The Universal Design File: Designing for People of All Ages and Abilities

Abstract: The Universal Design File discusses the history of universal design and provides excellent illustrations of each principle. Seven in-depth case studies are profiled. This book was the first comprehensive look at the concept and application of universal design in products and the built environment.

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Chapter 1

A Brief History of Universal Design

A Brief History of Universal Design

Like a bean sprout that emerges only after its root is deep and strong, universal design has its beginnings in demographic, legislative, economic, and social changes among older adults and people with disabilities throughout the 20th century.

Changing Demographics

At the beginning of the 20th century, older adults and people with disabilities were true minorities. The average human lifespan was only 47 years, and people who received spinal cord injuries had only a 10% chance of survival. Most people with chronic conditions lived in nursing institutions.

People are living longer today. The average lifespan has increased to 76, largely due to healthier living, better medicine, and vaccines and sanitation that have virtually eliminated many killer infectious diseases (*The Denver Post*, 1998). Nearly 80% of the population now lives past the age of 65. Projections based on U.S. Census Bureau estimates indicate that the number of persons ages 65 and over will grow to almost 40 million by the year 2010 (Jones and Sanford, 1996). Last year, 4 million people in the United States were over the age of 85 and about 60,000 topped age 100. By 2020, the Census Bureau estimates that 7 million to 8 million people will be over age 85 and 214,000 will be over age 100. By contrast, at the end of World War II, only 1 in 500 made it to age 100 (*The Denver Post*, 1998).

In addition, more people are now living with disability. Two world wars created a huge population of veterans with disabilities, and antibiotics and other medical advances enabled people to survive accidents and illnesses which were previously fatal. At the end of 1994, 53.9 million people in the United States (20.6% of the population) had some level of disability (Figure 1), and 26.0 million (9.9%) had a severe disability. It is estimated that among the population 6 years and over, 8.6 million people had difficulty with one or more activities of daily living (ADLs) and 4.1 million needed personal assistance of some kind (McNeil, 1997).

These demographic changes result in a population that is older and more disabled than many realize, and these trends continue. The limitations imposed by products and environments designed and built without regard to the needs and rights of all American citizens are significant but often unrecognized.

Public acknowledgment of people with disabilities and progress toward universal design has developed in the last few decades along three parallel tracks of activities: legislation fueled by the disability rights movement, the barrier-free design to universal design movement, and advances in rehabilitation engineering and assistive technology.

Federal Legislation

The Civil Rights Movement of the 1960s inspired the subsequent Disability Rights Movement that greatly influenced the legislation of the 1970s, 1980s, and 1990s. These new laws prohibited discrimination against people with disabilities and provided access to education, places of public accommodation, telecommunications, and transportation.

The barrier-free movement in the 1950s began a process of change in public policies and design practices. The movement was established in response to demands by disabled veterans and advocates for people with disabilities to create opportunities in education and employment rather than institutionalized health care and maintenance. Physical barriers in the environment were recognized as a significant hindrance to people with mobility impairments.

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Efforts of the Veterans Administration, The President's Committee on Employment of the Handicapped, and the National Easter Seals Society, among others, resulted in development of national standards for "barrier-free" buildings. In 1961, the American Standards Association (later known as The American National Standards Institute, or ANSI), published the first accessibility standard titled, "A 117.1 – Making Buildings Accessible to and Usable by the Physically Handicapped." These standards were not enforceable, however, until adopted by state or local legislative entities.

A number of states responded with their own accessibility standards, and by 1966, 30 states had passed accessibility legislation; by 1973, the number was up to 49 states. Individual federal agencies attempted to provide minimum access through additional regulations and standards. This resulted in numerous, often differing accessibility guidelines. An attempt to "standardize" these federal guidelines occurred in 1984 when the ANSI specifications were incorporated into the Uniform Federal Accessibility Standard (UFAS).

Significant federal legislation began to be passed in the late 1960s, including the following:

> The <u>Architectural Barriers Act of 1968</u> mandated the removal of what was perceived to be the most significant obstacle to employment for people with disabilities: the physical design of the buildings and facilities they had to use on the job. The Act required all buildings designed, constructed, altered, or leased with federal funds to be made accessible.
>
> <u>Section 504</u> of the <u>Rehabilitation Act of 1973</u> was the first civil rights law for people with disabilities. This Act made it illegal to discriminate on the basis of disability and applied to federal agencies, public universities, federal contractors, and any other institution or activity receiving federal funds. The promulgation of regulations was initially stalled by the U.S. Department of Health, Education and Welfare. In protest, disability rights advocates held numerous demonstrations. As a result, regulations were finally issued in 1977.

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The Education for Handicapped Children Act of 1975 (now called the Individuals with Disabilities Education Act, or IDEA) guaranteed a free, appropriate education for all children with disabilities. This Act had an effect on educational programs as well as on the facilities in which they were conducted.

The Fair Housing Amendments Act of 1988 expanded the coverage of the Civil Rights Act of 1968 to include families with children and people with disabilities. The Act required accessible units be created in all new multi-family housing with four or more units, both public and private, not just those that received federal funds. Accessibility Guidelines were issued by the U.S. Department of Housing and Urban Development in 1991 to facilitate compliance.

The Americans with Disabilities Act of 1990 (ADA) awakened widespread public awareness of the civil rights of people with disabilities. Discrimination in employment, access to places of public accommodation, services, programs, public transportation, and telecommunications is prohibited by this law. Physical barriers that impede access must be removed wherever they exist. The ADA has a uniform nationwide mandate that ensures accessibility regardless of local attitudes. The Architectural and Transportation Barriers Compliance Board (Access Board) issued Accessibility Guidelines for accessible design in 1991. These guidelines were adopted with modifications by the U.S. Department of Justice and became the enforceable ADA Standards for Accessible Design.

The Telecommunications Act of 1996 mandates that telecommunications services and equipment and customer premises equipment be “designed, developed, and fabricated to be accessible to and usable by individuals with disabilities, if readily achievable.” It applies to all types of telecommunications devices and services, from telephones to television programming to computers.

A Brief History of Universal Design

Federal legislation began as requirements for minimum accessibility to small percentages of facilities and features, which lawmakers felt was sufficient. It has progressed to providing full access to public and private programs and facilities and has begun to affect devices and services in the home.

Barrier-Free to Universal Design

Early on, advocates of barrier-free design and architectural accessibility recognized the legal, economic, and social power of a concept that addressed the common needs of people with and without disabilities. As architects began to wrestle with the implementation of standards, it became apparent that segregated accessible features were "special," more expensive, and usually ugly. It also became apparent that many of the environmental changes needed to accommodate people with disabilities actually benefited everyone. Recognition that many such features could be commonly provided and thus less expensive, unlabeled, attractive, and even marketable, laid the foundation for the universal design movement.

Rehabilitation Engineering and Assistive Technology

Rehabilitation engineering and assistive technology emerged in the middle of the 20th century. Efforts to improve prosthetics and orthotics intensified with the return of thousands of disabled veterans from World War II in the 1940s. During the 1950s, engineering research centers sponsored by the Veterans Administration and other federal organizations were established to address other technological problems of rehabilitation, including communication, mobility, and transportation. Rehabilitation engineering centers expanded during the 1960s and 1970s.

Rehabilitation engineering became a specialty that applied scientific principles and engineering methodologies to these problems. The label, "assistive technology," was applied to devices for personal use created specifically to enhance the physical, sensory, and cognitive abilities of people with disabilities and to help them function more independently in environments oblivious to their needs.

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Intersecting Paths

Though coming from quite different histories and directions, the purpose of universal design and assistive technology is the same: to reduce the physical and attitudinal barriers between people with and without disabilities.

Universal design strives to integrate people with disabilities into the mainstream and assistive technology attempts to meet the specific needs of individuals, but the two fields meet in the middle. In fact, the point at which they intersect is a gray zone in which products and environments are not clearly “universal” or “assistive,” but have characteristics of each type of design. A number of products have enjoyed crossover success, often starting as assistive devices and becoming mainstream products, such as the kitchen utensils with thick grips popularized by Oxo International in their “Good Grips” line. A few products have moved the other way, typically conceived as high-tech devices for small markets that find new application in the rehabilitation arena, such as voice recognition software.

The potential benefit of cooperation between professionals in both fields is exciting but mostly untapped. Commercial designers have much to learn from rehabilitation technologists familiar with the ergonomics of disability and aging. Rehabilitation technologists and their clients can benefit from designers’ expertise in creating products and environments that are functional, safe, attractive, and marketable for a wide diversity of users.

Changing Economics

The economic downturn of the 1980s had a negative impact on funds for rehabilitation engineering research and the removal of environmental barriers. At the same time, product manufacturers were beginning to recognize the market-broadening potential of more accommodating products.

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In 1988, New York City's Museum of Modern Art exhibit, "Designs for Independent Living," featured products selected for their beauty as well as their consideration of the needs of older adults and people with disabilities. Selections included products from the United States, Denmark, England, Italy, Netherlands, and New Zealand. It was clear that the commercial world was beginning to acknowledge aging individuals and people with disabilities as viable customers.

In 1990, Oxo International introduced its Good Grips kitchen utensils for people who were limited by arthritis. These upscale products immediately found an enthusiastic audience, even though their advantages over utensils with oversized handles sold through assistive technology suppliers were primarily aesthetic. Oxo International grew at a 40% to 50% annual rate from 1990 to 1995, to $20 million a year. Other companies quickly copied their approach.

Another emerging economic trend is the increasing "globalization" of the marketplace. Consumer businesses hoping to remain successful in the coming decades must recognize the opportunities and challenges inherent in global competition. While the size of potential customer markets is growing, the diversity of the consumer base is expanding at the same time to include differences in language and culture, customs, experiences, and historical design precedents. All of these increase the need for design that is sensitive to individual abilities and preferences.

Because reasonable cost is a fundamental issue in any design and production process, universal design has become a very marketable approach, since it addresses the diverse needs of a majority of consumers.

Changing Social Climate

Throughout history, community attitudes and physical barriers in the built environment have prevented people with disabilities from fully participating in society. Access to education, employment, housing, recreation, cultural events, and transportation has been denied many people. Along with the growth in the disabled population, the quest for independence and equal rights has grown, as well.

Buyers of assistive technology now demand that products be designed with concern for their impact on the image, as well as the function, of the user. Devices are expected to be appropriate for use at the office or school, at home, in the community, and on vacation.

Similarly, aging members of the baby-boom generation (those born between the years 1946 and 1964) have begun to see the usefulness of products conceived for people with limitations. In a 1990 issue of *Capturing Customers*, Peter Francese noted, "As more Americans age, products that offer youthfulness without denigrating aging will do well. These consumers are not like their parents – they don't feel that older is ugly" (American Association of Retired Persons, 1992).

The Future

At the end of the 20th century, the world is very different than 100 years ago. People are living longer and surviving better. Potential consumers of design who may be functionally limited by age or disability are increasing at a dramatic rate. These populations are no longer an insignificant or silent minority.

The current generation of children, baby boomers entering middle age, older adults, people with disabilities, and individuals inconvenienced by circumstance, constitute a market majority. All of these constituencies and indeed, all consumers, deserve to be recognized and respected. Facilities, devices, services, and programs must be designed to serve an increasingly diverse clientele.

The demographic, legislative, economic, and social changes that brought us to this point are increasing the momentum that will propel us into a 21st century that will need to be more accommodating of individual differences. Universal design provides a blueprint for maximum inclusion of all people.

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2

Chapter

Understanding the Spectrum of Human Abilities

Understanding the Spectrum of Human Abilities

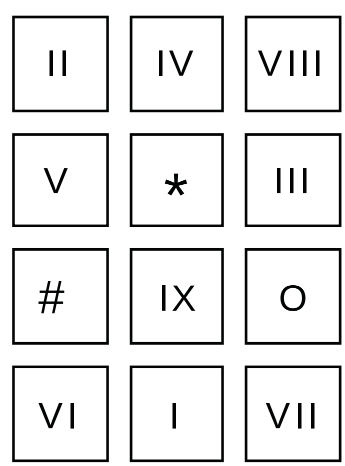
Each of us is unique in age, size, abilities, talents, and preferences. Any human characteristic that can be measured spans a broad range in any population. An understanding of human diversity is critical to designing effectively. Successful application of universal design principles requires an understanding of how abilities vary with age, disability, the environment, or the circumstances.

Human abilities can be grouped into the following categories: cognition, vision, hearing and speech, body function, arm function, hand function, and mobility. The following sections describe how variations in each of these areas may affect design usability, the types of people who may use a design, and ways to test a product or environment to assess its broad usability.

Universal Design and Cognition

1. How cognition affects design usability...

Imagine if your telephone's keypad were arranged as shown at right:



Roman numerals are foreign to the keypad design, as is the jumbled layout. Most people could probably still place a call, but it would put more demand on their thought processes. Everyone would require more time to use this keypad, and probably make more mistakes because of the cognitive "mapping" each of us has internalized from making countless phone calls with conventional keypads.

Obviously, using this design is even more difficult for individuals who do not understand Roman numerals, or who have cognitive limitations and difficulty doing things in a non-standard way.

2. **Universal design for cognition means considering the variety of human abilities in receiving, comprehending, interpreting, remembering, or acting on information. This includes:**

- self-starting; initiating tasks without prompting
- reacting to stimuli; response time
- paying attention; concentration
- comprehending visual information
- comprehending auditory information
- understanding or expressing language
- sequencing; doing things in proper order
- keeping things organized
- remembering things, either short- or long-term
- problem-solving; decision-making
- creative thinking; doing things in a new way
- learning new things

3. **Cognition can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:**

- very young children, with limited vocabulary, grammar, and reasoning skills
- individuals with limited literacy
- individuals using foreign languages or having different cultural backgrounds
- older adults with diminished memory and reasoning skills
- individuals who are fatigued or distracted

- individuals with limited comprehension, memory, concentration, or reasoning due to:
  - retardation
  - Down's syndrome
  - learning disabilities
  - head injuries
  - stroke
  - Alzheimer's disease

4. **Assess the effectiveness of a design for cognition by answering the following questions. Is the design still as usable and safe if you…**
   - are using it for the first time without help or instructions?
   - cannot read?
   - perform steps out of order?
   - try to use it much faster or slower than intended?
   - make a mistake and want to correct it or start over?
   - are distracted or interrupted while using it?

Universal Design and Vision

1. **How vision affects design usability…**

If you do not have a vision impairment, consider the following circumstances.

Try reading a book at the beach without sunglasses, finding your way after walking out of a movie theater into bright daylight, or driving toward the sun. You will experience the limiting effects of glare. Try getting a key into your front door in the dark, reading a detailed road map in your car at night, or finding the light switch in a dark room. You will appreciate the limitations caused by inadequate light.

When you're lost and struggling to find a specific road sign, all signs may seem small and hard to locate. How much more difficult would this be if your glasses or windshield were badly smudged?

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How difficult would it be to find the sign if you could not move your neck, used only one eye, or viewed the world through a cardboard tube?

The scenarios described above may cause anyone to make mistakes, slow down, get help, or avoid even simple tasks because the demand on visual capabilities is too great, whether temporarily or permanently.

2. Universal design for vision means considering the variety of human abilities in perceiving visual stimuli. This includes:

- perceiving visual detail clearly
- focusing on objects up close and far away
- separating objects from a background
- perceiving objects in the center, as well as at the edges of the field of vision
- perceiving contrasts in color and brightness
- adapting to high and low lighting levels
- tracking moving objects
- judging distances

3. Vision can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:

- individuals distracted by a “busy” visual environment
- individuals fatigued from excessive visual tasks
- individuals functioning under colored lighting or very high or very low lighting conditions
- individuals functioning in adverse weather conditions
- older adults and others with:
  - blindness
  - hereditary loss of vision
  - cataracts
  - glaucoma
  - retinitis
  - presbyopia (farsightedness after middle age)
  - macular degeneration
  - eye injuries

4. Assess the effectiveness of a design for vision by answering the following questions. Is the design still as usable and safe if you...

- view it in very low light?
- view it in very bright light?
- view it much closer or further away than intended?
- could see it only in black and white?
- view it through a tube?
- view it with one eye closed?
- view it using only peripheral vision?

Universal Design and Hearing and Speech

1. How hearing and speech affect design usability...

If you do not have a hearing impairment, consider the following circumstances.

Have you ever struggled to determine where a siren was coming from while driving with the radio on? Has the congestion from a head cold, especially if you did any airline traveling, ever left you temporarily impaired in hearing, speech, or even balance?

Try giving directions to someone across a busy street. Try following verbal instructions while listening to music through headphones. Much of the message may get lost or confused in the ambient sound.

If you have ever used a cordless or cellular phone in a car, a shopping mall, or the airport, you have had the experience of trying to hold a conversation amid background noise and other distractions. In addition, the variable quality of transmission often causes lapses in communication or even interference from other conversations.

The situations described above can cause anyone to miss important information, repeat messages, rely on other sensory input, or just give up because the demands on auditory capabilities are too great, whether temporarily or permanently.

2. **Universal design for hearing and speech means considering the variety of human abilities in perceiving auditory stimuli. This includes:**
   - localizing the source of sound
   - separating auditory information from background sound
   - perceiving both high- and low-pitched sounds
   - carrying on a conversation

3. **Hearing and speech can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:**
   - individuals whose attention is divided among several auditory sources
   - individuals functioning in very noisy environments
   - individuals using headphones
   - older adults and others with:
     - deafness
     - hereditary loss of hearing
     - blockages in the route to the inner ear
     - damage from prolonged exposure to excessive noise
     - diseases
     - presbycusis (reduction of hearing in older age)
     - head injuries or stroke

4. **Assess the effectiveness of a design for hearing by answering the following questions. Is the design still as usable and safe if you...**
   - use it in a noisy environment?
   - use it with one ear plugged?
   - use it with both ears plugged?
   - eliminate the sounds of the letters c, ch, s, sh, f, and z?

Universal Design and Body Functions

1. How body function affects design usability...

If your body is non-disabled, consider the following circumstances.

Imagine working in a chair with one missing caster. With every change in posture, you might lose your balance. This would affect your concentration and productivity and might cause you to avoid changing body position.

Try doing your job from a straight-back chair with your spine firmly against the seat back and your feet on the floor. Retain that position without twisting or bending as you try to retrieve materials from your desk, use the telephone, and perform other simple everyday tasks. Limitations to your reach, field of vision, and mobility make simple tasks more difficult and eventually cause fatigue and pain from the lack of range of motion.

Perhaps you have carried a bulky object up or down a flight of stairs. The added weight made balance more difficult and the object may have prevented you from using the railings for support or even seeing the steps in front of you.

Remember the last time you had the flu. Even the simplest tasks were exhausting, and it was difficult to concentrate on anything for very long. Getting up from the bed or a chair required a few extra seconds for you to clear your head and keep your balance. If you took any medication, these effects may have been more pronounced and prevented you from even attempting other tasks, such as driving.

Consider the difficulty of strenuous exercise on a very hot summer day.

In each of the situations described above, the demands of the tasks may exceed human capabilities to some extent, making the task inconvenient, frustrating, exhausting, dangerous, or impossible.

2. **Universal design for body function means considering the variety of human abilities in performing common tasks. These tasks include cardiovascular, musculoskeletal, and central nervous system functions such as:**
    - physical exertion
    - achieving, maintaining, and changing posture
    - maintaining equilibrium
    - breathing

3. **Body function can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:**
    - very young children, with limited physical development
    - older adults with diminished stamina, balance, or other body functions
    - individuals of extreme body size or weight
    - women in later stages of pregnancy, whose balance is affected by the weight of the baby
    - individuals with pain or limited range of motion due to temporary or minor injuries or illness
    - individuals under adverse environmental conditions (e.g., bad weather, extremes of temperature, poor air supply, unstable footing)
    - individuals who are fatigued or ill
    - individuals with chronic limitations due to:
        - epilepsy or other seizure disorders
        - allergies
        - multiple chemical sensitivities
        - asthma
        - diabetes
        - arthritis
        - musculoskeletal injuries or illness
        - hernia
        - stroke

4. Assess the effectiveness of a design for body function by answering the following questions. Is the design still as usable and safe if you...

- have shortness of breath?
- stop frequently to rest?
- need to lean on something for support while using it?
- cannot bend, stoop, or twist at the waist?
- use it only in a seated position?
- cannot turn your head?
- are sensitive to dust, fumes, smoke, or chemicals?

Universal Design and Arm Function

1. How arm function affects design usability...

If your arms are unimpaired, consider the following circumstances.

Think of objects you regularly reach for, lift, and carry. Some ordinary household products weigh more than you might guess. A six-pack of 12-oz. cans and a ream of paper each weigh over 5 lbs. One-gallon containers of milk or juice weigh about 8 lbs. each, and cartons of detergent up to 20 lbs. each. Could you move these products using only one arm? How would you reach them if you could not straighten your arms to reach forward, up, or down?

What about other ordinary tasks like driving, cooking, eating, drinking a cup of coffee, or opening a window? Think about the last time you experienced pain in a shoulder or elbow. How did it affect the way you performed these everyday tasks? How would your strength and movements be limited if you constantly wore a 3-lb. weight on each wrist?

In each of the situations described above, the demands of the tasks may exceed human capabilities to some extent, making the task inconvenient, frustrating, exhausting, dangerous, or impossible.

2. Universal design for arm function means considering the variety of human abilities in upper extremity range of motion, coordination, and strength. This includes:

- reaching up, down, forward, or behind
- pushing
- pulling
- lifting
- lowering
- carrying

3. Arm function can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:

- very young children, with limited physical development
- older adults with diminished joint range of motion or strength
- individuals with pain or limited range of motion due to temporary or minor injuries or illness
- individuals who are fatigued
- individuals with only one free arm due to carrying things or performing another task
- individuals wearing thick clothing
- individuals with chronic limitations due to:
  - congenital loss or deformation of an arm
  - cerebral palsy
  - post-poliomyelitis
  - muscular dystrophy
  - multiple sclerosis
  - Lou Gehrig's disease (amyotrophic lateral sclerosis, or ALS)
  - Parkinson's disease
  - spinal cord injuries
  - amputations
  - arthritis
  - bursitis
  - tendonitis
  - stroke

4. **Assess the effectiveness of a design for arm function by answering the following questions. Is the design as usable and safe if you…**
   - wear 3-lb. weights on each wrist?
   - hold your elbows against your body?
   - use only your non-dominant arm?

Universal Design and Hand Function

1. **How hand function affects design usability…**

If your hands are unimpaired, consider the following circumstances.

Consider how much you depend on use of both hands. Using only one hand, try hammering a nail, tying a shoe, or placing a telephone call. Try dialing a mobile phone while driving.

Try turning a door knob with oily or wet hands, or when carrying packages.

Try using only your non-dominant hand for precision tasks such as using scissors, cutting food, or shaving. Try doing these tasks while wearing mittens.

Perhaps you have experienced a minor cut or burn that temporarily limited your ability to open a jar, squeeze a tube of toothpaste, operate a faucet, or hold a cup of coffee.

In each of these situations, the demands of the tasks may exceed human capabilities to some extent, making the task inconvenient, frustrating, exhausting, dangerous, or impossible.

2. **Universal design for hand function means considering the variety of human abilities required to perform common tasks.**
These tasks include:
   - grasping
   - squeezing
   - rotating
   - twisting
   - pinching
   - pulling
   - pushing

3. **Abilities of hand function can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:**
   - very young children, with small hands and weak fingers
   - older adults with diminished joint range of motion or strength
   - individuals with pain or limited range of motion due to temporary or minor injuries or illness
   - individuals whose hands are fatigued from repetitive tasks
   - individuals wearing gloves
   - individuals with wet or oily hands
   - individuals with only one free hand due to simultaneously performing another task
   - individuals with chronic limitations due to:
     - congenital loss or deformation of a hand
     - cerebral palsy
     - post-poliomyelitis
     - muscular dystrophy
     - multiple sclerosis
     - Lou Gehrig's disease (amyotrophic lateral sclerosis, or ALS)
     - Parkinson's disease
     - spinal cord injuries
     - amputations
     - carpal tunnel syndrome
     - arthritis
     - stroke

4. **Assess the effectiveness of a design for hand function by answering the following questions. Is the design as usable and safe if you…**
   - wear mittens?
   - repeat no motion more than three times per minute?
   - do not bend or rotate your wrists?
   - use only one hand?
   - use only the fist of your non-dominant hand?
   - exert no more force than the strength in your little finger?

Universal Design and Mobility

1. **How mobility affects design usability…**

If your legs are unimpaired, consider the following circumstances.

Consider driving your car without using your legs. Without walking, how could you get to work? Could you do your job without leaving a seated position? What if there are stairs along the way?

Consider the difficulty of maintaining your balance while walking or standing in an airplane, subway car, or bus. Imagine having this difficulty even on stable ground.

Remember the last time you walked a long distance or ascended a long flight of stairs and how the fatigue affected your stability. Did you tend to use the railings more toward the end? Consider how carefully you use stairs that are slippery with water or ice, and how dangerous it is when you lose your balance on stairs.

Notice the different ways people walk on different surfaces. Grass, sidewalks, loose gravel, carpeting, and tile floors each require a different gait to maintain balance and avoid tripping or slipping. When surfaces change unexpectedly, falls can result.

If you've ever injured a leg and used crutches, you realize the additional time and effort required to cover distances, especially if stairs, revolving doors, or slippery floors were in your way.

Understanding the Spectrum of Human Abilities

You may have also learned the importance of space to elevate or straighten your leg or maneuver a wheelchair. As you recovered, you learned the value of grab bars and sturdy surfaces to lean on.

In each of the situations described above, the demands of the tasks may exceed human capabilities to some extent, making the task inconvenient, frustrating, exhausting, dangerous, or impossible.

2. Universal design for mobility means considering the variety of human abilities in performing common tasks. These tasks include:

- rising from a seated position
- standing upright
- walking
- running
- jumping
- climbing
- kneeling
- balancing on one foot
- operating foot controls

3. Mobility can vary widely according to age, disability, the environment, or the particular situation. This variability should be considered when the design population may include:

- very young children, with limited physical development
- older adults with diminished strength, stamina, balance, range of motion in spine and lower extremities, or proprioception (sensing the positions of body parts and the motions of the muscles and joints)
- individuals of extreme body size or weight
- individuals with pain or limited range of motion due to temporary or minor injuries or illness
- individuals who are fatigued
- individuals under adverse environmental conditions (e.g., bad weather, uneven or unstable terrain)

- individuals with chronic limitations due to:
  - congenital loss or deformity of a leg
  - cerebral palsy
  - post-poliomyelitis
  - muscular dystrophy
  - multiple sclerosis
  - cerebral vascular disease
  - diabetes
  - Lou Gehrig's disease (amyotrophic lateral sclerosis, or ALS)
  - Parkinson's disease
  - amputations
  - spinal cord injury
  - arthritis
  - stroke
  - asthma, emphysema, or other respiratory complications

4. **Assess the effectiveness of a design for mobility by answering the following questions. Is the design as usable and safe if you…**
   - cannot see the floor surface?
   - cannot lift either foot?
   - wear two different shoes (different heel heights and sole friction)?
   - use a cane?
   - use crutches?
   - use a wheelchair?
   - cannot rise from a seated position?

3 chapter

The Principles of Universal Design and Their Application

The Principles of Universal Design and Their Application

Universal design is simple in theory but more complicated in practice, and simply defining the term is not sufficient. Proponents of universal design have traditionally employed two strategies to communicate the approach. The first method has been through citation of good examples of aspects of the concept, such as lever door handles that require no grasping, remote controls to adjust devices from afar, and motion detecting room lights. The second strategy has been to offer time-proven tests for universal use, such as determining whether a device "can be used with a closed fist," or "can be used in the dark," or "requires 5 lbs. or less of force." There were no definitive criteria covering all aspects of any design.

Staff of The Center for Universal Design, as part of its project "Studies to Further the Development of Universal Design," conducted a series of evaluations of consumer products, architectural spaces, and building elements. The purpose of the evaluations was to determine optimal performance characteristics and use features that make products and environments usable by the greatest diversity of people.

The Center's staff then convened a working group of architects, product designers, engineers, and environmental design researchers to assemble a set of principles of universal design that would encapsulate the existing knowledge base. These principles would apply to all design disciplines and all people. The principles could be applied to evaluate existing designs, guide the design process, and educate designers and consumers about the characteristics of more usableproducts and environments.

The Principles of Universal Design and Their Application

The Principles of Universal Design (The Center for Universal Design, 1997) developed by this group are presented here in the following format:

name of the principle, intended to be a concise and easily remembered statement of the key concept embodied in the principle;

definition of the principle, a brief description of the principle's primary directive for design; and

guidelines, a list of the key elements that should be present in a design that adheres to the principle. (Note: all guidelines may not be relevant to all designs.)

Following each guideline are two to five photographs that demonstrate good applications of the guideline. The designs shown in the photos are not necessarily universal in every respect, but each is a good example of that specific guideline and helps illustrate its intent.

References

The Center for Universal Design. (1997). *The Principles of Universal Design* (Version 2.0). Raleigh, NC: NC State University, Author.

The Principles of Universal Design

by Bettye Rose Connell, Mike Jones, Ron Mace, Jim Mueller, Abir Mullick, Elaine Ostroff, Jon Sanford, Ed Steinfeld, Molly Story & Gregg Vanderheiden

PRINCIPLE ONE: Equitable Use

The design is useful and marketable to people with diverse abilities.

Guidelines:

1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.
1b. Avoid segregating or stigmatizing any users.
1c. Make provisions for privacy, security, and safety equally available to all users.
1d. Make the design appealing to all users.

PRINCIPLE TWO: Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

Guidelines:

2a. Provide choice in methods of use.
2b. Accommodate right- or left-handed access and use.
2c. Facilitate the user's accuracy and precision.
2d. Provide adaptability to the user's pace.

PRINCIPLE THREE: Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Guidelines:

3a. Eliminate unnecessary complexity.
3b. Be consistent with user expectations and intuition.
3c. Accommodate a wide range of literacy and language skills.
3d. Arrange information consistent with its importance.
3e. Provide effective prompting and feedback during and after task completion.

PRINCIPLE FOUR: Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Guidelines:

4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
4b. Maximize "legibility" of essential information.
4c. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
4d. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

PRINCIPLE FIVE: Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Guidelines:

5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
5b. Provide warnings of hazards and errors.
5c. Provide fail safe features.
5d. Discourage unconscious action in tasks that require vigilance.

PRINCIPLE SIX: Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

Guidelines:

6a. Allow user to maintain a neutral body position.
6b. Use reasonable operating forces.
6c. Minimize repetitive actions.
6d. Minimize sustained physical effort.

PRINCIPLE SEVEN: Size and Space for Approach and Use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Guidelines:

7a. Provide a clear line of sight to important elements for any seated or standing user.
7b. Make reach to all components comfortable for any seated or standing user.
7c. Accommodate variations in hand and grip size.
7d. Provide adequate space for the use of assistive devices or personal assistance.

PRINCIPLE ONE:

Equitable Use

The design is useful and marketable to people with diverse abilities.

GUIDELINE 1A:

Provide the same means of use for all users: identical whenever possible; equivalent when not.

Reception desk makes information accessible to all visitors, regardless of visual abilities, through provision of tactile and high-contrast maps.

1a1

Door handles on side-by-side refrigerator/freezer extend the full-length of the doors to accommodate users of all heights and postures.

1a2

People of any height and posture have equal access to drinking fountains placed at various heights.

1a3

Powered door with sensors is convenient for all shoppers, especially if hands are full.

1a4

Single, grade-level entrance created by bridge and earth berm is usable for all people, regardless of mobility.

1a5

GUIDELINE 1B:

Avoid segregating or stigmatizing any users.

1b1

Elevator adjacent to escalators in shopping mall avoids segregating group members using different modes of mobility.

1b2

Billboard-size captioned video screen at public event allows hearing-impaired attendees to sit anywhere.

Diaper-changing station in men's room challenges stereotype of mothers-only baby care.

1b3

GUIDELINE 1C:

Make provisions for privacy, security, and safety equally available to all users.

Family toilet room allows access for any family member who may need assistance.

1c1

TTY access to 911 service provides access to non-hearing persons.

1c2

ATM has screen that tilts to enable customers of varying heights and postures to conduct transactions with equal privacy.

1c3

High and low door glazing makes doorways safer for people of any stature or posture.

1c4

Kitchen utensil with large, soft grip is more comfortable for nondisabled cooks as well as those with hand limitations.

1d1

GUIDELINE 1D:

Make the design appealing to all users.

Ramp into pool appeals to children learning to swim as well as to swimmers with mobility limitations.

1d2

Rocker wall switch is as popular for its upscale appearance as its usability for persons with hand limitations.

1d3

Water play area simulating a meandering brook invites enjoyment for everyone in and around the water.

1d4

Campsite with log retaining wall appeals to campers needing a place to sit as well as wheelchair users needing a place to transfer.

1d5

Photography Credits

1a1. Whitehouse & Company, New York, New York
1a2. J.L. Mueller, Inc., Chantilly, Virginia
1a3. The Center for Universal Design, Raleigh, North Carolina
1a4. The Center for Universal Design, Raleigh, North Carolina
1a5. The Center for Universal Design, Raleigh, North Carolina

1b1. The Center for Universal Design, Raleigh, North Carolina
1b2. J.L. Mueller, Inc., Chantilly, Virginia
1b3. The Center for Universal Design, Raleigh, North Carolina

1c1. The Center for Universal Design, Raleigh, North Carolina
1c2. The Center for Universal Design, Raleigh, North Carolina
1c3. The Center for Universal Design, Raleigh, North Carolina
1c4. Mitchell/Giurgola Architects, New York, New York

1d1. Smart Design, Inc., New York, New York
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1d3. Leviton Manufacturing Company, Little Neck, New York
1d4. Carol R. Johnson Associates, Inc., Cambridge, Massachusetts
1d5. U.S.D.A. Forest Service: Siskiyou National Forest, Grants Pass, Oregon

PRINCIPLE TWO:
Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

2a1

Computer hardware and software offer choice of input and output options.

GUIDELINE 2A:

Provide choice in methods of use.

Hallway sign transmits signal to "talking" infrared receiver to allow choice of auditory, as well as visual and tactile information.

2a2

Powered height-adjustable work surface allows user to choose standing or seated positions at the touch of a button.

2a3

Adjacent ramp and stairs provide choice of access to building.

2a4

Built-in tub seat and multiple grab bars allow tub or shower use in seated or standing position.

2a5

GUIDELINE 2B:

Accommodate right- or left-handed access and use.

Railings on both sides of walkway provides safety and stability in both directions for right- and left-handers.

2b1

Double-leaf doors allow use of right- or left- hand entry.

2b2

Large-grip scissors accommodate use with either hand and allows alternation between the two in highly repetitive tasks.

2b3

GUIDELINE 2C:

Facilitate the user's accuracy and precision.

Size and spacing of big-button telephone keys accommodate users who don't see the keys accurately, hurry through the process, or lack dexterity.

2c1

Distinctive store entrance architecture makes it easier for visitors to locate from parking lot.

2c2

2c3

Tapered slot and hand rest help customer to insert ATM card accurately.

principle two

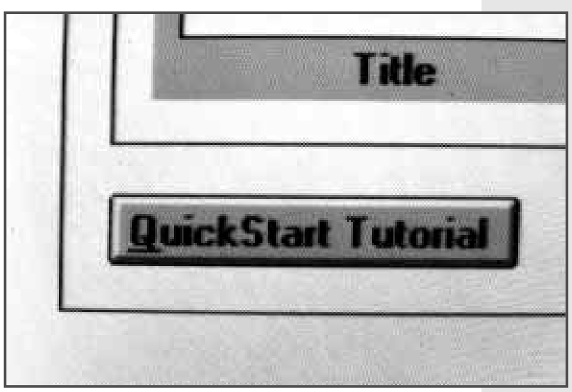
FLEXIBILITY IN USE

GUIDELINE 2D:

Provide adaptability to the user's pace.

2d1

Speed control on dictation machine enables the transcriptionist to work at his/her best pace; tape recorders with this feature are preferred by many visually impaired "talking book" readers who listen at accelerated rates.



2d2

Tutorial option allows software users to select their own learning pace.

Photography Credits

2a1. The Center for Universal Design, Raleigh, North Carolina
2a2. Whitehouse & Company, New York, New York
2a3. Herman Miller, Inc., Zeeland, Michigan
2a4. The Center for Universal Design, Raleigh, North Carolina
2a5. The Center for Universal Design, Raleigh, North Carolina

2b1. Barba Architecture & Preservation, Portland, Maine
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2b3. The Center for Universal Design, Raleigh, North Carolina

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2c3. The Center for Universal Design, Raleigh, North Carolina

2d1. J.L. Mueller, Inc., Chantilly, Virginia
2d2. J.L. Mueller, Inc., Chantilly, Virginia

PRINCIPLE THREE:
Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

principle three

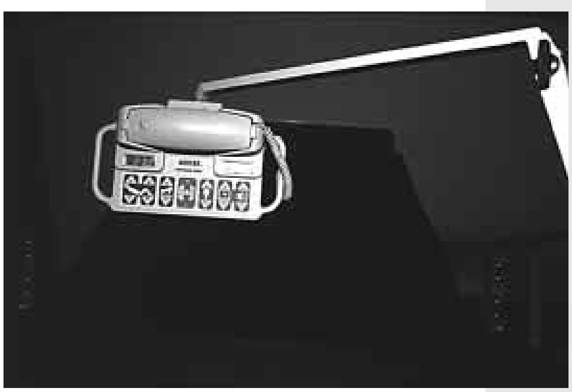
SIMPLE AND INTUITIVE USE

GUIDELINE 3A:

Eliminate unnecessary complexity.

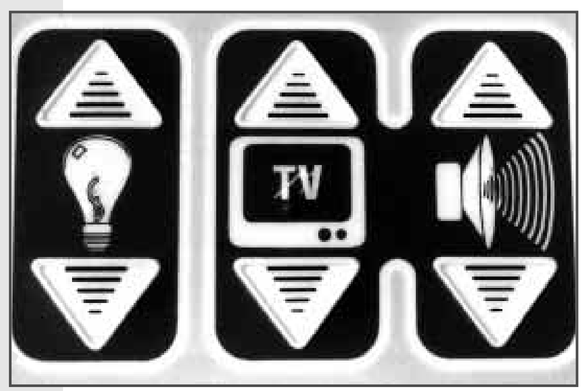
3a1

Operation of single-lever faucet is readily understood without instruction or previous experience.



3a2

Use of icons reduces complexity of control panel for hospital patient's room.



3a2 inset.

GUIDELINE 3B:

Be consistent with user expectations and intuition.

Generations of customers know what to expect inside this familiar, distinctive package.

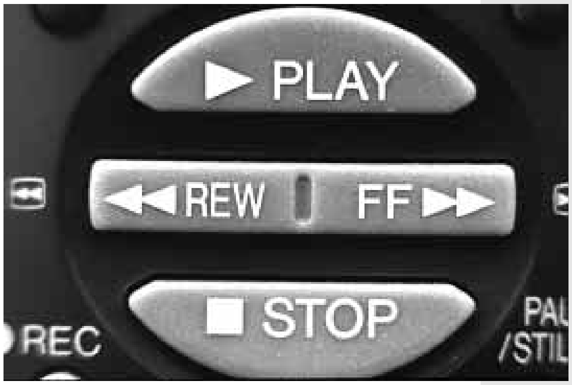
3b1

Automobile power seat control switch mimics the shape of the seat, enabling driver or passenger to make adjustments intuitively.

3b2

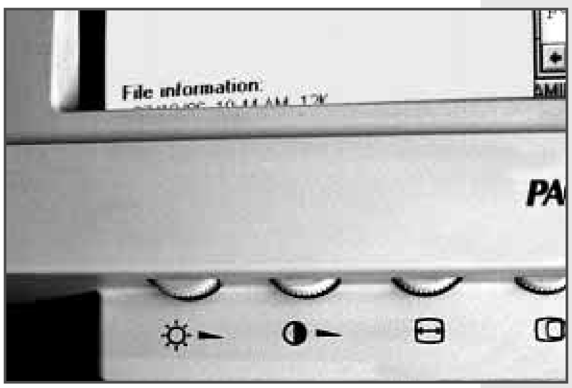
GUIDELINE 3C:

Accommodate a wide range of literacy and language skills.



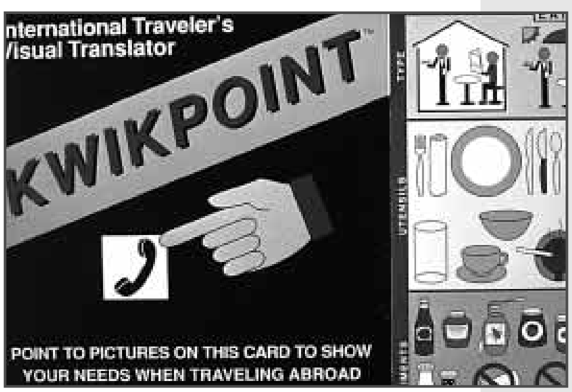
3c1

Icons used in TV remote control design minimize the need for reading.



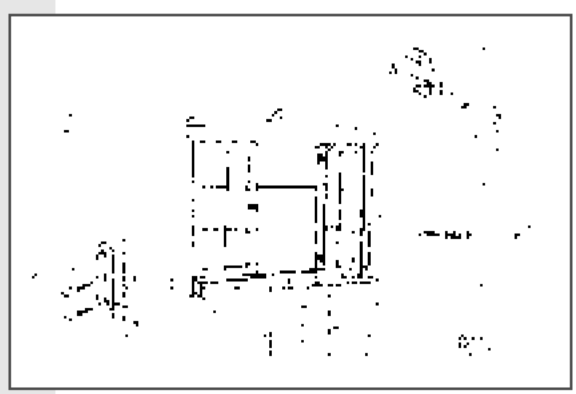
3c2

Icon labels adjacent to computer display controls describe each adjustment.



3c3

Pocket translation card for international travelers allows user to point to icons for communication.



3c4

Assembly instructions for imported furniture eliminate translation problems by providing clear illustrations without text.

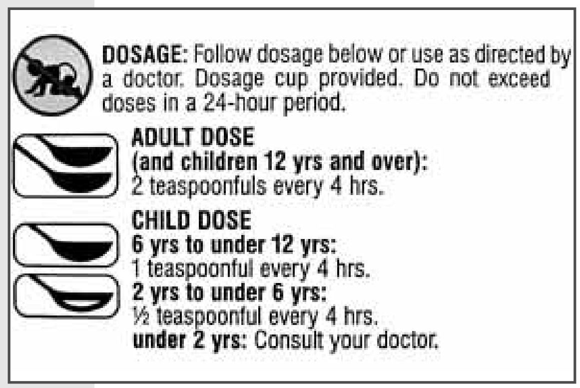
GUIDELINE 3D:

Arrange information consistent with its importance.

Large memory-dial buttons in prominent location at top of phone pad speed emergency calls.

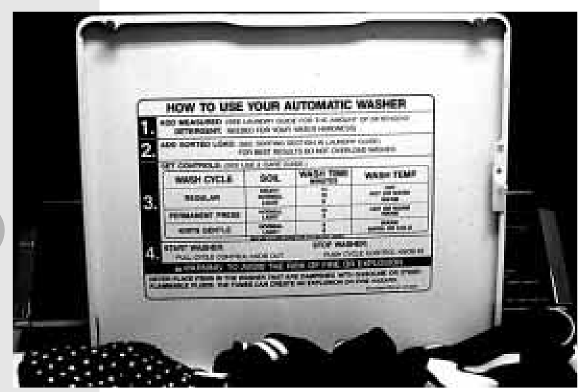
3d1

Illustrated and color coded warning label emphasizes pre-cautions in taking cough medicine.



3d2

The essential washing instructions are printed on the inside of clothes washer lid.



3d3

principle three

SIMPLE AND INTUITIVE USE

GUIDELINE 3E:

Provide effective prompting and feedback during and after task completion.

3e1

On-screen VCR programming takes the user through a step-by-step menu for setup and operations.

3e2

Computer screen shows portion of task completed to inform user of progress in disk formatting.

3e3

Numbered, step-by-step instruction manual guides microwave oven user through the cooking process.

Photography Credits

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3a2 inset. The Center for Universal Design, Raleigh, North Carolina

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3c3. J.L. Mueller, Inc., Chantilly, Virginia
3c4. IKEA Svenska AB, Almhut, Sweden

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3d3. J.L. Mueller, Inc., Chantilly, Virginia

3e1. J.L. Mueller, Inc., Chantilly, Virginia
3e2. J.L. Mueller, Inc., Chantilly, Virginia
3e3. The Center for Universal Design, Raleigh, North Carolina

PRINCIPLE FOUR:

Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

principle four

PERCEPTIBLE INFORMATION

GUIDELINE 4A:

Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.

4a1

Modified round wall thermostat incorporates enlarged visual information, tactile lettering, edge texture, and audible click stops at 2-degree temperature intervals.

4a2

Appliance manufacturer supplies instructions in large print, Braille, and audio cassette formats.

4a3

Subway fare machine provides push-button for selecting instructions in audio format.

GUIDELINE 4B:

Maximize "legibility" of essential information.

Plastic bowls have lids with large round tabs in contrasting colors to locate them easily by touch or sight.

4b1

Dark background on overhead airport terminal signage contrasts with lighted ceiling.

4b2

Contrasts in color, brightness, and texture among components help parents to place baby securely in portable bathtub.

4b3

Subway fare machine provides tactile lettering in all-capital letters and printed lettering in capital and lower case letters for maximum legibility in each format.

4b4

GUIDELINE 4C:

Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

Audio plugs and jacks differentiated by color make it easier to connect equipment, especially when using phone or on-line technical assistance.

4c1

Fountain in conference center lobby provides auditory focal point from which to direct visitors, especially those with visual limitations.

4c2

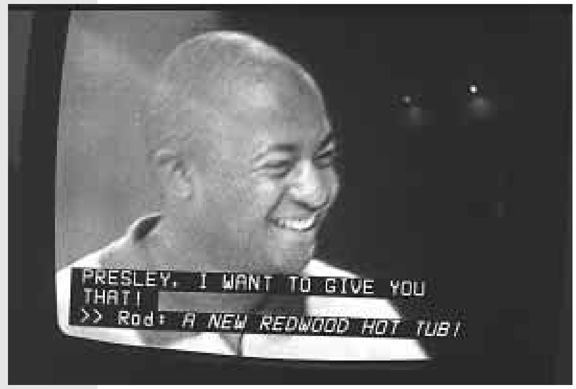
Strong color and texture contrasts in tactile park map make it easier to give directions to visitors.

4c3

GUIDELINE 4D:

Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Color television includes an internal decoder chip for program captioning.



4d1

Public phone is compatible with hearing aids and incorporates a volume control as well as a TTY.

4d2

Internet web site includes text-only option for surfers using screen-reader software.

4d3

Photography Credits

4a1. The Center for Universal Design, Raleigh, North Carolina
4a2. Whirlpool Corporation, Benton Harbor, Michigan
4a3. J.L. Mueller, Inc., Chantilly, Virginia

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PRINCIPLE FIVE:
Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

principle five

TOLERANCE FOR ERROR

GUIDELINE 5A:

Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.

5a1

Shop machinery power control includes a ridge guard around the "START" button, minimizing accidental activation.

5a2

Lip or curb at sides of ramp reduces risk of slipping off.

5a3

Bagel slicer shields hands from blade while holding bagel securely.

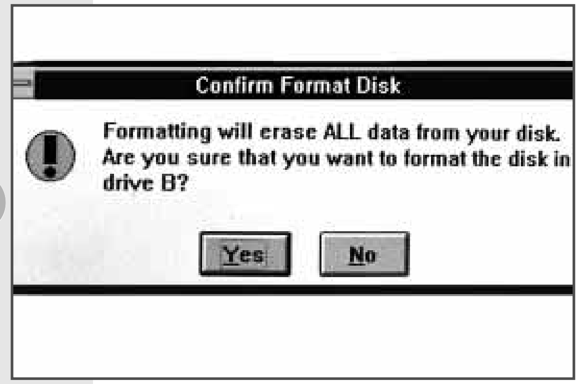
principle five

TOLERANCE FOR ERROR

GUIDELINE 5B:

Provide warnings of hazards and errors.

Computer disk management software warns user of consequences prior to formatting.



5b1

Prominent escalator labeling advises parents of potential hazards to children.

5b2

Strong graphic message on sticker augments package warnings to discourage children from accidental ingestion of household poisons.

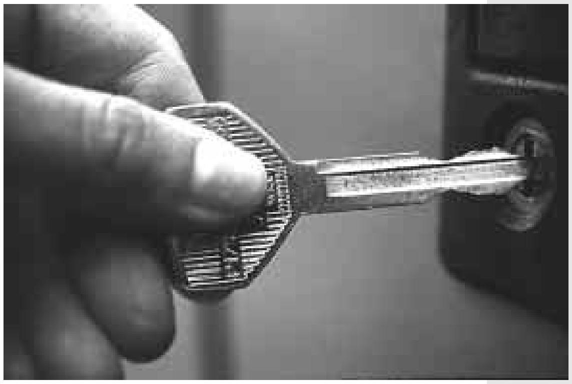
5b3

Red tip on contact lens cleaner bottle warns user not to confuse with eye drop bottle of identical shape.

5b4

GUIDELINE 5C:

Provide fail safe features.



Double-cut auto key is always right side up.

5c1

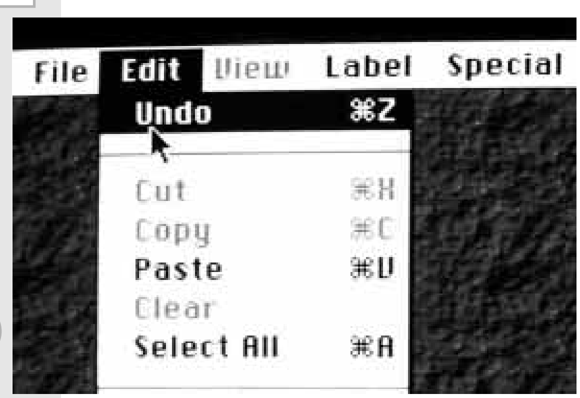
Clothing iron shuts off automatically after 5 minutes of non-use.

5c2

Ground-fault interrupter (GFI) electrical outlet reduces risk of shock in bathrooms and kitchens.

5c3

“UNDO” option allows computer user to correct mistakes without penalty.



5c4

GUIDELINE 5D:

Discourage unconscious action in tasks that require vigilance.

"Deadman" handle on power lawnmower requires the user to squeeze together the lever and handle to keep engine running.

5d1

Sodium content critical to special diets is marked prominently on soup can label.

5d2

Unique configuration of cable terminals discourages unconscious accidents in connecting computer components.

5d3

Photography Credits

5a1. The Center for Universal Design, Raleigh, North Carolina
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5a3. Larien Products, Northampton, Massachusetts

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PRINCIPLE SIX:
Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

principle six

LOW PHYSICAL EFFORT

GUIDELINE 6A:

Allow user to maintain a neutral body position.

Split, angled keyboard allows computer operator to maintain neutral position from elbow to fingers.

6a1

Sign at subway station platform is located at eye level for passengers seated on train.

6a2

Lever-type window latch can be operated without grip or manipulation.

6a3

Door lever can be operated with closed fist or elbow, unlike door knobs.

6a4

GUIDELINE 6B:

Use reasonable operating forces.

Kitchen food container with snap-seal requires only a gentle movement to open or close.

6b1

Water flow control in water park is easy for children to operate.

6b2

Electric power eliminates physical effort of opening garage door.

6b3

Oversized latch for microwave door requires minimal operating force.

6b4

GUIDELINE 6C:

Minimize repetitive actions.

Voice-recognition computer technology eliminates the need for highly repetitive keystrokes.

6c1

Troubleshooting hint card attached to equipment reduces repeated manipulation of instruction manuals.

6c2

1/4-turn cap on pain reliever medication bottle minimizes repeated twisting.

6c3

GUIDELINE 6D:

Minimize sustained physical effort.

Free-rolling casters greatly reduce the physical effort of traveling with carry-on luggage.

6d1

Garden hose nozzle with locking trigger minimizes sustained squeezing.

6d2

Pedestrian malls with places to rest allow shoppers to take a break whenever needed.

6d3

Photography Credits

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6c3. The Center for Universal Design, Raleigh, North Carolina

6d1. J.L. Mueller, Inc., Chantilly, Virginia
6d2. The Center for Universal Design, Raleigh, North Carolina
6d3. The Center for Universal Design, Raleigh, North Carolina

PRINCIPLE SEVEN:

Size and Space for Approach and Use

Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

SIZE AND SPACE FOR APPROACH AND USE

GUIDELINE 7A:

Provide a clear line of sight to important elements for any seated or standing user.

7a1

Lowered counter section at nurses' station provides line of sight for patients of various heights.

7a2

Full-length entry sidelight provides outward visibility for persons of any height.

7a3

Kitchen cabinets have full-extension pullout shelves to allow user to see entire contents of shelves from a variety of heights and from either side.

GUIDELINE 7B:

Make reach to all components comfortable for any seated or standing user.

Water temperature control is offset toward outside of bathtub to reduce reach for both seated and standing bathers.


7b1

Under-counter refrigerator provides access from a seated position.


7b2

Subway fare machines mounted at various heights offer controls at comfortable locations for seated or standing travelers.

7b3

principle seven

SIZE AND SPACE FOR APPROACH AND USE

GUIDELINE 7C:

Accommodate variations in hand and grip size.

7c1

Open-loop door hardware accommodates hands of all sizes.

Chopping knife loop handle accommodates hands of all sizes.

7c2

GUIDELINE 7D:

Provide adequate space for the use of assistive devices or personal assistance.

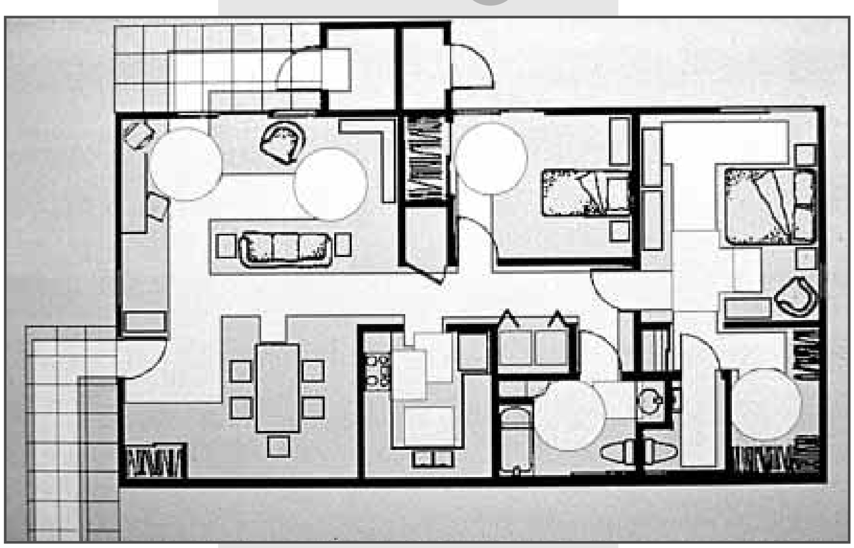
Wide-opening vehicle door provides for close approach to seat with wheelchair or walker.

7d1

Wide gate at subway station accommodates wheelchair users as well as commuters with packages or luggage.

7d2

Home floor plan provides ample hallway and room space for wheelchair passage and maneuvering.



7d3

Photography Credits

7a1. Herman Miller, Inc., Zeeland, Michigan
7a2. The Center for Universal Design, Raleigh, North Carolina
7a3. Stor Trac Company, Denver, Colorado

7b1. The Center for Universal Design, Raleigh, North Carolina
7b2. J.L. Mueller, Inc., Chantilly, Virginia
7b3. J.L. Mueller, Inc., Chantilly, Virginia

7c1. The Center for Universal Design, Raleigh, North Carolina
7c2. J.L. Mueller, Inc., Chantilly, Virginia

7d1. J.L. Mueller, Inc., Chantilly, Virginia
7d2. J.L. Mueller, Inc., Chantilly, Virginia
7d3. The Center for Universal Design, Raleigh, North Carolina

4 Chapter

Case Studies on Universal Design

Case Studies on Universal Design

The decision to adopt a universal design approach is ultimately based on economics. Manufacturers are in business to generate revenue, and the increased costs associated with the integration of more usable features in products and environments, whether in materials or in the time consumed by a more complicated design process, must be justified. Cost control and final pricing are constant concerns. Just as customers are concerned about value, manufacturers need reassurance that a larger market share can be captured by products that are easier for more people to use, especially if they cost more to produce.

Case studies of companies that have experienced success practicing universal design can be illuminating for others considering the approach. The Center for Universal Design, as part of its project, "Studies to Further the Development of Universal Design," compiled a series of case studies that describe efforts to incorporate universal design in products, spaces, and building elements (Mueller, 1998). The following case studies document the process by which designed solutions were created, from concept to execution, and the degree of success in incorporating universal design features in the final designs. In some instances, universal design was practiced in a limited way and in others it began as a small project that had a large effect on an organization. In some cases, universal design became absorbed into the corporate culture.

Subjects for the case studies were selected from among a group of candidates that included winners of design award programs, producers of design recognized for universal design qualities in print media, professional contacts among staff of The Center for Universal Design, and companies recommended by the Center's National Advisory Council. Preliminary phone interviews were conducted to determine the availability of information about the design's development, the influence of universal design concepts on the process of its design, and the company's willingness to share information.

Seven case studies are presented here, each illustrating one of The Principles of Universal Design (The Center for Universal Design, 1997). Information for the case studies was gathered through an interview process, either by phone or in person. Each case was unique and the interview structure was customized, using a general format as a model.

The cases presented here are of two types: retrospective examinations of singular successful universal design efforts, and documentations of ongoing universal design programs. These case studies identify and describe the forces which influenced the development of universal design solutions and demonstrate successful introduction of universal design in the marketplace.

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Case Studies on Universal Design

Case 1/Principle One

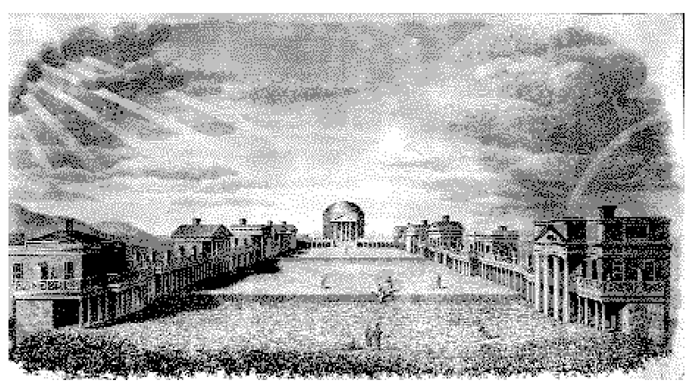
Equitable Use

Promoting Equality While Preserving History At the University of Virginia

Academical Village
University of Virginia
Facilities Management
Charlottesville, VA
December 1994

Jefferson's Design

"Making the Lawn accessible will be the biggest challenge," architect James Murray Howard concluded as he contemplated how to accommodate students in wheelchairs on the University of Virginia campus. Known as "the quadrangle" on most university campuses, the vast, terraced "Lawn" was the centerpiece of the original campus designed by Thomas Jefferson. The Lawn had been the site of commencement exercises for such famous graduates as Woodrow Wilson, Edgar Allen Poe, and Robert Kennedy.



Jefferson's terraced Lawn for the University of Virginia
Benjamin Tanner engraving for the University of Virginia from the Boye map of Virginia, 1827, Special Collections Department, University of Virginia Library

Case 1/Principle One
Equitable Use

Background

The University of Virginia (UVA) is located in Charlottesville, VA. Founded in 1819, UVA was originally surveyed and sited by Thomas Jefferson in 1815. Classes began in 1825. By 1994, UVA had grown into a state-supported institution of 18,000 students and 1650 full-time faculty.

Jefferson's original Academical Village remained the focal point of the campus throughout its history, which included an 1895 fire in the Rotunda, during which students had saved the life-sized marble statue of Jefferson by carrying it out in a mattress.

It was not until the 1980s that serious conservation of all of Jefferson's buildings was undertaken. By this time, some of the deterioration required considerable investment. In the course of this construction, renovation, and conservation work, it also become necessary to consider the needs of students and visitors with disabilities.

As a state-supported institution, UVA was prohibited by Title II of the Americans with Disabilities Act from discrimination on the basis of disability. As a result, architectural barriers were to be removed wherever readily achievable, especially when construction or renovation was undertaken.

An Architect's Challenge

Murray Howard was the curator and architect of what Jefferson had called Central College. Construction of Central College, which Jefferson later termed the Academical Village, was begun in 1817. Howard and a number of other architects contributed to the daunting task of designing modifications throughout the UVA campus to accommodate students and visitors with disabilities.

Case 1/Principle One
Equitable Use

Jefferson's Academical Village was a historical landmark recognized on the World Heritage List, as well as the National Registry of Historic Places. The 5-terrace design for the University's Academical Village Lawn was one of the few original landscape details remaining intact. Most of the architectural details had survived from the 1820s with little alteration.

Bordering the sides of the Lawn were two parallel rows of five houses, the Pavilions, which were connected by walkways and student rooms. Faculty members lived in the Pavilion rooms, while fourth-year students selected according to academic and community service records, lived in the individual rooms between the Pavilions. Residence in a Pavilion room on the Lawn was an honor, even though bathrooms and showers were located separately in buildings behind the rooms, or in cellars below.

At the north end was the Rotunda, the last building built by Jefferson. Bordering the Lawn to the south was Old Cabell Hall, designed by Stanford White at the turn of the century.

An Equitable Balance Between Accessibility and History

Preserving as much as possible of Jefferson's design while allowing students with mobility limitations access to all levels of the terrace for ceremonies was a formidable design challenge to Howard and to the University of Virginia. Though not part of Jefferson's original design, landscaping and buildings throughout the UVA campus had historical significance as well, such as Old Cabell Hall and Monroe Hill Home nearby. These presented additional challenges to accessibility.

Case 1/Principle One
Equitable Use

Access to the Lawn

As Howard had surmised, access to the Lawn was a complex problem defying a single solution. Therefore, grade-level access to each terrace of the Lawn was achieved through a variety of routes between the Pavilions. Where necessary, modern methods of ensuring access were designed and constructed so as not to disturb or attach to original details, including masonry and plantings which survived from the 1800s. The ramp shown here was entirely self-supporting and did not touch adjacent masonry or disturb adjacent greenery. Even the illumination was arranged so as not to intrude on the evening appearance of the Village.

Modern ramp built adjacent to original shrubbery and stairs

For more direct access during occasional ceremonies such as commencement, a removable ramp and platform system was constructed down the center of the lawn from the Rotunda at the north to Old Cabell Hall at the south.

Some access to the Lawn and the surrounding landscape was integrated into existing structures, as in the case of access to the lowest level of the terrace through Old Cabell Hall opposite the Rotunda. In 1994, Old Cabell Hall was under renovation, and part of the work included incorporation of an access ramp from parking and walkways behind the hall up to the first level of the Lawn. The considerable level change required an elevator and very long ramps to achieve an acceptable grade. The large open space inside Old Cabell Hall made it possible to locate these ramps internally, making all-weather access much easier, as well as minimizing the impact on the exterior design of the Academical Village.

Case Studies on Universal Design

Case 1/Principle One
Equitable Use

Equitable Access Throughout the Campus

Designing for the integration of historical details with modern accessibility technology resulted in more equitable use for all students. At the rear of Pavilion V, a modern electrically powered lift provided wheelchair access from grade level to the porch.

A wheelchair lift integrated into a brick walkway and porch

All the lift's components, except the controls, were installed entirely below ground in an 8-foot pit. The photos below show that the floor of the lift is covered in brick identical to the surrounding walk, and the lift sides rise from the pit before the lift begins to rise. When not in use, the lift is entirely invisible.

Creating an accessible 15-foot level change just west of the Academical Village between the grade level at the 1920s Brown College dormitories and the Monroe Hill House on the hill above presented site design as well as architectural concerns. The solution was to install an elevator within a new outbuilding designed to reflect the 1820s era architecture.

To minimize intrusion into the existing pathways, the outbuilding was nestled into the hillside and the surrounding trees. The upper elevator patio was connected to the meeting building by a wooden ramp which appeared to be a natural continuation of the building's original porch.

Elevator concealed in new outbuilding at Monroe Hill House

Case 1/Principle One
Equitable Use

Unobtrusive Access

One measure of the success of the design solutions at the University of Virginia were their near-invisibility, as in the example here. But since accessible routes also needed also be easily located, campus guides were well-trained and maps were designed to illustrate access routes for self-guided visitors.

As UVA continued its restoration and renovation, as well as new construction, the concept of Universal Design remained evident. Balance between the needs of a modern 18,000-student campus and historical preservation presented ongoing challenges to the architects who saw these challenges not as problems but as opportunities for creative work.

Case Studies on Universal Design

Case 2/Principle Two
Flexibility in Use

Fiskars Considers Variety of Customer Ages and Abilities

Fiskars, Inc.
7811 West Stewart Ave.
Wausau, WI 54401

Fiskars Oy Ab
Helsinki Finland
January 1995

"Just Common Sense"

"It just seems like common sense to me," said Jim Boda, director of Research & Development for Fiskars, Inc. Fiskars' senior industrial designer Doug Birkholz agreed. It was 1991, and Boda and Birkholz were evaluating a new scissors design begun 18 months earlier.

In 1989, a Fiskars vice president received a one-page study from the Arthritis Foundation citing arthritis as a major concern of aging baby-boomers. Struck by the size of this population and by their own personal experiences with aging family members, Fiskars' designers began to consider how well their products were designed for this market.

Beginning in 1989, Fiskars began to develop new products based on sensitivity to the aging consumer market, particularly those with arthritis that interfered with their ability to grasp and manipulate hand tools.

Case 2/Principle Two
Flexibility in Use

Company Background

Fiskars, Inc., produced nearly half the scissors sold in the US. The quality of their scissors was among the top three manufacturers in the world, including Henckels and Gingher, whose products were more expensive.

Based in Helsinki, Finland, Fiskars was one of the oldest companies in the western world, with roots dating back to the 17th century. By the 1990s, the company had organized around four business units:

The Inha Works manufactured aluminum fishing and recreational boats, door and window hinges, rail fittings, and heat radiators, primarily for the Finnish and Swedish markets.

The UPS Group manufactured uninterruptible power supplies (UPS) for the computer industry, financial institutions, and trade and industrial operations worldwide.

The Real Estate Group managed the company's real estate properties along the southwestern coast of Finland along with related services.

The Consumer Products Group, the largest unit, was headquartered in Madison, Wisconsin, and managed the manufacture, sale, and worldwide distribution of three product families: scissors and other housewares products, outdoor recreation products, and lawn and garden products. The Consumer Products Group maintained offices in North America and Europe, as well as offices and manufacturing facilities in Fiskars, Finland. Their products were marketed under the Fiskars name as well as under the labels of some of its customers.

Case 2/Principle Two
Flexibility in Use

Fiskars' History

The use of scissors predates written history, but the design was believed to have originated during the Bronze Age, which began about 3000 B.C. In the 18th century, steel replaced bronze and iron blades.

In 1649, a Dutch merchant and owner of an ironworks was chartered to establish a blast furnace and forging operation in Fiskars, a small village in western Finland. The country was under Swedish rule at the time, and much of the nails, wire, knives, and hoes produced by the operation were sent on company ships to Stockholm.

Over the next 160 years, industrial and economic development accelerated in Europe. During this time, Fiskars developed its skills and reputation as one of the finest copper and ironworks in northern Europe. In the 1830s, the company expanded into the manufacture of forks and scissors. In 1837, Fiskars established the first machine shop in Finland and manufactured the first Finnish steamship engine the following year. Fiskars continued to develop its reputation as a premier steel and ironworks company, extending its production into architectural, industrial, agricultural, and home products.

Throughout its history, Fiskars strove toward five principles:

- A sense of its identity and direction
- Commitment to quality
- Attention to details
- Understanding of each of its marketplaces
- Strong relationships with its customers

Taking the "Common Sense" Approach

Eighteen months after its vice president had first read about the effects of arthritis on the baby boomer generation, Fiskars had developed the "Golden Age Scissors" concept, based on consideration for users with arthritis.

Case 2/Principle Two
Flexibility in Use

The lightweight design accommodated both right- and left-handers equally well and offered a larger, softer grip to distribute pressure more evenly across the palm of the hand. The scissors also incorporated a lock closure and a spring assist to open the scissors, eliminating one of the tasks of cutting.

No market surveys among older or disabled customers were conducted to justify the design. It just seemed like "common sense." As it became obvious to Fiskars designers that the product had features useful to anyone, Fiskars changed the name to reflect a less age-related focus, and the "Golden Age Scissors" became known as the "Softouch" scissors and went into production in 1991.

Fiskars' Softouch Scissors

Positive Customer Feedback

Elder Fiskars customers responded that until Softouch went on the market, they had given up sewing. Children found that Softouch gave them much greater cutting ability. Businesses began to use them in production jobs to minimize the risk of repetitive motion and cumulative trauma disorders.
Both Softouch Scissors and Softouch Microtip Scissors, another soft-grip design, won awards from the American Society on Aging in 1993.

Fiskars' Rotary Cutters

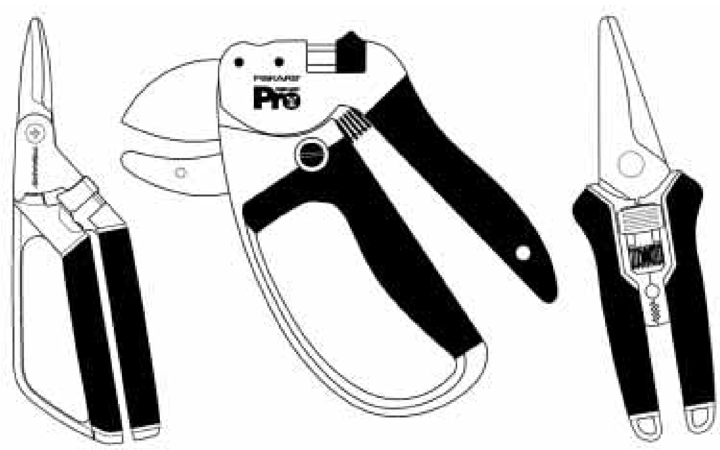
Softouch scissors were sold through a wide variety of outlets, from kitchen supply retailers to New York's Museum of Modern Art Design Store.

Spin-offs and Competition

Focus groups of 40 to 70-year-old customers with limited hand function were conducted in the development of other Fiskars' products, IDSA award-winning Rotary Cutters and Rotary Paper Trimmer. These products were conceived in reaction to competitive rolling-cutter products from Olo and Dritz. Fiskars' advantage over these lay in superior ergonomics. In citing the design for a 1994 Industrial Design Excellence Award, jurors noted that the handle contours made it "comfortable for any size hand, allowing the user to distribute downward pressure across the hand while maintaining neutral arm position."

New Market Concept, Not Market Niche

Jim Boda and Doug Birkholz felt that the Universal Design approach had required a "paradigm shift" at Fiskars toward a broader definition of their market to include people with manual limitations, whether due to age or disability.



Softouch Floral Shears, Power Lever Pro, and Softgrip Multi-Snip

They noted that Fiskars Research and Development staff integrated this shift readily, but other departments, such as Lawn & Garden Products, were more conservative and resistant to redefining fundamental marketing strategy. Nevertheless, the concept took hold, and customers with limited hand function were eventually considered also in the design of garden tools such as Softouch Floral Shears, Power Lever Pro, and Softgrip Multi-Snip gardening tools. The approach was also integrated into designs for ax and shovel handles marketed by Fiskars in Europe.

Case 2/Principle Two
Flexibility in Use

Applying the "Universal Design" Concept

Fiskars designers agreed that introducing a new product such as Softouch or Rotary Cutter was somewhat easier than "displacing" an existing product, whether the company's own or that of a competitor. They believed that market "space" was already available and waiting for a product that meets a significant need.

This suggested that products reflecting Universal Design as a new paradigm were more likely to be successful than existing products facelifted or subtly altered to reflect this approach.

For Fiskars, the key was to avoid designing for a specific market segment, e.g. "Golden Age Scissors," in favor of integrating features that addressed the needs of these populations with those of the general market. This, in a nutshell, was the concept of Universal Design.

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Case Studies on Universal Design

Case 3/Principle Three

Simple and Intuitive Use

Worldwide Distribution Requires Simplicity in Product Assembly

IKEA, US, Inc.
IKEA Svenska AB
Almhut, Sweden
March 1995

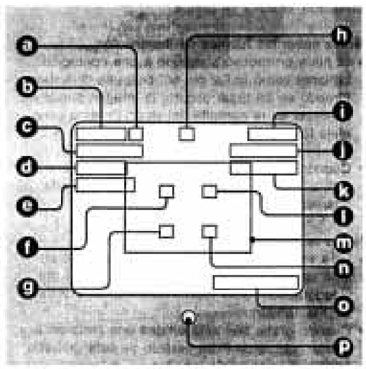
When in Doubt, Read the Instructions

On the adjacent page is a portion of the 159-page manual for a Sony video camera sold in 1990. The illustration defines each of the 16 indicators that may light up in the viewfinder occasionally to inform the user of some vital bit of information.

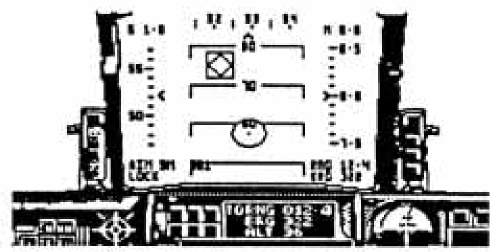
Even subtracting the pages printed in French and Spanish, this manual was 80 pages long. In fact, the manual weighed exactly 1/3 of the camera itself (including the battery). And the camera was smaller.

Next to the Video Camera illustration is the Head-Up Display (HUD) illustration of an F-16 fighter simulator showing 13 indicators (3 fewer than the video camera viewfinder).

Case 3/Principle Three
Simple and Intuitive Use



Video Camera Viewfinder



F-16 HUD display

Video recording was not meant to be a more demanding task than flying a fighter jet. The user, far less skilled and practiced than a military fighter pilot, was probably more confused than aided by all this data. Moreover, the 80-page instruction book did little to clarify it and make it useful when Mom or Dad dusted off the camera for a Saturday afternoon trip to the zoo with the kids.

"Just Who Designed This, Anyway?"

Product instructions seemed to be written by someone with thorough knowledge and understanding of how the product works. In fact, they were often written by the product's design or engineering staff. Compounding these problems were illustrations which themselves were unclear and often related to a slightly (or very) different product offered by the manufacturer.

Anyone who needed the help of a child to assemble a toy or to program a VCR knew the frustration of reading product instructions. Most instructions seemed to be a result of less-than-perfect translation from another language into English, and this, in fact, was often the case.

Case 3/Principle Three
Simple and Intuitive Use

IKEA Design for Worldwide Distribution

Background

IKEA was a Swedish furniture manufacturer hugely successful in marketing its home furnishing products worldwide. From 1987-1991, IKEA doubled in annual sales to $3.2 billion. In 1995, US sales reached $511 million and $5 billion worldwide. A subsidiary of Ingka Holdings AB in Amsterdam, Netherlands, IKEA Svenska AB had 126 stores in 25 countries. The first of IKEA's US stores opened in Philadelphia in 1985.

IKEA derived its name from a brief history of the founder, **I**ngvar **K**amprad, who grew up in Sweden on a farm called **E**lmtaryd, in the parish of **A**gunnaryd. Under Kamprad's leadership, IKEA set international standards for functional design, people-centered management, and creative marketing.

IKEA's catalogs were not only a marketing tool for their range of home furnishings, but also a vehicle for communicating the company's concern for family values and environmental issues.

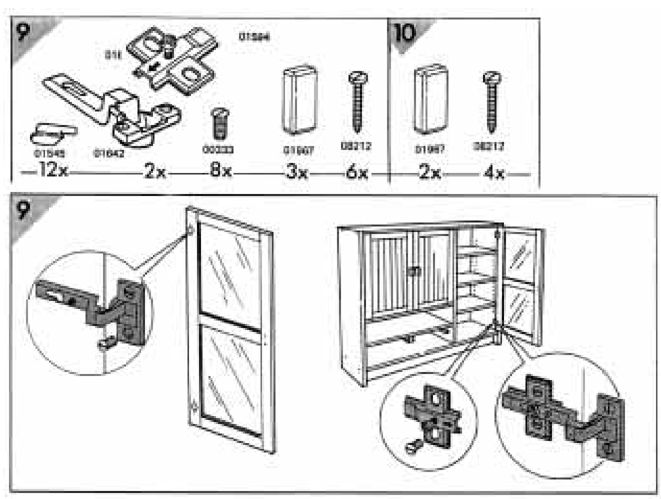
From the IKEA catalog

Case 3/Principle Three
Simple and Intuitive Use

Designing for Assembly

IKEA's furniture products were shipped in disassembled form for economy of manufacture and transportation, resulting in price advantage in the marketplace.

Economy and efficiency in manufacture was also extended to product assembly, with an added benefit. Not a word was included in these instructions, eliminating the cost and potential confusion in translation. Instead, simple illustrations detailed every step of assembly.



Portion of the assembly flyer for an IKEA home entertainment cabinet

Consumers Union compared several brands of home furniture kits in a March, 1996 issue of *Consumer Reports*. While complaining that the lack of text made the instructions hard to follow, *Consumer Reports* still rated IKEA products the easiest to assemble of the bookcases and home entertainment centers tested.

The clarity of the diagrams, with details of the proper location for each fastener, coupled with the simplicity of construction, made home assembly so simple that even an, um, adult could do it.

Case 3/Principle Three
Simple and Intuitive Use

Video Cameras, Fighter Jets, and Furniture

The development of product assembly instructions and product use manuals often resulted in greater confusion than clarity, leaving the reader to find a child to figure it all out by simply picking up the pieces and fitting them together. Without the instructions, assembly became essentially a Tinker-Toy task, for which most adults had long since lost their qualifications.

Surely furniture assembly was not nearly as technologically complicated as flying an F-16 fighter, or even operating a video camera. But IKEA demonstrated the power of well-designed product instructions. Noted in the business world for its success through exemplary business practices, IKEA's most basic tenet was to "sell the same product in the same way in Houston as it could elsewhere in the world."

Surely the ease of assembly supported this idea; one with wide applications to other areas of product and environmental graphic design in the world marketplace.

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Case Studies on Universal Design

Case 4/Principle Four
Perceptible Information

Designing for the Senses at The Lighthouse

The Lighthouse, Inc.
111 E. 59th Street
New York, NY 10022

A Living Laboratory of Accessibility

"We must have a building that demonstrates what we advocate. The importance of light, of signage, all of the kinds of issues we stress, we are going to be living with, day in and day out...This will be a living laboratory," said Dr. Barbara Silverstone, executive director of The Lighthouse, Inc., which had been known as The Lighthouse for the Blind since its creation in 1906. In 1990, both its name and its headquarters underwent fundamental changes.

Background

The Lighthouse had occupied its headquarters in Manhattan since 1906. In the past, people who were blind had engaged in self-segregated activities at the Lighthouse. By the 1970s, the philosophy had begun to shift toward greater integration in the community.

In 1990, when The Lighthouse set out to modernize and expand its headquarters in Manhattan, a conscious effort was made to create a structure that would reflect the philosophy of function as independently as possible in the mainstream.

This meant designing a model environment without creating an “accessibility oasis” that would teach little of how to cope with barriers in the community.
The mixed-use building housed a performing arts and conference center, a child development center, a music school, and a library, as well as clinics, labs, training facilities, and administrative offices. These spaces needed to be designed with consideration for people with a wide variety of visual abilities, including people who were partially sighted or blind.

The Graphic Design Challenge

The Lighthouse’s building graphics were designed by Roger Whitehouse, a New York City graphic design consultant. Whitehouse wrote a white paper in 1993 for the Society for Environmental Graphic Design (SEGD) on the Americans with Disabilities Act signage requirements.

In his paper, Whitehouse pointed out conflicts between tenets of graphic legibility and ADA requirements. For example, the ADA required all-capital lettering for tactile signage, while it was known that combined capitals and lowercase lettering provided a more distinctive visual pattern through the variety of letter heights and shapes. Caps with lowercase also took less space, allowing use of a larger type size in a given space if used in preference to all caps.

Accessible

40-point caps with lower case are more readable than 30-point caps...

ACCESSIBLE

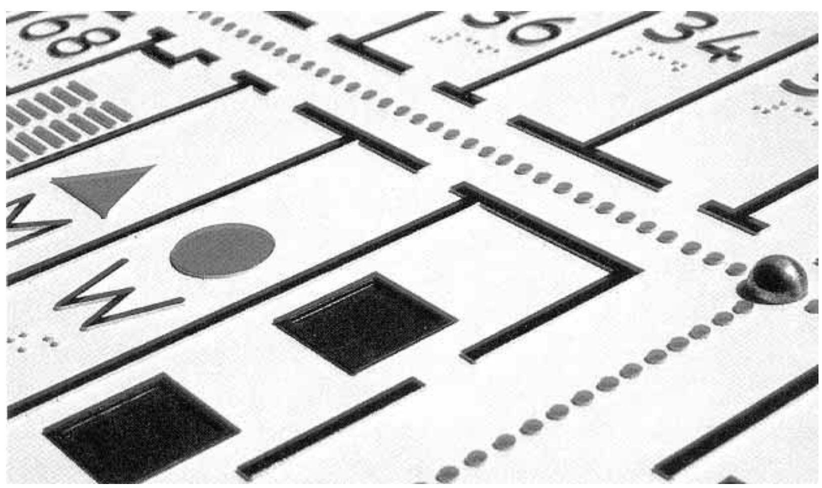
Whitehouse further pointed out SEGD's interpretation of those ADA graphic requirements which might be unclear to graphic designers attempting to comply with this law. Specific acceptable uses of Braille, type styles and width-to-height ratios, as well as clarification of acceptable locations, finishes, contrasts, and illumination of signage were presented in the white paper.

Wayfinding at The Lighthouse

Signage and maps were designed to meet the requirements of the ADA and be usable by people with a variety of visual as well as physical and cognitive abilities. Whitehouse addressed the caps only vs. caps with lowercase dilemma with redundant lettering.

Room information was presented in white-on-black caps with lowercase lettering, in addition to tactile all-caps lettering and Grade 2 Braille. Talking signs were also incorporated into the room signage as another redundant system.

Visual and tactile maps with specially designed symbols were located throughout the building. Layout was kept consistent among the floors to facilitate location of rest rooms, fire exits, and elevators.



Whitehouse's tactile map with Braille, symbols, and raised "Haptic" lettering

On these maps, Whitehouse's own "Haptic" typeface was used, which incorporated generous spacing for tactile reading, a slash inside the zero to prevent confusion with the letter O, and an open-top numeral 4 to avoid confusion with the letter A.

The Architecture

At the Lighthouse, Mitchell/Giurgola Architects combined the principle of integration with an understanding of the navigational skills of people who are visually impaired. Before implementation, plans were reviewed by Lighthouse researchers, staff, and people with visual impairments.

To increase visibility, contrast needed to be increased. But rather than simply increasing the overall illumination within the building and with it, risk of glare, contrasts of color were used to delineate borders, doorways, railings, and level changes. Interestingly, doors and door frames to engineering spaces were "painted out"; painted the same color as the walls, to avoid confusion with accessible areas. This simple and effective strategy for simplifying the environment aided wayfinding for people with cognitive as well as sensory limitations (Cohen, 1993).

Contrasts between carpeted and tiled floors separated work and public spaces. Traditional lighting fixtures were adapted by H.M. Brandston & Partners to avoid glare and sudden changes in brightness, which made it difficult to adapt for some people who are visually impaired.

The needs of people with disabilities other than visual impairments were also considered in the design of building features. For example, the auditorium incorporated a variety of seating options for wheelchair users as well as an infrared system for assistive listening and for descriptive audio for people with limited vision.

Originally both the "up" and "down" lights in the elevator lobbies were identical circles, one above the other. It was pointed out that people with severe visual impairments might not perceive the unlighted circle, but only a single, ambiguous light. If the individual also had cognitive limitations, the problem would be compounded. Therefore, the indicator circles were changed to triangles, so that the lighted indicator would also show direction, making it necessary only to see the lighted indicator.

A Universal Design Laboratory

Reopened on June 20, 1994, the Lighthouse's headquarters offered people of all abilities an opportunity to experience and give feedback on the concept of increasing independence through a more universal approach to wayfinding and graphic design. Lighthouse staff took advantage of every opportunity for feedback from visitors to the building, whether they were nondisabled, visually-impaired, or cognitively or physically impaired. What they learned about signage, symbology, typefaces, and wayfinding became invaluable to graphic designers learning to deal with these issues not only in architectural graphics, but also in graphic user interfaces and other areas of graphic design. Upon completion of the project, Steven Goldberg of Mitchell/Giurgola Architects observed, "I don't think any of us who worked on the project will ever look on architecture the same way again."

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Case Studies on Universal Design

Case 5/Principle Five
Tolerance for Error

The "Squeeze-Meter" Dispenser Eliminates Measuring Tasks

McKechne Plastics
Gilmont, NY
October 1994

Background

Industrial designer Bob Donoghue knew he had a useful idea. It was one of those simple solutions to a problem everyone has at one time or another. How can you easily and accurately measure a specified amount of liquid, say a teaspoon? It was a problem that had caused its share of spills and waste, as well as concern over accurate dosage of medicines. Labeling of many over-the-counter medicines had become so complicated and small as to be impossible to read for all but the best eyes under ideal lighting.

A Simple but Effective Solution

Donoghue had devised a reservoir which could be molded into the top of any flexible plastic container. When the container was squeezed, a siphon tube carried the liquid into the reservoir. When the reservoir was full and the container was released, any additional liquid squeezed up would siphon back down into the bottle. Then the container could simply be inverted, and only the measured amount would pour out. By sizing the reservoir appropriately, any amount of liquid could be precisely metered without manual or visual precision. In fact, the user would not even have to look at the container, meaning it could be used accurately in the dark. Donoghue envisioned use of his invention in containers for liquid medical products, where dangerous measuring mistakes are common, especially in times of crisis or in the middle of the night, when the user's attention and vision are not at their best.

Getting the Idea into Production

Donoghue realized the potential of his invention, and was granted a patent in 1985. He first approached Johnson & Johnson about the application of the device to their ACT Fluoride Anti-Cavity Treatment. This seemed an ideal product, since using the correct amount of fluoride treatment was important. The "Squeeze-Meter" dispenser became part of the ACT package. For the ACT application, the dispenser was sized to dispense the correct 10 ml. dose of fluoride treatment.

Jobe's Liquid Fertilizer and Johnson & Johnson's ACT Fluoride bottles

In 1987, Weatherly Consumer Products of Lexington, Kentucky, adapted the Squeeze-Meter dispenser for use in its Jobe's Liquid Fertilizer containers. This product was intended for quick, accurate feeding of houseplants, a chore often neglected by busy homeowners. The dispenser was sized to hold the correct amount of fertilizer for one quart of water, again requiring only a gentle squeeze, then a tip into the bucket of water.

By 1992, Donoghue had sold the patent to McKechne Plastics of Gilmont, New York. McKechne Plastics, the original developer of the Fuller Brush, designed and manufactured plastic containers for producers of consumable home products, like Weatherly and Johnson & Johnson.

McKechne proved to be innovative in manufacturing as well as marketing Donoghue's Squeeze-Meter dispenser. The company contracted the assembly of the dispensers to a local organization which employed people with disabilities.

Marketing Difficulties

McKechne designers could add the Squeeze-Meter dispenser to a client's design, adding the popular feature for only pennies per container. But these pennies were important, and large production runs were needed to amortize the considerable cost of changes to container molds. Unless a product had the potential for large-scale production, the additional cost per package could be prohibitive. McKechne's sales staff found it a challenge to sell addition of the Squeeze-Meter dispenser to the cost of product packaging for other reasons, too.

Many potential manufacturers didn't perceive a benefit to the feature. "They really didn't mind that their customers were spilling and wasting their product," Donoghue noted. They were selling only the liquid, and waste simply meant greater product sales. Furthermore, McKechne sales representatives found it difficult to convince clients of the benefits to elder users and those with visual or manual limitations that made measurement such a difficult task.

Ongoing Development

The Squeeze-Meter dispenser was not a perfect solution to the need Donoghue had perceived. Some users found that it was still possible to spill liquid if the container were squeezed too forcefully. Because the reservoir configuration and siphon tube usually required that the outlet be positioned near the top of the opening of the reservoir itself, squeezing the container hard enough often made the package into a "squirt gun," Donoghue realized.

Donoghue set about redesigning the Squeeze-Meter dispenser to avoid this problem, and was granted a patent on the improved version which went into production in 1996. The new dispenser was fabricated by a new process that provided for the formation of the reservoir as a separate part that could be combined with the siphon tube and mounted within the confines of the squeezable container itself. The new dispenser prevented the "squirt-gun" effect as well as spilling if the container were squeezed too forcefully.

A Unique and Successful Example of Universal Design

The Squeeze-Meter dispenser was an example of a product that incorporated the universal design principle of Tolerance for Error by eliminating the need for manual and visual precision in measuring liquids.

It certainly had proven effective in marketing several products. Ten years after its introduction, Johnson & Johnson's ACT Fluoride Treatment package still incorporated Donoghue's dispenser design. Several new products were also under development, including an eye wash bottle and a separate screw-on measuring chamber which could be provided to consumers by manufacturers of large-quantity containers, such as detergents or commercial liquids.

Case Studies on Universal Design

Case 6/Principle Six

Low Physical Effort

Redesign of Classic Tupperware Incorporates Universal Design

Tupperware Worldwide
14901 S. Orange Blossom Trail
Orlando, FL 32837
February 1996

Recreating a Classic

It was 1990, and Morison Cousins, Director of Design for Tupperware Worldwide, faced a formidable challenge. Tupperware had decided that it needed to update its products to reach a new generation of homemakers. This would mean changing a design which had remained essentially unchanged since the 1950s while increasing in sales for three decades.

Cousins remembered the 1950s fondly, and Tupperware had been among the more popular and exciting home products during these years. Born in Brooklyn in 1935, Cousins had studied industrial design at Pratt Institute and had later opened his own design office, also in New York, before joining Tupperware.

Case 6/Principle Six
Low Physical Effort

Background

Tupperware had literally been a household word for generations. But long before Tupperware became an integral part of the classic suburban lifestyle in the 1950s, Earl Tupper was a self-educated engineer working for a duPont chemical plant. With the beginning of WWII, industrial materials for home products became scarce, and Tupper began to experiment with a refining process to make use of duPont's leftover polyethylene plastic. When refined, this plastic became the basis for Tupper's revolutionary kitchen product.

In 1958, Tupper sold the company to Rexall Drug, which became Dart Industries in 1969. Dart Industries spun off Tupperware in 1986, along with several other divisions, Hobart (commercial kitchen appliances), Ralph Wilson Plastics (plastic laminates for countertops), and West Bend (small appliances), to form Premark International, Inc.

Tupperware Express, a direct merchandising effort, was canceled in 1992 due to high shipping costs. Instead, the company increased its sales force by 27% and increased use of promotions, and sales improved in 1993 and 1994. In 1995, Tupperware accounted for 56% of Premark's profits.

Overseas sales accounted for 80% of Tupperware sales, which were especially strong in Japan, Latin America, and Asia. Premark planned to introduce Tupperware to India in 1997.

An Innovative Marketing Idea

Until Earl Tupper introduced his Tupper Plastic products in 1945, kitchen containers were either glass jars or ceramic crocks. Many homemakers were familiar with the use of Mason jars for preserving fruits and vegetables.

Tupper's airtight seal made polyethylene Tupper containers functionally superior to conventional containers. But plastics had been seen very little outside of industrial applications. As a result, few homeowners knew the advantages of the material or even how to open the Tupper containers, and they sold poorly.

Tupper realized that the product had to be brought directly into the homes of users in order to convince the public. Tupper's first direct sales person was Brownie Wise, who conceived the idea for the "Tupperware party" to do just that.

Tupperware parties brought awareness of these new plastic products into suburban neighborhoods. Tupper product sales flourished, and Tupper instituted strict quality controls to back up the products' lifetime warranties.

Growing up with the Baby Boomers

Unlike so many consumer products, Tupperware containers remained useful for decades after purchase. The same container that kept the baby's food fresh was still used years later to save dinner leftovers for that same child when she came home late from high school cheerleading practice.

In the ensuing years, young homemakers who purchased their first Tupperware in the 1940s reached middle age, while their children and their elderly parents used Tupperware products as well. Though life changed considerably for baby boomers and their families through the next 3 decades, Tupperware design remained essentially the same.

Case 6/Principle Six
Low Physical Effort

Sealing Out Some Users

For many children, elders, and people with disabilities, the same airtight seal that had been Tupperware's trademark was a barrier, because the narrow lip was difficult to open. At the same time, many who had been young homemakers in 1945—and among Tupperware's most faithful customers—had begun to experience arthritis and other natural effects of aging that made use of that classic seal difficult for them as well.

One of those users was the mother of Morison Cousins, Director of Design for Tupperware Worldwide. Like many of her contemporaries, she had found that the narrow lip around the edge of the seal had become difficult to use.

Usability Meets Durability

In 1990, Cousins undertook the redesign of Tupperware products. In developing his own One Touch Seal and the redesign of the classic Wonderlier bowls, Cousins had in mind users like his 87-year-old mother. He replaced the narrow lip seals with larger seal tabs and double-arc handles that were easier to grasp.

Strong color contrast between the lids and bowls increased usability for people with limited vision. The very features appreciated by museum curators also had a straightforward usability, even for people limited by age or disability.

Tupperware's Wonderlier Bowls

Products for the 1990s

In 1994, Tupperware added about 100 new products to the line, which included Modular Mates stackable storage containers, Bell tumblers, Wonderlier and Sevalier bowls, One Touch containers, Tuppertoys, and Tupperware microwave cookware. In 1995, 12 million Tupperware parties were held.

Cousins' adherence to simple, elegant forms helped to preserve the utilitarian character that had endeared Tupperware products to homemakers. His approach also earned Tupperware products a place in six museums around the world, including New York's Museum of Modern Art.

With Cousins' redesign of the classic Tupper seal, Tupperware products became not only capable of enduring through the user's lifespan, but remaining useful throughout that lifespan as well.

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Case 7/Principle Seven
Size and Space for Approach and Use

Steelcase's New Approach to Workplace Design

Steelcase, Inc.
901 44th Street, SE
Grand Rapids, MI 49508
February 1996

Background

Since 1968, Steelcase, Inc., was the world's largest manufacturer of office furniture, with over 900 independent dealers worldwide and manufacturing plants in the US and ten foreign countries. About twice the size of its closest competitor, Herman Miller, Inc. in nearby Zeeland, Michigan, Steelcase's roots reached back to early in the 20th century, when all office furniture was made of wood and offices were heated with wood and lighted with gas lamps. Because fire was a constant danger, sheet-metal designer Peter Wege decided to build steel furniture instead. With the help of $75,000 from investors, Wege founded the Metal Office Furniture Company in 1912.

Despite its superior fire safety over wood, metal furniture was more expensive, and it wasn't until Wege's company won its first government contract in 1915 that architects began specifying metal furniture. In 1921, Wege hired a consultant to develop a trademark for his company that would promote the durability of his products.
The trademark was Steelcase.

Case Studies on Universal Design

Case 7/Principle Seven

Size and Space for Approach and Use

The Metal Office Furniture Company patented the suspension file cabinet in 1934 and created office furniture for the headquarters of Johnson Wax with Frank Lloyd Wright in 1937. The company was able to survive the shortage of steel for civilian use during WWII by producing steel furniture with interchangeable parts for US Navy warships. After the war, this work became the basis for the company's modular office furniture products.

The Metal Office Furniture Company's trademark became its name in 1954, and five years later, Steelcase, Inc., introduced a system of cabinets, frames, and panels to customize work areas to workers' individual needs.

Overseas, Steelcase created Steelcase Japan as a joint marketing and sales venture with Kurogane Kosakusho in 1973 and Steelcase Strafor in France with Strafor Facom in 1974. In 1995, a joint office furniture manufacturing venture in India, Steelcase/Godrej & Boyce, was formed.

Steelcase was able to triple its sales in the 1980s due to growth from several acquisitions begun in 1978. In 1987, the Steelcase Design Partnership was formed from seven companies in special market niches such as designer seating, desktop and computer accessories, textiles and wood office furniture.

With the recession of the early 1990s, purchases of new office furniture slowed, and Steelcase began to diversify into such operations as construction products, consultant services, and products for the health care field. In 1993, Steelcase started two new companies: Turnstone to cater to small businesses and home office workers, and Continuum, Inc., which commissioned work from minority designers.

Case 7/Principle Seven

Size and Space for Approach and Use

In 1995, Marriott, AT&T, and Steelcase developed a collaborative project to enhance office services for traveling business people. Through this project, selected Marriott hotels offered a “Room That Works,” equipped with a large table, mobile writing desk, adjustable office chair, task lighting, power outlets, and PC modem jack.

A Departure from Conventional Office Design

In 1991, Steelcase designers Mark Baloga, Paul Siebert, and Steve Eriksson began conceptual work on a new product that combined features of product design with those of interior and architectural design. The concept, which came to be known as the Personal Harbor® workspace, won a Gold Award in the 1995 Industrial Design Excellence Award (IDEA) competition and was featured in *Business Week’s* 1995 Best Product Designs of the Year.

Personal Harbor® was a departure from conventional office design. In developing this new concept, Steelcase did not rely on interviews and other conventional customer research. Instead, Steelcase researchers did exhaustive videotape studies of how workers actually function in a variety of companies. The result was a design based not on how people *say* they work, but how they actually did work, particularly in their interactions with coworkers.

A Mix of Shared and Private Space

The 6' x 8' work station was complete with walls, door, lighting, ventilation, power supply, worksurfaces, and storage systems. Even a partial ceiling was included. The walls and door of the Personal Harbor® reached 78" high and were raised 2 1/2" above the floor to provide for air circulation, even when fully closed.

Case 7/Principle Seven

Size and Space for Approach and Use

To facilitate both collaborative and individual tasks, the Personal Harbor® offered the user freedom in adjusting the privacy of the work space at will. A small clear-glazed window was located on a side wall above the worksurface, and the door incorporated a full-length frosted panel which could be special-ordered in clear glaze.

Although the private space included within Personal Harbor® was small by conventional office design standards, the 48" wide entrance afforded a seamless transition into common areas when needed, complete privacy when desired, or anything in between.

Personal Harbor® and Activity Products from Steelcase

Steelcase designers called the transition into common space the Personal Harbor's® "front porch."

Well-Integrated Accessibility

As might be expected of such a self-contained work space, requirements of a number of codes were incorporated, including the accessibility guidelines of Title III of the Americans with Disabilities Act.

The sliding, curved door incorporated a full-length vertical bar handle on the outside and 16" vertical bars on the inside, at both the inner and outer edges. The bars were approx. 1 1/4" in diameter with 1 1/2" clearance between the bar and the door surface. The force required for opening or closing was less than 5 lb. There was no latch or lock mechanism on the Personal Harbor® door.

Integrated Storage and Worksurfaces

In studying ADA guidelines for accessibility, Steelcase designers noted that reach ranges for wheelchair users were greater to the sides than straight ahead. Therefore, inside the Personal Harbor® was a wide column, nicknamed the "totem," which protruded no more than 4" into the space and could be oriented to the user's right or left. Stacked within the totem were shelves, drawers, and space for a telephone, a CD player, control panel for lighting and ventilation, and side-mounted power outlets, all between 15" and 54" above the floor.

Fixed shelves were located behind the curved wall housing the door, and height-adjustable shelves were integrated with the worksurface, also adjustable in 1" increments. The user had a choice of a convex worksurface for greater surface space, or a concave shape for greater maneuvering room. With the concave surface, there was 60" of turning space to allow ample room for wheelchair maneuvers inside, even with the door closed. A mobile auxiliary worksurface could be nested beneath the fixed worksurface or parked behind the user as necessary.

User-adjustable lighting was provided above as well as behind the worksurface, including a motion detector which turned on the lights when the threshold was approached.

A Usable Space for All

The four-year development of the Personal Harbor® design obviously included consideration of the needs of workers with disabilities. However, these considerations were so well-integrated with other design parameters as to be invisible. The result was a work station with universally useful features, yet flexible enough to accommodate specific needs and preferences of individuals. Nothing in the design identified the user as old or young, disabled or able bodied.

Case 7/Principle Seven

Size and Space for Approach and Use

A unique hybrid of product, interior, and architectural design, the Personal Harbor® illustrated the consideration for space, equability, and flexibility characteristic of good examples of Universal Design.

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Conclusion

Conclusion

Universal design can be subtle. At its best, products and environments have universally usable features that are so well integrated they become indistinguishable.

The Principles of Universal Design (The Center for Universal Design, 1997) are a breakthrough in specifying concretely all aspects of the concept for all design disciplines. They are useful for evaluating existing products and environments, guiding the design process, and educating designers and consumers about the characteristics of more usable designs.

The examples in Chapter 3 illustrate the intent of each guideline that accompanies the Principles. While the examples serve this purpose well, it is the authors' hope that these products, features, building elements, and spaces are only a beginning. Better examples should become increasingly easy to find as the concept of universal design gains broader acceptance and is adopted more widely.

The Principles of Universal Design are a work in progress. The next phase of development is to generate two additional levels of information. The first level is a set of design strategies that suggest ways to satisfy each guideline. The second level is a set of performance measures, or tests, that can be applied to a product or environment to assess its universal usability. Both of these additional levels of information need to be design discipline-specific, since people interact with landscapes, interior spaces, products, and communications devices and services in such different ways.

Conclusion

The biggest challenge faced by universal design advocates is increasing awareness of the approach among design professionals, manufacturers and consumers. Designers can influence their clients to appreciate the relatively small cost and large benefit associated with improved usability for all users. Manufacturers can realize higher sales to a wider market and deeper customer loyalty through production of products that are easier for more people to use. Finally, consumers will benefit from environments and products that impose less demand on their physical, sensory and cognitive abilities. All three of these constituencies must be educated about the benefits of universal design to stimulate widespread demand that it be practiced.

One of the best ways to influence the future of our designed world is to educate the next generation of practitioners. The Universal Design Education Project (UDEP), funded by several government and private entities, strives to integrate universal design issues into design curricula nationwide. While this effort has been beneficial, other academic disciplines should be introduced, as well. Students studying not only design, but also engineering, business, and public policy should be taught that access is a civil rights issue, and that maximum usability of all products and environments benefits everyone, both directly and indirectly. Universal design is the best way to integrate access for everyone into any effort to serve people well in any field. Although it will never be easy to design for diverse populations, concern for people should become an expected component of the process of designing any environment, product, service, or policy.

The need for sensitivity to usability issues will only become more pressing in the coming decades as user populations become more diverse. One significant trend is the increasing longevity of the human race, worldwide. Another factor is improved medical technologies that allow more critically injured and seriously ill people to survive. At the same time, consumer markets are becoming more global, as information and goods travel the globe with increasing ease. These three trends combine to create markets that are more diverse in age, ability, and experience. Recent federal legislation and changing demographics have raised the visibility of the issues of accessibility and greater usability. We must maintain and build this momentum.

It is our hope that this book has increased your knowledge, stimulated your creative energies, and galvanized your commitment to the successful practice of universal design.

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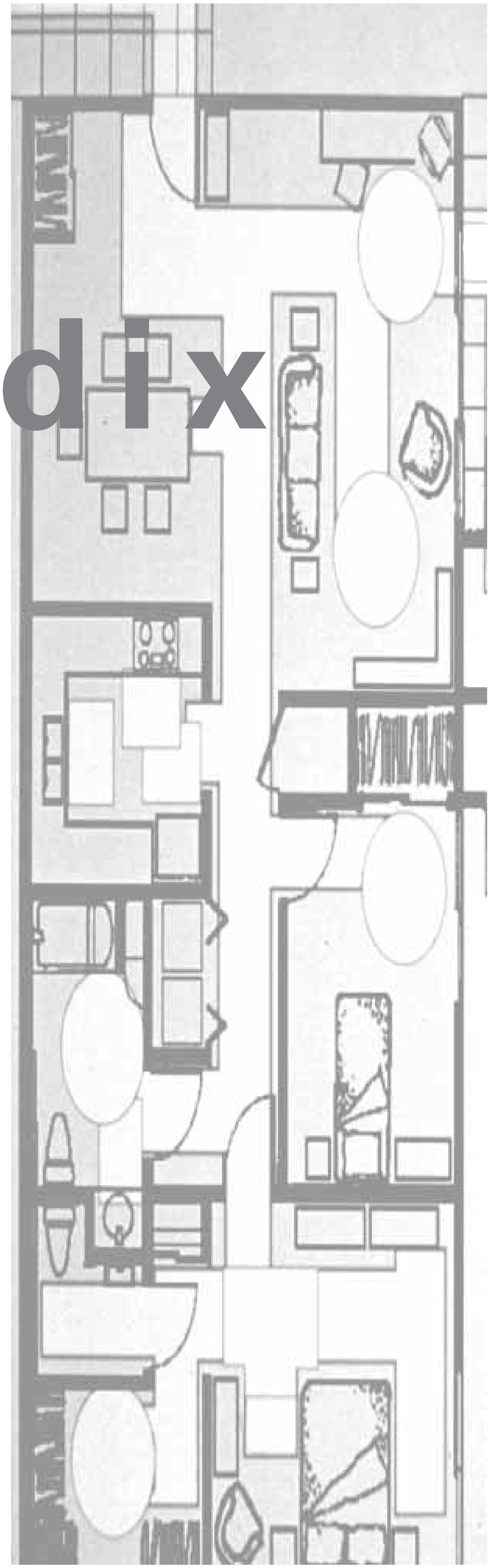
Appendix



Appendix

Resource List

This list is a selected bibliography of books, pamphlets, reports, articles, papers, and other media pertaining to universal design. It does not constitute an exhaustive list of all available materials but is, rather, a selection of works that represents the research, development, and application of universal design in a variety of disciplines.

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Universal design newsletter. [Quarterly newsletter]. Universal Designers and Consultants: 6 Grant Avenue, Takoma Park, MD 20912-4324.

UD newsline. [Quarterly newsletter]. The Center for Universal Design: North Carolina State University, Box 8613, Raleigh, NC 27695-8613.

Universal Design Practitioners

Universal Design Research and Development Organizations

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International Universal Design Resources On-Line:

Design for Ageing Network, European Union
<http://valley.interact.nl/dan/home.html>

E&C (Enjoyment & Creation) Project, Japan
<http://www.eandc.org>

European Institute for Design and Disability
<http://www.lboro.ac.uk/info/usabilitynet/eidd/EIDDHOME.htm>

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