Thirty Something (Million): Should They Be Exceptions?

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There are over thirty million people in the U.S. with disabilities or functional limitations (of which a major cause is aging), and this number is increasing. An examination of the role of human factors in addressing this population is presented which would include both special designs for disability/aging and the incorporation of disability/aging into mainstream human factors research and education. Statistics regarding the size and characteristics of this population are presented, including the costs of disability. Examples demonstrating the economic and commercial feasibility of incorporating disability/aging considerations in mass market designs are provided along with a discussion of the benefits to non-disabled users.

Introduction

Many nations are becoming more aware of the large numbers of persons with disabilities and the problems they face. This group includes those born with disabilities and those whose abilities diminish during their lifetime through disease, accident or aging. Recent Federal legislation in the United States, primarily Section 508 of Public Law 99-506 and the Americans with Disabilities Act, addresses accessibility problems faced by persons with disabilities in the workplace and community. In addition, the demographic trend toward a growing elderly population (particularly as the "baby boom" generation ages) is raising the prospect of a large number of consumers with decreasing abilities. The serious impact this will have on mass market products is beginning to be recognized by manufacturers.

These developments have sparked increased discussion within the human factors community. There is little question that human factors research and principles can be a benefit to those who are designing special devices for persons with functional limitations. However, the open question is, "Should the mainstream design of products include consideration of people who have disabilities or are elderly?" (In other words, should mass market products be made more accessible via their initial design?)

It is easy to answer this question in the affirmative from a humanitarian standpoint, yet this is likely to represent a major change in scope for the human factors field. The specific role of human factors with regard to design for disability/aging is yet to be determined. Such a change must also be well considered in terms of effects on personnel, curricula and economic perspectives.

It is useful to break this complex question into the following component questions:

- Who is included in the category of "disabled and elderly persons"?
- How large is the disabled and elderly population?
- Can't the needs of disabled or elderly persons be handled separately or as exceptions?
- What can the human factors field do for this group?
- Is it economically and practically feasible to include disabled and elderly persons in the design process for mass market products?
- What are the "benefits" of incorporating disability and aging considerations into mainstream human factors activities?
- What are the "costs"?

Who Is Included in the Category of "Disabled and Elderly Persons"?

It is important to understand that there is no clear line between people who are categorized as "disabled" and those who are not. A performance or ability distribution for a given skill/ability is generally a continuous function, rather than bimodal with distinctive 'able' and 'disabled' groups. This distribution includes a small number of individuals who have exceptionally high ability, a larger number of individuals with mid-range ability, and another longer tail representing individuals with little or no ability in that particular area. In looking at such a distribution, it is impossible to simply draw a vertical line and separate able-bodied from disabled persons. It is also important to note that each aspect of ability has a separate distribution. Thus, a person who is poor along an ability distribution in one dimension (e.g., vision) may be at the other end of the distribution (i.e., excellent) with regard to another dimension (e.g., hearing or IQ). Thus, individuals do not fall at the lower or upper end of the distribution overall, but generally fall into different positions depending upon the particular ability being measured.

The 95th Percentile Illusion

It should be clear that even if elderly and disabled persons are included in the mainstream design process, it is not possible to design all products and devices so that they are usable by all individuals. There will always be a "tail" of individuals who are unable to use a given product.

In order to include a sizeable portion of the population in the category of "those who can use a product with little or no difficulty," the 95th percentile data are often used. The problem is that there are no "95th percentile" data for specific designs. Rather, there are only data with regard to individual physical or sensory characteristics. Thus there is 95th percentile data for height, a 95th percentile for vision, hearing, etc. As a result, it is not possible to determine when a product can be used by 95% of the people. It is only possible to estimate when a product can be used by 95% of the population along any one dimension. Since people in the 5% tail for any one dimension (e.g., height) are usually not the same people as the 5% tail along another dimension (e.g., vision) (Kroemer, 1987), it is possible to design a product using 95th percentile data and end up with a product that can be used by far less than 95% of the population.

To illustrate this phenomenon, imagine a mini-population of ten individuals. Ten percent of them (1 of 10) have one short leg, 10% have a visual impairment, 10% have a missing arm, 10% are short and 10% cannot hear.

Let's assume that we design a product that required 90th percentile ability along each of the dimensions of height, vision, leg use, arm use, and hearing. In this instance we would end up with a product which was in fact only usable by 50% of this population. This occurs because, although only 10% of this mini-population is limited in any single dimension, different individuals fall into the 10% tail for each dimension and only 50% of the population is within the 90th percentile for all five areas.

In real life, the effect is not quite this dramatic, and its calculation is not so simple. First, the percentage of individual with disabilities is less than 10% along any one dimension. Secondly, there is often overlap where one individual would have more than one disability (elderly individuals, for example).

On the other hand, there is a much wider range of different individual types of disability. In addition, the data from which the 95th percentiles are calculated often exclude persons with disabilities (Kroemer, 1987), making the percentage who could use the design(s) smaller than one would first calculate.

How Large is the Disabled and Elderly Population?

Determining the exact number of individuals with disabilities or with limitations due to aging is difficult. Estimates vary depending upon the definitions of disability used and the sources of the data. There is also a substantial number of individuals with disabilities who have returned to the work force despite significant functional limitations and who therefore do not consider themselves disabled. Their functional limitations, however, must be taken into account when they are trying to perform within an environment of facilities and tools designed for "normal" or 95th percentile function.

To further confuse efforts to understand the makeup of this segment of our population, most of the data reported overlap. That is, the same individual may be counted in both the visually impaired and hearing impaired segments. Adding the two numbers together would give a false reading of the size of the "hearing or visually impaired" population. For example, in one study the incidence numbers are reported as shown in Table 1 (based on data from National Center for Health Statistics, 1979, as reported in Czajka, 1984).

Table 1: Prevalence of Selected Impairments in the United States

	All Ages	Over 65
Impairments (vision, hearing, etc.)	20.3%	50.1%
Circulatory conditions	21.7%	63.8%
Respiratory conditions	26.2%	35.0%
Skin and musculoskeletal conditions	25.5%	57.4$
Other chronic conditions (diabetes, urinary, other)	27.8%	30.5%

Based on recompilation of data from Czajka (1984). Source: National Center for Health Statistics, 1979 and 1980 National Health Intervew Survey

If you add the numbers in Column 1 of Table 1 together, you get 121% of the population (all ages). Adding the numbers in Column 2 gives you 236% (of the 65+ population). Clearly these numbers are not exclusive of each other. It is therefore important to differentiate incidence figures for single types of impairment from "total person" counts. In the latter case one must verify that the figures used are mutually exclusive before doing any adding. It is also important to note from this that many individuals will have multiple impairments, and solutions targeted at a single disability may not be useful to them. For example, 75% of people with speech impairments report other impairments, as do 73% of those who are blind, 71.4% of those with complete paralysis of the extremities, 70.4% of those with glaucoma, 55.4% of those who are deaf in both ears, and 38.6% of persons with hearing impairments other than deafness (National Health Interview Survey 1983-85; in LaPlante, 1988).

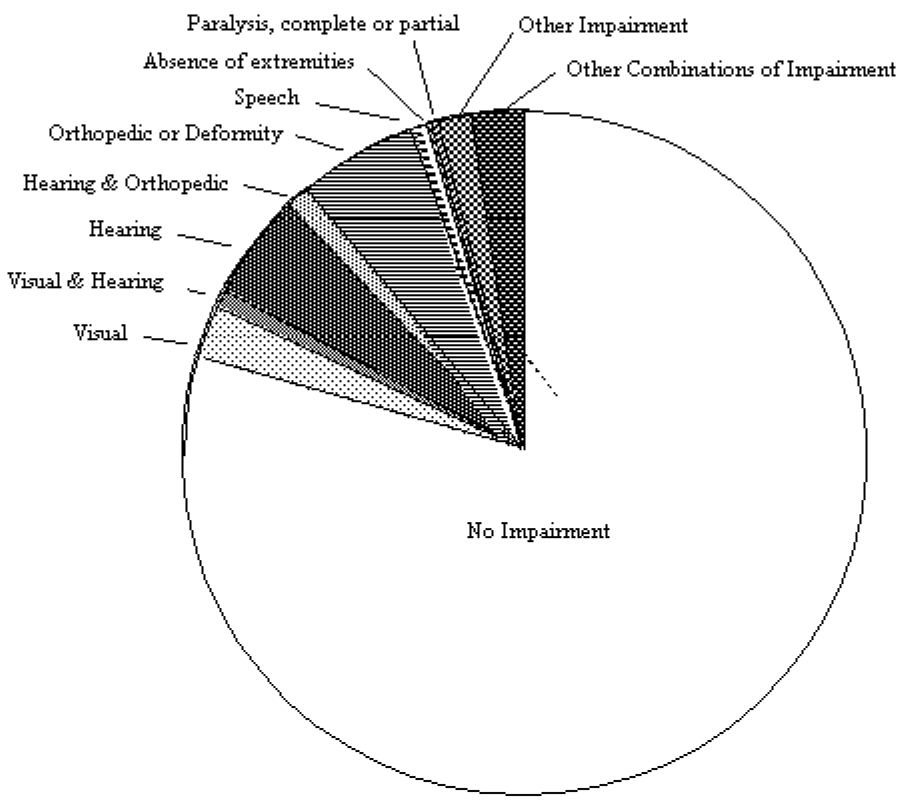
Finally, it is important to distinguish between the number of people that have an impairment and the number with a functional limitation. Impairment is a function of the basic capabilities (or lack thereof) of the individuals themselves. Functional limitation_ is a reflection of the interaction between these impairments and the design (physical, social, etc.) of the world around them. Safer designs might somewhat reduce the number of injuries and therefore the impairment figures. The greater potential for reducing these figures, however, is in reducing the number of people with functional limitations through better design of products, environments and systems. In this paper, both impairment and functional limitation figures are presented. In each case they are labeled as impairment or limitation as well as single dimensional (overlapping) or non-duplicative.

Though individual estimates vary, it appears that there are over thirty million people in the United States who are disabled or have functional limitations due to injury, illness or aging (Kraus & Stoddard, 1989). This is something between 12% and 20% of the population. Many of these individuals also have multiple disabilities.

Although this is a large number, it should be noted that the types and degree of impairment vary widely. Figure 1 shows a breakdown of just the "impairments" data from the 1979 National Health Interview Survey (NHIS). (Numbers within the chart are non-duplicative; however, these individuals may have respiratory, circulatory or other conditions as well.) Because of the diversity of disabilities, the number of individuals with any one particular type or combination of disabilities is much smaller. This makes it more difficult to accommodate this population in the overall design process because of the many dimensions which would need to be considered. The fact that the size of any of these individual populations is quite small (less than 5%) of the total also helps explain how such a large portion of the population can be left out even while designing for the 95th percentile along single dimensions.

Figure 1
Percent of U.S. Population with Selected Impairments

(all ages ; non-institutionalized population)

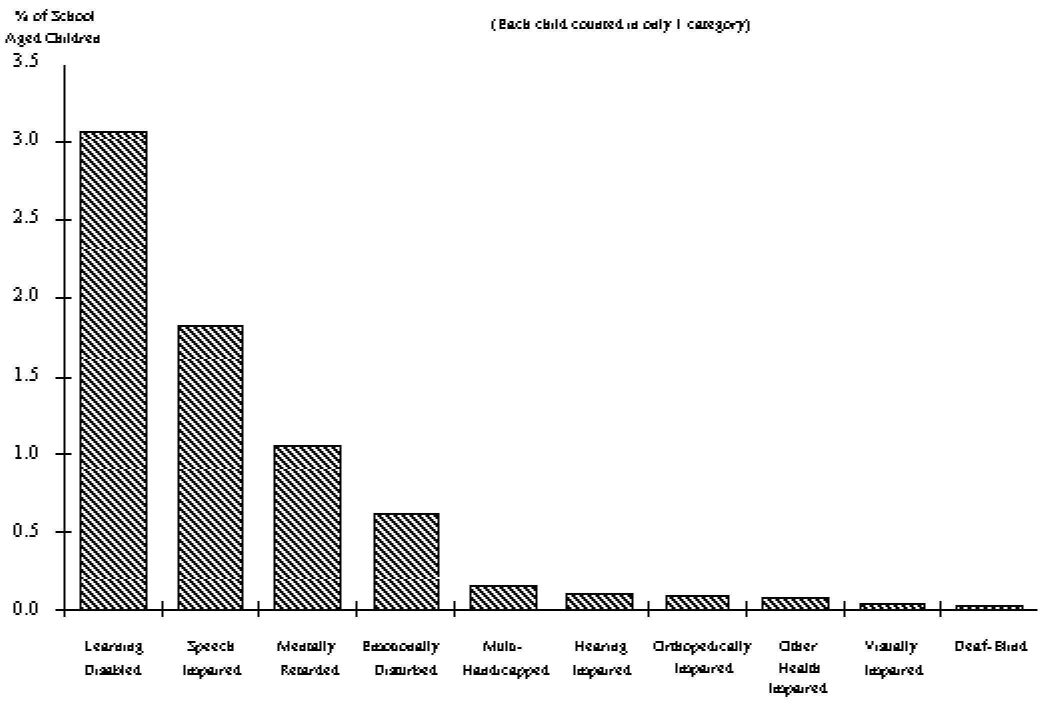


Source: 1979 National Health Interview Survey (NHIS)
Data catagories are exclusive

Figures 2 and 3 provide two different profiles of the population with disabilities. For younger people (Figure 2), the percentage with some of the "classic" types of disabilities (e.g., deafness or blindness) is quite small, while other less easily identified disabilities (e.g., learning disabilities) represent a large portion of the population. Since many of the larger disability groups cannot be addressed directly through physical design, it may appear that the problem is smaller than first thought. Even the small percentages, however, represent fairly large numbers (i.e., millions) of individuals. In addition, proper design of the human interface, especially of information processing equipment, can help to address the problems of persons with language and cognitive impairment as well.

Figure 2

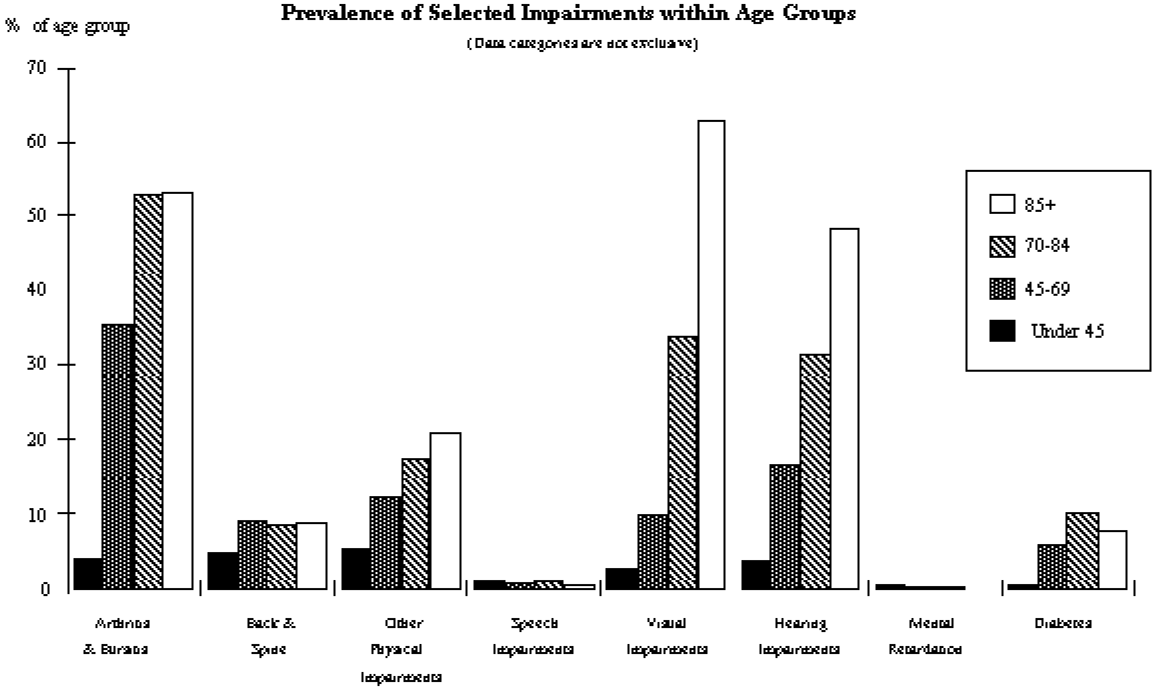
Prevalence of Impairments (Primary Diagnosis) for School Aged Children (3 - 21 yrs)



Source. Kraus & Stoddard (1989). Office of Special Education and Rehabilitation Services 1988,
OSEP state reported data, 1986-87 school year

Figure 3

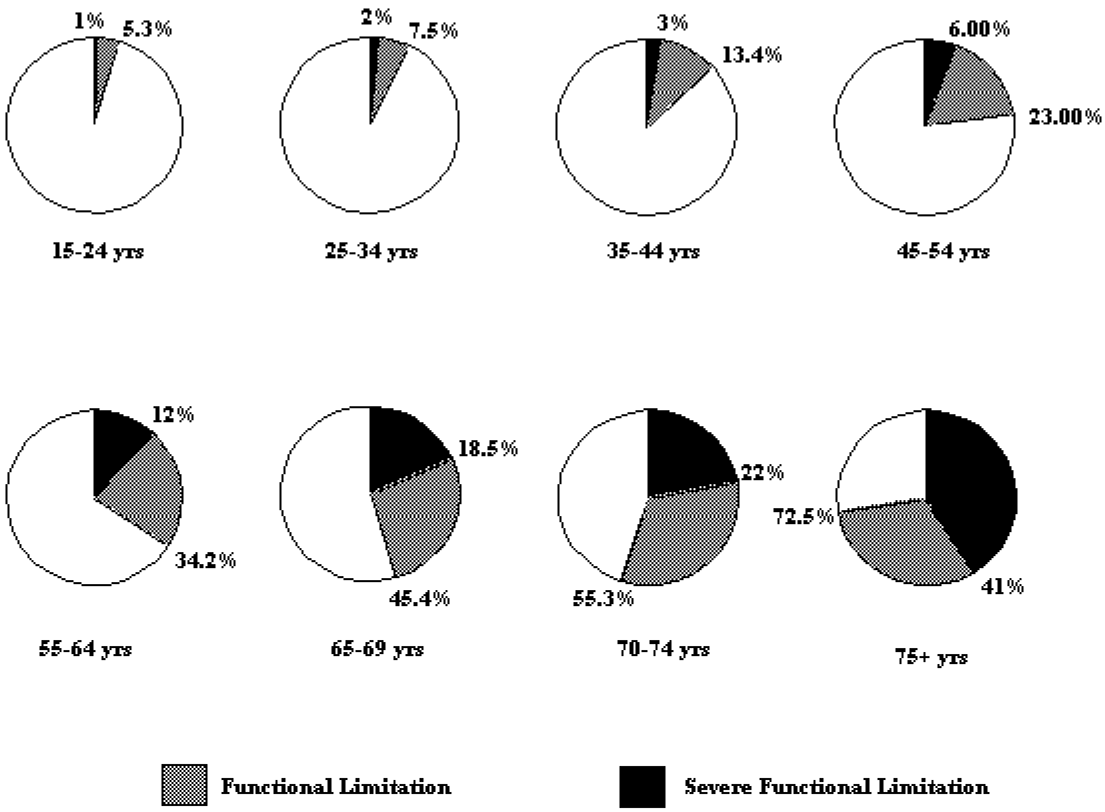
Prevalence of Selected Impairments within Age Groups



Based on data from LaPlante (1988)
Survey. National Health Interview Surveys, 1983-1985. tabulations from public use tapes

Probably the most sobering statistics, however, are those shown in Figures 4 and 5, dealing with aging. For those of us who survive to age 65, we find that the number who have functional limitations will leap up to 45% (based on U.S. statistics). For those of us who survive to age 75 or more, the percentage jumps to a staggering 72.5%. This is particularly important since medical advancements are increasing the life expectancy, making it more probable that we will reach this age. Figure 5 provides a forecast of the aging population over the next 60 years. As can be seen, the portion of the U.S. population that is over 55 grows steadily and is predicted to reach 35% of the population by the year 2050.

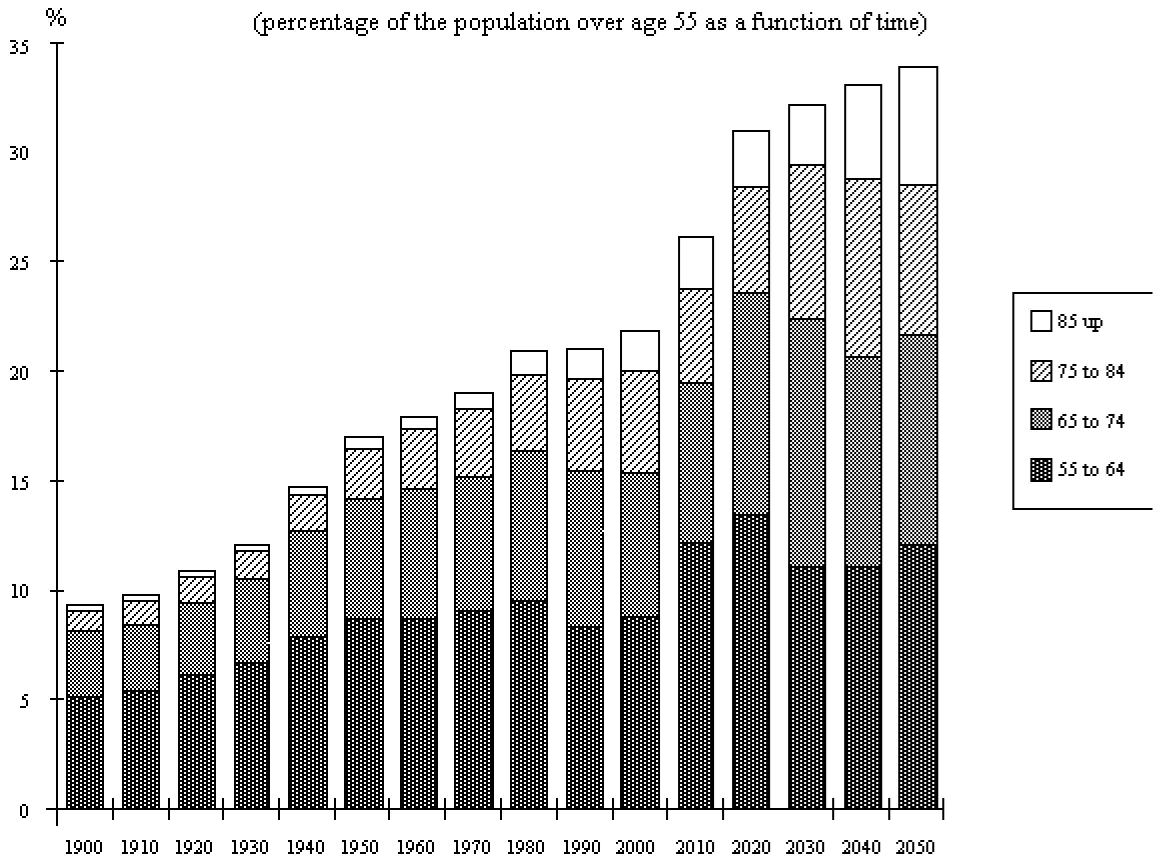
Figure 4
Functional Limitation as a Function of Age



Source: Bureau of the Census, Series P-70, #8
Survey: SIPP, 1984

Figure 5: The Graying of America

(percentage of the population over age 55 as a function of time)



Sources: 1900-1980: U.S. Bureau of the Census, Decennial Censuses of Population. 1990-2050: U.S. Bureau of the Census, Projections of the Population of the United States, by Age, Sex and Race:1983 to 2080. Current Population Reports, Series P-25, No. 952, May 1984. Projections are middle series.

As we look at older populations we also see a shift in the relative percentage of individuals with specific types of disabilities. Comparing Figures 2 and 3, we can see that, although visual and hearing impairments are relatively rare in the younger population, their prevalence increases sharply as we age, dwarfing the major disability categories of youth (learning disabilities, mental retardation, speech impairments). Given the current demographic trends, including the ability of modern medicine to extend the life span, it is clear that an ever-increasing portion of the population (at least for the foreseeable future) is going to be experiencing functional limitations of some sort.

It is interesting to note that the disabled community refers to those without disabilities as "TAB's," or the Temporarily Able-Bodied. All of us are aging and most of us hope to live to be elderly. If we make it, most of us can look forward to experiencing some type of functional limitations sufficient to make operation of the products in our environment (as they are now designed) more difficult or impossible. For most, this transition from able-bodied to disabled is a gradual, continuous process. Thus, design for the mainstream that considers the needs of an aging, and decreasingly able-bodied population, appears particularly worthwhile.

Can't the Needs of Disabled and Elderly Persons Be Handled Separately or As Exceptions?

Although the total number of elderly or disabled persons is large, each individual disability or impairment area represents only a small portion of the population. We are therefore not dealing with one large group of people but with many small groups which together represent a major portion of our population. This raises a question as to the most effective means of addressing these problems. Is it better to design everything so that it is accessible to most persons, including those with disabilities? Or is it more effective to design for the able bodied population and create special designs for persons with specific types of disability?

First we must start with the understanding that it is impractical, if not impossible, to design everything so that it is accessible by everyone regardless of their limitations. Some things have inherently limited usefulness to some populations (e.g., a stereo system for deaf individuals, or a kaleidoscope for blind persons), and accessibility for these products for those disabilities is less of an issue. There are also combinations of impairments which would make adaptation difficult to do on a standard basis (e.g., a deaf-blind-aphasic individual). However, for most types or degrees of impairment there are simple and low cost (or no cost) adaptations to product designs which can significantly increase their accessibility and usefulness to individuals with functional impairments. In these cases, inclusion of the design feature or approach in the standard product can be of substantial benefit to the individual and society as a whole (see further discussion in next section).

Another argument for incorporating accessibility directly into the design of mass market goods stems from the population distribution characteristics of elderly and disabled persons. As shown earlier, the number of persons with disabilities overall is large, but those with specific types of impairment represent a small portion of the total population. These small groups are further divided by the degree of limitation. People with mild hearing loss, for example, would use different techniques and aids from those with severe hearing loss. Thus, the target user groups are too small to be addressed individually. They are also geographically distributed across the U.S. As a result it is both economically impractical and a marketing and support nightmare to design individual appliances (stoves, microwave ovens, mixers, vacuum cleaners, cars, etc.) for each population. Finally, due to aging and other causes, we are all at risk of having to operate our appliances with diminishing functional capabilities over time.

We are therefore left with a balancing act. It is unreasonable to design everything so that it can be used by everyone. It is equally unreasonable to produce special designs for each major consumer product to accommodate the different disability groups. Some special aids and other devices will continue to be necessary to fulfill those needs that accessible mass market design cannot effectively meet. But where mass market goods can easily be made more accessible through careful and informed design, it appears to be the best and most economical approach.

What Can the Human Factors Field Do For This Group?

As human factors researchers, we haven't been directing much effort toward the needs of the disabled and elderly population even though they comprise a large portion of the general population. For example, only a small percentage of the papers in Human Factors Journal has dealt with disability and aging issues. A special issue was produced a number of years ago, and a scattering of papers have appeared over time. Handbooks sometimes include a chapter on aging or disability (Salvendy 1987), but for the most part these issues are not incorporated into the other chapters or into mainstream human factors work as a whole. Disabilities and functional limitations of aging are only peripherally mentioned in our textbooks and rarely included in our data tables. Courses on disability or aging in human factors curricula are rare and usually take the form of special topic seminars. Little or no attention is paid in the standard curriculum to the needs, characteristics or design considerations to accommodate persons with reduced or diminishing abilities.

This lack of focus on those with functional limitations is not because our skills are not applicable to their problems. It also does not appear to be a direct function of insensitivity, although there is room for improvement there. Rather, it seems mostly to be a lack of awareness and a lack of basic knowledge and skills needed to work and teach in this area. Developing this background and expertise would require that we master a much broader range of information than we currently do. It would also require the development of new areas of knowledge, including the types, degrees and implications of disabilities and functional limitations, the demographics for these populations, the psychological and economic aspects of disability, and specific strategies for increasing usability of designs by persons experiencing limitations.

Is It Economically and Practically Feasible to Include Disabled and Elderly Persons in the Design Process for Mass Market Products?

Experience so far has shown that consideration of disabilities and functional limitations in mainstream design is very definitely feasible from both an economic and practical standpoint. In the majority of cases, accessibility can be added to a product's design for little or no cost.

For example, Apple Computer has incorporated several special features directly into their standard operating system to accommodate individuals with various disabilities. One feature, called "Sticky Keys," allows individuals who only have one hand available or who use a head or mouth stick to operate the standard keyboard. Ordinarily, a person typing with a single finger or stick cannot use a keyboard, since it requires that you hold down two or more keys simultaneously for some operations (e.g., control-g or alt-h). The "Sticky Keys" feature allows the person to type the keys sequentially rather than concurrently. It is activated by tapping five times on the shift key and deactivates should any two keys be depressed simultaneously (as a normal typist would). Thus, the feature is transparent to those users who don't need it.

Another feature now standard on Macintosh computers is called "Mouse Keys." Individuals who do not have the motor control necessary to operate a mouse can use the "Mouse Keys" feature to control the mouse cursor on the screen by using the keys on the numeric keypad. A third feature is "CloseView," which allows individuals to enlarge the screen image up to 16 times its normal size. Thus visually impaired individuals may use the computer without special add-on devices.

All of the above features have been standard on all Macintosh computers for the past two years. Once the features were developed, the cost to include them in the product was essentially zero. The "Sticky Keys" and "Mouse Keys" features take up just 4k of space on the disk and are included in every system shipped. The "CloseView" feature is just 20k and is included in the package of system disks shipped with each computer. Even when these same features had to be incorporated directly in the hardware (as they did for the Apple IIGS), the manufacturing cost was negligible (since it simply changed the code in the microcontrollers for the keyboard). Although Apple Computer has taken the early lead in this area, other major computer manufacturers and operating system developers have similar features under development.

Another example of no-cost accommodations can be found on some mass market mixing bowls. These bowls have small braille legends cast onto the underside of the bowl, listing the capacity in braille. Other than a few seconds to cut the dimples into the original mold, there is no additional cost involved in making the bowls. Some microwave manufacturers also offer braille/tactile overlays for their control panels to facilitate their use by blind or visually impaired users. US Sprint has a braille version of its FONE cards.

Accessible Design Can Sometimes Decrease Costs: In some cases, creating a design which is more accessible can in fact decrease the costs involved in manufacture or maintenance/support of a product. One example is to be found in elevator design. Individuals in wheelchairs or on crutches had great difficulty with the large "banks" of elevators present in many buildings. Often the elevator door would open, but before the person in a wheelchair could get to the correct elevator, the door would close. An obvious solution would be for the elevators to stay open for a longer period of time. However, building codes required that a building's floors be visited by the elevators with a specified frequency. If the doors were made to stand open longer, additional elevators would need to be installed in the building to meet the level of service standards. In a building like the Sears Tower, this could result in a substantial portion of the building being consumed by elevators.

On examining the problem more carefully, however, it was noted that the problem was not that individuals in wheelchairs or on crutches were unable to enter an elevator within the time the door normally remained open. The problem was knowing which elevator was coming so they could position themselves in front of its door. By simply reprogramming the elevator's controlling computer it was possible to have the elevator activate the signal tone and light for the proper elevator in advance of its arrival at the floor.

Adopting this advance warning as a standard for elevators solves the accessibility problem without increasing costs. In addition it was found that both disabled and able-bodied persons were able to board the elevator much more rapidly when this advance warning was given. As a result, it was then possible to either decrease the number of elevators and still provide the same level of service to the floors, or to increase the level of service, since the time the elevator is open on a floor could be reduced. Thus, the more accessible design turned out to be less expensive overall.

Disability Design Can Increase the Functionality for Able-Bodied Users: It is very common for accessible designs also to prove beneficial for individuals who do not have limitations (Newell & Cairns, 1987). In the elevator example above, the advance warning not only increased the speed with which the elevators could service the floors, but also made it much easier for normal passengers to maneuver their luggage and board the elevator (i.e., without having to grab one bag and throw it into the elevator door while they retrieved their other bags from in front of the wrong elevator).

Probably the most common example of accessible design is the curb cut. Although the curb cuts are put in for persons in wheelchairs, it is estimated that for every individual in a wheelchair using a curb cut, somewhere between ten and one hundred bicycles, skateboards, shopping carts, baby carriages and delivery carts use the curb cut. It is also not uncommon to see individuals walk slightly out of their paths in order to walk up a curb cut rather than stepping up onto the curb, indicating a preference for the curb cut even when walking.

The "Mouse Keys" feature on the Macintosh computer provides another example. In addition to allowing the user to move the cursor across the screen, the "Mouse Keys" also have a "one pixel" feature. Tapping specific keys on the numeric keypad causes the mouse to move one pixel in the corresponding direction. As a result, it is possible to very precisely position the mouse on the screen. Since the normal mouse continues to be active at all times, it is possible for an able-bodied individual to use the regular mouse for general pointing movements and to move the mouse into the approximate area of interest. He/she can then reach over and tap on the numeric keypad keys (with "Mouse Keys" activated) in order to nudge the cursor the exact number of pixels required for precise positioning. Thus, the "Mouse Keys" feature adds functionality and a precision of movement which was not previously available to able-bodied users.

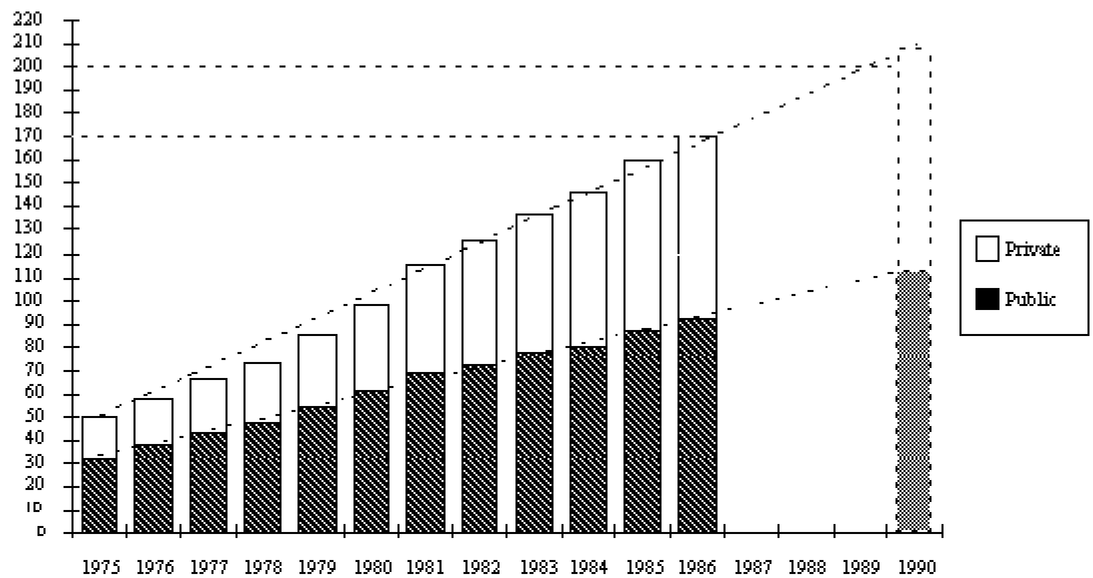
A real-time Palentype (similar to stenotype in the U.S.) translation aid was developed in England to allow a deaf member of Parliament to follow floor debates more easily and precisely. It later found its way into the courtroom for lawyers who could hear normally but wanted transcripts of the day's trial (Newell et al., 1984).

In general, when products, environments or systems are made more accessible to persons with limitations, they are usually easier for more able-bodied persons to use. Some of the potential benefits include lower fatigue, increased speed and lower error rates.

The Consequences of Not Providing Accessible Designs: The benefits above are only half of the economic justification for more accessible design. A second and perhaps more significant economic benefit would be reduction of the costs to society which result from individuals being unable to effectively function independently in the world as it is currently designed. These costs take the form of benefits paid out of tax dollars for special assistance due to a disabled person's unemployment or non-independent living. In addition, there is the loss to society of these individuals' productivity (meaning loss of tax revenues, creation of wealth, and contributions to society).

Overall disability expenditures in the U.S. rose approximately linearly from 50 billion dollars in 1975 to 170 billion dollars in 1986 (Berkowitz & Greene, 1989). Assuming this trend continues, the outlays for 1990 are estimated to exceed 200 billion dollars, as shown in Figure 6. Approximately half of the 1986 cost was for medical treatment, while the other half was for direct transfer payments. (Transfer payments are the actual funds allocated each year to people because of disabilities.) Other economic losses from disability (not including transfer payments) are estimated to have been in excess of 177 billion dollars in 1980 (Chirikos, 1989) (equivalent to 290 billion dollars in 1990 dollars).

Figure 6
Disability Expenditures
Public and Private Sectors



Based on data from Berkowitz and Greene 1989

Approximately one-third of the persons with disabilities who can and would like to work are unemployed. This amounts to approximately two million people (Kraus & Stoddard, 1989). Figuring an average annual salary of $15,000, that amounts to 30 billion dollars in lost productivity, as well as several billion dollars in lost tax revenues. This is in addition to the large costs in the form of transfer payments made to those individuals who cannot live independently.

What Are the "Benefits" of Incorporating Disability and Aging Considerations into Mainstream Human Factors Activities?

As we have seen, considering those with functional limitations in the overall design process is good for the design process overall. Design which is more accessible to persons with disabilities typically can benefit able-bodied users as well by reducing fatigue, increasing speed and decreasing the number of errors made. As in the elevator example, consideration of disability issues can also cause us to see design issues more clearly, leading to new insights and better overall design.

Creating more accessible designs can also increase the market for many consumer products. With increasing awareness of the accessibility issues, people are beginning to look for more accessible designs. The U.S. government, for example, has recently passed legislation (Section 508 of Public Law 99-506) requiring that the General Services Administration develop accessibility guidelines that should apply to all future electronic office equipment acquisitions (purchase or lease). Similar measures are being examined by other countries as well as many school systems and state governments in the U.S.

Accessibility features should begin to provide a market edge even in the home market. Although only one in five or six individuals in the United States has a significant functional limitation, a much higher percentage of households have individuals who have functional limitations. Products purchased for use in a household that has even one member with a disability may be more attractive if their design is more accessible. More accessible design will also increase the useful product life of many products purchased by or for individuals who are aging.

Finally, as noted above, there are tremendous potential economic benefits from making it easier for individuals with functional limitations to live more independently and become or remain employed.

What Are The Costs?

The most significant cost involved in considering functional limitations in mainstream design is that of building the necessary knowledge and skills in our human factors researchers, educators, and practitioners. Before we can include the disability aspects in mainstream research and teaching, we must considerably expand our knowledge base and experience in these areas. This is difficult for most professionals, who already have difficulty keeping up with the literature.

In order to include design for persons with functional limitations in our college curricula, we will need to expand the already overcrowded content of our courses and/or add courses to the already difficult coursework requirements for our students. Since incorporating individuals with limitations in our standard design process does not eliminate the need for custom design of special aids, we must also somehow address custom design for disability to cover the needs that cannot be met through more accessible mass market design.

Conclusion

Incorporating disability considerations in our research and teaching will require substantial effort both as individuals and as a field. Before we can effectively incorporate disability and aging issues into our curriculum we will need to better define and refine this area. The basic principles involved in accessible design need to be explored and defined. More specific data regarding the different areas of impairment as they relate to design need to be gathered, condensed and made available to researchers and designers. Some design guidelines exist (Lifchez & Winslow, 1979; Sorenson, 1979; Newell, 1987; Newell & Cairns, 1987; Calkins, 1988; Vanderheiden, 1988; Enders & Hall, 1990; Mueller, 1990) but much more work is needed in the delination and documentation of the basic principles of accessible design.

It seems apparent, however, from the demographics and trends in our population, that for an increasing number of the professionals and educational programs in human factors, design for disability and aging must merge with, and become a continuum of, the normal design process. Aside from the significant benefits to society, these efforts should also make our field more robust and lead it into new directions and to new insights.

Acknowledgements

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