaptable cabinetry is not the idea itself, it is simply a matter of learning how to do something different. Barriers to innovation include the cost of extra materials and labor, production constraints of existing tools and physical plant and marketing costs. To introduce an adaptable cabinet in a competitive market, the product must not require any capital investment on the part of the manufacturer and must fit into the standard manufacturing process. If the adaptability features are largely invisible to the consumer, the cost of the product must be essentially the same as the standard product.

KraftMaid learned a lot from the experiment as well. They intend to introduce universal design to their lines. Their strategy will be to investigate how they can use their current components to deliver solutions that will meet the needs of all people. Part of this effort will be to reorganize their product brochures to make it easy for the consumer, builder and designer to use the potential of their line to meet the needs of a more diverse consumer population. The company feels that their line is so broad and so deep that they can meet the accessibility needs of virtually any consumer. To them, universal design is a means to demonstrate the responsiveness of their products.

Barriers to Implementation

In continuing the effort to provide more accessible cabinetry, there are several barriers that have to be overcome:

- perceptions
- cost competitiveness
- durability and reliability
- code issues

Perceptions

The first step toward universal design is overcoming the perception that there is no need or demand for usability features. The history of most industrial products demonstrates a continued evolution toward greater safety and utility. For example, adjustable automobile seats were originally found on only the most expensive vehicles. Today all vehicles have them. Seat belts were only found on racing cars at one time. Now they are, by mandate, required in every passenger automobile. Automated windows and air conditioning are examples of features that clearly are not critical for safety and can easily be done without. Yet, more and more cars in the moderate price range are equipped with them as standard equipment. Universal design is a continuation of the inevitable evolution of technology. In all the examples above there is a cost associated with the added safety and convenience. In some cases, such as air conditioning, the cost is significant. But, consumers are willing to pay the cost if they perceive it to add value to the product and they have the ability to pay.

Throughout the history of mass production, producers have learned that markets have to be made; the consumer doesn't always respond without being educated. As Sy Syms, a clothing retailer, says in his advertising campaigns, "The educated consumer is our best customer." GE's Real Life Design campaign demonstrates how producers can educate the consumer. The object of the campaign is to make people aware of the value added features in universal design, to change their perceptions. Consumers, in fact, are already being educated. The baby boomer generation is learning from their parents how valuable accessible and usable products are to maintaining independence in old age. Everyone with a family member who has a disability is learning about the importance of accessibility

to community resources and housing. And, because there are mandates to end discrimination based on disability, all their friends and relatives are learning as people with disabilities lead more socially integrated lives. It won't take much for the population to start recognizing the value of universal design features for themselves as well as for others.

The product design plays a role in changing perceptions as well. A product that only provides increased utility for people who use wheelchairs will not be as successful as one that has increased utility for everyone. If possible, the design should advertise its features by bringing attention to them using color, shape, texture, etc. The GE Real Life kitchen does all of these things. KraftMaid was correct in criticizing the adaptable vanity prototype because it appears to have no value other than knee clearance. How many people need knee clearance? Their idea for a sliding step for children and other features that would benefit a larger population would bring added value to the product and appeal to a broader market.

Cost Competitiveness

Cost, of course, cannot be ignored as an important barrier toward achieving universal design. Although cost is related to value and people are willing to pay for extra value, some people simply don't have the resources and some products have to contend with extremely competitive markets. In the case of bathroom vanities, builders not consumers purchase most of the products. The builder seeks to maximize products and will not select a vanity that costs more than a competitive product without assurance that it will help sell the home or apartment. A nice vanity alone is not sufficient to make a dwelling unit more marketable. Thus, for a product like this, universal design has to have more added value (e.g. step for children, more usable storage space, counter height alternatives, etc.) or be priced the same as competitive products.

Keeping the cost of universal design competitive means that designs have to work within the constraints of a company's production and distribution process. As we discovered with the vanity experiment, the cost implications of material selection, dimensioning, fastening technology, machining, parts inventory, storage and shipping all have to be considered carefully. Each company will have different constraints and each will prefer

different solutions to the same problems. Because of these constraints, there are good opportunities for inventors and specialty manufacturers to develop universal design components that can be marketed to "original equipment manufacturers" or "OEM'S" like Yorktowne or KraftMaid. Three good example of this are Hafele, AD/AS and the Kiwi Connection. They all make products that KraftMaid incorporated in the cabinets for the GE Real Life Design kitchen. By using specialty companies as a source of components, the OEM can avoid purchases of new manufacturing equipment and materials. Using their existing manufacturing resources combined with new components made by other companies they can produce more usable products without any impact on production costs.

Durability and Reliability

Durability and reliability are always important issues when introducing new products. The purchaser is concerned that innovative products will deliver the level of performance achieved by established solutions. The producer is concerned about quality control and returns or call-backs which can eat into profit margin. Two aspects of universal design raise a red flag for the purchaser and producer. One is the use of new materials or components and the other is the use of moving parts.

Universal design can often be provided without resorting to departures from tried and true materials and methods of construction. However, new materials and components are often needed to advance the state of the art and, in particular, to counterbalance the increased cost of new features. In the case of the prototype vanity, we attempted to use only the standard materials and methods used by the manufacturer. KraftMaid was already familiar with the Ezyfold hinge so that was not a problem. For another manufacturer, it might have been. We would have had to demonstrate the quality of the device and explain how it was to be installed. Our experiment indicated that we will have to find some way to eliminate a lot of material to reduce the cost of the prototype design. This will probably require an additional component, one that may have to be invented.

Moving parts invariably result in increased reliability and durability problems. A rule of thumb in product design is to keep such components to a minimum. In universal design,

however, a major goal is to provide alternative methods of use and adjustability for different statures and postures. This often leads to the introduction of moving parts. In the prototype vanity, we sought to introduce the adjustable height feature through wall mounting. The company felt that wall mounted units would be less durable than a floor mounted design. Two other important design issues in adjustable cabinetry are water and electrical connections. Connections to electrical and plumbing fixtures mounted in countertops and cabinets are prone to failure as the devices are adjusted. Serious safety problems can result if these connections are not properly designed. However, there are construction methods that can be used to overcome these problems.

In the case of lavatories and sinks, standard plastic plumbing supply lines with “speedy” connectors can be used. They are easy to replace when adjusting the counter to a new height. For counters with automatic lifting systems, a more durable connector and flexible lines with enough slack to accommodate the full range of heights will be needed. Drain lines in fixed installations can be built with standard extension tubes that are adjustable to accommodate different spans. For the automated systems, the line from the drain to the trap will have to be flexible. In both cases, the trap will have to be installed to accommodate the counter top in the lowest position. Even with special instructions in drawings and specifications, architects find that plumbers are likely to install rough-ins and traps at standard heights. They are notorious for ignoring construction documents.

Electrical connections in adjustable counters and cabinets can be handled in several ways. The first is to avoid electrical fixtures in the movable cabinetry. Put switches and outlets in other locations. This isn’t always possible or desirable. Switches on the front face of counter aprons can be very convenient. Lighting under cabinets improves visibility at work stations significantly. Remote control, wireless or sound activated switches can sometimes be a good solution if they are reliable in the setting. Another is the use of low voltage power and a transformer. This is appropriate for lifting units that must have a power source and also for under cabinet lighting. Low voltage lighting is smaller and easier to install under cabinets. Wiring for low voltage devices can be thinner and requires less protection and lighter fastening systems. If standard power will be used, the

cabinetry must have room for the required receptacles and junction boxes necessary for safe installations. Built-in conduit may be desirable for wire runs.

Code Issues

Cabinetry in accessible multifamily dwellings must comply with local or state accessibility codes, the Fair Housing Accessibility Guidelines and, if applicable, the ADA Architectural Guidelines. Most state codes follow the ANSI A117.1 standard or the ADAAG. Each of the codes/guidelines has different requirements. ADAAG and ANSI have requirements that apply to all storage units and to ovens, cooktops, sinks and lavatories in cabinets. The only requirements of the FHAG that apply to cabinetry are those for clear floor space for wheelchairs and knee clearances for vanities, if designed for a front approach.

The adaptable vanity is a good case study that can be used to illustrate the various code issues related to accessible cabinetry. These requirements in the FHAG apply to adaptable vanities:

- height: 34 max. to top of lavatory rim
- apron clearance: 27 in. min.
- clearance depth: 17 in. min.
- width: 30 in. clear min.

Ron Mace at the Center on Universal Design completed an analysis of the accessibility code requirements that apply to lavatories. He found that the requirements for clearances under the lavatories are not that easy to meet with current lavatory products and typical vanity construction. There are subtle interrelationships that work to decrease the extent of accessibility that can be achieved. In the FHAG, the combination of maximum height and apron clearance requirements leaves only 7 in. for the bowl depth. Meeting ADAAG and ANSI is more complicated because they both have additional requirements. These include:

- lavatory rim height: 29 in. min.
- depth of knee space: 8 in. min. at top, 11 in. min. at bottom
- toe clearance: 9 in. high and 6 in. deep, min.

Mace found that when all these requirements are taken into account, existing products lead to less knee space than could be achieved (see Fig. 16). Furthermore, the maximum height of 34 in. to the rim limits use of the lavatory by people who are tall and have difficulty bending. Attempts have been made to modify ANSI and ADAAG to make them more flexible and, in particular, to encourage the use of the adaptable concept. However, regulators and some consumer advocates are uncomfortable with requirements for adaptability for three reasons: 1) they are not sure that consumers will be aware of the adaptability features; 2) they fear that building management will not make the adaptations when asked by tenants; 3) they are concerned about the safety of innovative products. Thus, accessibility codes and standards themselves present some barriers to implementation of universal designs. Code writers would rather have requirements that mandate a specified level of accessibility than adaptability.

Other code requirements apply to cabinetry design, including structural, sanitary and electrical codes.

Counter tops with knee space introduce structural safety issues. The counter top and its superstructure must not only be thin enough to provide sufficient knee space but also strong enough to span the clear area and support the counter loads over a long time. Although many furniture connectors and brackets are

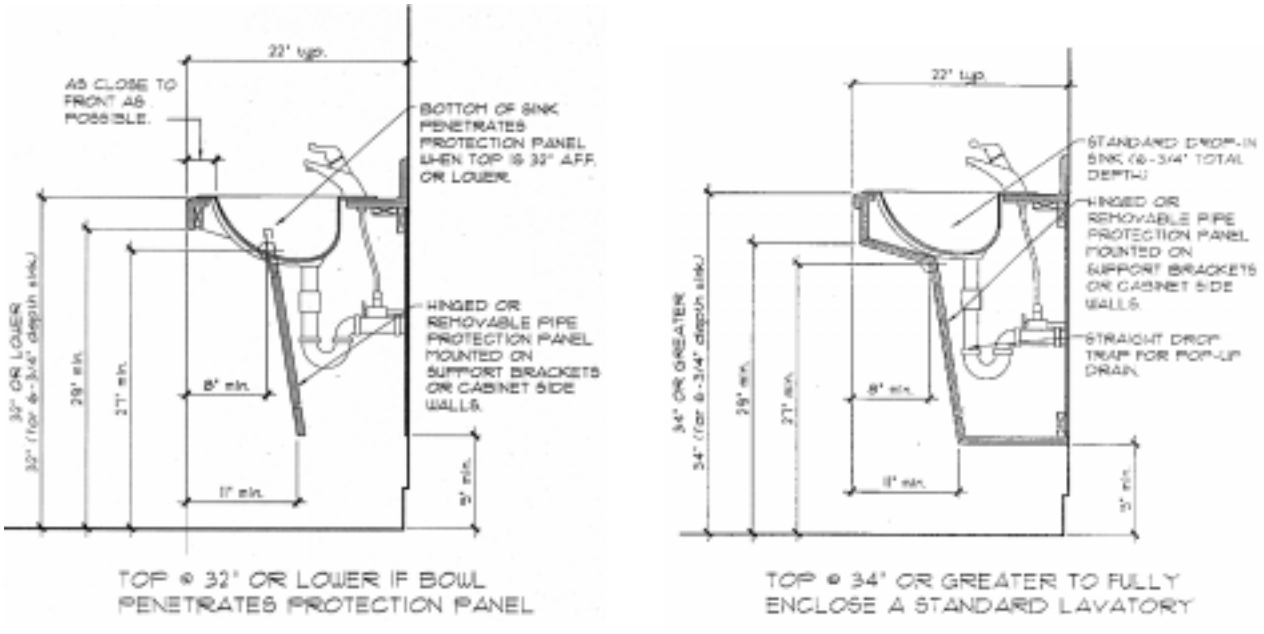


Fig. 16 Standard sink arrangements do not give the maximum knee clearance (drawings courtesy of Ron Mace)

available that will provide the level of structural strength necessary, code authorities are not familiar with these systems and may prefer to see 2x4's and other stock lumber used. They may also be uncomfortable with non-permanent connections. Another problem with codes is that there are no quantitative requirements for many cabinet items. The result is that code authorities may demand an unrealistic level of strength based on the standards used for load bearing construction elements.

Waterproofing and hygiene are other code concerns. Adjustable countertops for vanities or sinks cannot be permanently fastened to the wall. If the units are to retain the ability for movement, joints at moving parts cannot be sealed. Methods must be developed to insure that water and other liquids will not cause damage to the surroundings. The most common solution is to permanently connect the backsplash to the counter. Then, the backsplash moves as the counter moves. AD/AS reports that they have had difficulty obtaining code approval for flexible plumbing. They use a flexible plastic drain line that has corrugations on the outside. Although it is smooth on the inside, code officials often suspect that it has corrugations on the inside as well. Such an interior surface would collect waste and breed bacteria.

Electrical codes require a minimum number of outlets spaced along counters in kitchens. Outlets are required near bathroom sinks as well. There are limitations regarding the location and type of outlets near plumbing fixtures. Adaptable cabinetry can interfere with meeting these code requirements. Careful planning of outlet locations is required as cabinetry designs are developed. Another electrical code issue is the definition of automated counter tops and cabinets. Are they equipment or appliances? Mechanical equipment like range hoods usually have to be hard wired into the electrical system. Appliances, on the other hand, can be plugged into outlets. If a product comes assembled and ready for operation, it is more likely to be accepted by code officials as an appliance. Obtaining a UL label is advised to insure acceptance. As an appliance, the code problems associated with wiring are not as significant. All that is needed is a cord designed to protect it from damage while the device moves and long enough to reach an outlet. The location of outlets behind vanities and other places where they will be covered up from view could present a code conflict. Such installations are different than outlets behind refrigerators because the cabinets will be used for storage. Installing shields

or panels to block access to the outlet from the storage area may solve the code concerns.

To avoid problems with approval, designers should insure that innovative products comply with applicable codes. Companies producing innovative products should do a thorough code analysis in the product development phase. Accessibility codes are not the only ones that should be reviewed. Structural, electrical and plumbing codes are likely to have related requirements, particularly if the product will be an adaptable cabinet. Through experience, AD/AS has compiled the main concerns of designers, code officials and contractors. They have prepared a small brochure entitled "Fifteen Answers to fifteen questions about Motorized Adjustable Kitchen Cabinet Counter Systems." Such materials are an essential part of marketing efforts. In this brochure, the company describes how their product not only meets but exceeds accessibility code requirements and how other code issues have been addressed.

There is a need to educate the national code making bodies about accessible cabinetry. Both designers and manufacturers can get easily frustrated with local code authorities who make interpretations that restrict use of innovative products. For product manufacturers, variability in interpretations across states and localities can severely restrict marketing efforts. OEM's are reluctant to incorporate innovative devices produced by specialty companies if they cannot be assured of uniform code acceptance. Codes that are more performance oriented, that is, in which the results are stipulated rather than the precise methods to achieve them are preferable. Clauses that allow "equivalent technologies" with the burden on the manufacturer to produce documentation of equivalent performance are another solution. Ultimately, working with code officials to develop less restrictive codes and to reduce unwarranted resistance will not only facilitate acceptance but reduce the liability risks of producers and installers.

Prior to the development of more responsive codes, companies producing innovative products can submit their products for review by model code bodies with research data demonstrating their utility and safety. Letters from the national model code agencies and state code officials can then be used to convince local officials to approve them. Companies like AD/AS keep a record of every project gaining approval which documents a precedent and helps to gain acceptance in new locations.

Principles for adaptable cabinetry design

Our research has helped us to identify several design strategies for use in achieving universal design in kitchen and bath cabinetry:

Strategy 1: provide options for approaching cabinets.

When planning kitchens and bathrooms, the space around cabinets should allow people to gain access from a seated or standing position. The space should have enough room to open the cabinet doors while approaching, and close the doors while leaving the area. The clearance between cabinets and opposite objects, including door swings, should be sufficient for wheelchair access. Where countertops are provided, there should be an area for seated work that is accessible by wheelchair users. Adjustable counter heights are desirable to accommodate individuals with a range of body sizes and reaching abilities. Counters that hold sinks or lavatories should be open underneath or adaptable for use by seated individuals. Somewhere in the room, there should be enough space to turn a wheelchair around. Space provided by adapting cabinetry can be used for this purpose.

Strategy 2: Reduce need for reaching, bending and carrying.

Countertops should be adjustable or options provided for seated and standing work. For some tasks and individuals, heights above 36 in. are very useful. Cabinet heights should be planned to put as much storage as possible within the comfort zone of reach for the entire population, within 24-48 in. from the floor. Where storage is higher or lower, adaptable devices should be considered to bring stored objects closer to the comfortable reach range. The backs of cabinet doors should be used to store frequently used items. Retractable storage devices should be used to bring items at the rear of the cabinet within range. It is desirable to reduce the number of motions required to gain access to storage by using systems that slide or pivot toward the user as doors are opened. Integrate rolling carts and retractable supporting surfaces into the design of kitchens to provide flexible temporary storage to reduce the length of lifting tasks. Door hardware should be located at the bottom edge of upper cabinets and at the top edge of base cabinets. Provide integrated steps for people of short stature to help them use high storage units.

Strategy 3: Provide storage to support each task center.

Kitchens and baths should be designed as an organized collection of task centers. Each center should have storage systems that are adequately sized and conveniently located to support the task. Items that are used most frequently should be closer to the user and be more accessible. Work centers should be planned to reduce the number of trips between them and other locations to a minimum. Countertop materials should be selected to facilitate task performance. For example, where hot utensils will be used, heat resistant materials can be used as surfaces to reduce the need to lift heavy objects. Counter shapes and details should facilitate tasks at work centers, e.g., contain spills or provide locations for electrical controls. Counter heights should be selected to provide the most comfortable height for the tasks done at each work center.

Strategy 4: Integrate electrical and plumbing systems into cabinets.

Powered systems should be carefully shielded and safely connected to power supplies. Cabinets and counters should accommodate mounting electrical switches and outlets where codes require them. Electrical systems should be located where they do not waste storage space. Dimensions of cabinets for sinks and lavatories should support adequate knee clearances with fixtures installed. Plumbing connections should accommodate adjustments in height. Plumbing supply lines, drains and rough edges should be protected to avoid injury to knees.

Strategy 5: Reduce the need for precision and force.

Hardware should be usable without pinch or power grips. C-type handles are most desirable. Minimize the force of opening doors and drawers. Minimize the force of operating retractable and sliding devices.

Strategy 6: Clarify the perception of the device.

Use contrasting colors to emphasize the location of important objects and features. Select surfaces that will not cause distracting glare. Use shapes that can help in tactile searching or orientation for those that have visual impairments. Interior lighting should be considered where room lighting will not

sufficiently illuminate the interiors of cabinets. Task lighting should be provided where cabinets above counters will cause shadows. Provide visibility to frequently used storage areas, e.g., glass fronts, open racks, etc.

Conclusion

The concept of universal design in cabinetry has actually been around for a long time. Its beginnings date to the time when domestic work became a subject of scientific research. Universal design is really a branch of ergonomic design. Early research, education and practice in this field concentrated on how design can simplify domestic work tasks and reduce effort. It failed to consider the range of needs in the population caused by disability, aging and differences in stature.

Demographic changes are increasing the importance of convenience as a design factor in home design. In particular, the increased numbers of people with disabilities living independently and the aging of the population are introducing market demand for universal design approaches. As consumers become more educated on the usefulness of universal design, we can expect the demand to be more visible. Legislation like the ADA and the Fair Housing Act are contributing to attitude change and helping to develop a market. Many existing products are good examples of universal design, particularly those that result in tangible and understandable benefits to all.

Producers have an opportunity to increase demand themselves by adopting universal design as a marketing theme. To be most effective, they should not focus on accessibility for people with disabilities alone. As in GE's Real Life Design campaign, they should use the diversity of needs in the population to emphasize the universal value of increased convenience, safety and responsiveness to individual needs.

Although there are many barriers to implementation of universal design in accessible cabinetry, the major barrier is the attitude toward change. All change is difficult. The introduction of adaptable features in particular, requires careful attention to many technical issues, including materials selection, production methods, engineering, marketing and appearance. Since universally designed products must compete with other generally available products, cost competitiveness is more

important than when products are designed as specialty items to meet accessibility codes.

Cabinet makers that are pioneering in the provision of universally designed products have learned that they can start by introducing a broader range of accessibility products into their current lines. This increases responsiveness to household needs and builder's marketing goals. A second strategy is to seek out component manufacturers to supply specialized items that add usability and value. Third, the development of better product information plays an important role because it conveys the availability of options and shows builders, designers and consumers how components can be coordinated to increase function.

Companies that wish to introduce innovative products, particularly adaptable devices, must do careful research and development to address the many factors contributing to acceptance by OEM's, builders and consumers. Resolving code issues is a major concern because code officials and design professionals often respond negatively if there is any hint that products will not perform according to specified norms in the industry. Not only do producers have to "do their homework" to make sure that their products meet the codes, they should document how their products meet or exceed the codes. They should also be working with code and standard making bodies to remove artificial obstacles to code approval. Organizations like ASAP are working with producers to encourage more responsiveness to universal design in codes and standards.

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Bibliography

GE Appliances. *Real Life Design.* Louisville, KY 1995

Pirkl, James. *Transgenerational Design*. Van Nostrand Reinhold: New York, NY 1995.

Salmen, John. *Special Interest Forum on Accessible Cabinetry Keynote Address*. June 20 1995.

Steinfeld, Edward. *Adaptable Dwellings*. US Department of Housing and Urban Development. 1979.

Steinfeld, Edward. "Teaching Accessibility Design." *Action on Accessibility.* Center for Accessible Housing: Raleigh, NC 1991.

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