APPENDIX C

Accessibility

This appendix presents recommendations for computer and component design related to lowering access barriers to computer use.
These guidelines were developed in consultation with the Trace Research and Development Center at the University of Wisconsin and based on research funded by the National Institute for Disability and Rehabilitation Research (NIDRR). For more information, see the reference at the end of this appendix.
For information about accessibility guidelines for software, see:
http://www.microsoft.com/windows/enable/

Contents

Introduction to Accessibility Recommendations

Personal computers are powerful tools that enable people to work, create, and communicate in ways that might otherwise be difficult or impossible. The vision of making computers easier for everyone to use, however, can be realized only if people with disabilities have equal access to personal computing.

Computer accessibility is becoming an increasingly important issue in the home and workplace. An estimated eight of ten major corporations employ people with disabilities who might need to use computers as part of their jobs. More than 30 million people in the United States alone have disabilities that can be affected by the accessibility of computer software. In addition, as the population ages, more people experience functional limitations that can cause computer accessibility to become a more important issue for everyone. Addressing disabilities in design frequently has benefits for all users, by making tasks simpler.

Legislation in the United States, such as the Americans with Disabilities Act (which affects private businesses with more than 15 employees) and Section 508 of the Rehabilitation Act (which affects the federal government and organizations that receive government funding), has also brought accessibility issues to national attention in both the public and private sectors. Accessibility is also being incorporated into official and international standards for usability, such as ANSI 200. Such recommendations affect the following:

- Visual displays and indicators
- Sound
- Manipulation and physical design
- Input devices and software controls
- Labeling
- Documentation

The rest of this section presents background information related to accessibility issues.

What Are Disabilities?

Individuals are not disabled—rather, some people have difficulties performing certain tasks, such as using a mouse or reading small print. When these limitations are serious enough to impact the person's performance, they are referred to as "disabilities." Anyone can experience the same difficulties because of illness or accident, environment (such as loud background noise), or hardware errors such as a missing mouse.

Disabilities can be divided into the following general categories:

- **Visual impairments.** This ranges from slightly reduced visual acuity to total blindness. Those with reduced visual acuity might only need images to be reasonably sized or specially enlarged, or they might need the high contrast between foreground and background. Users with more severe impairments might require output to be translated into audible cues, spoken text, or Braille.
- **Hearing impairments.** Some individuals do not notice beeps, distinguish different sounds, or recognize spoken words. These users might require that a computer prompt them in a different manner using a screen flash, an indicator lamp, or a display of messages as text.
- **Movement impairments.** Some users are unable to perform certain manual tasks, such as using a mouse or typing two keys at the same time. Others might have a tendency to hit multiple keys, "bounce" fingers off keys, or be unable to hold a printed book. Many users need keyboards and mouse functions to be adapted to their requirements, or they rely exclusively on a single input device.
- **Cognitive impairments.** Cognitive impairments take many forms, including short- and long-term memory loss, perceptual differences, and conditions such as Downs syndrome. Language impairments such as dyslexia or illiteracy are also very common. Even people learning the language used by their computer software as a second language can be considered to have a form of language impairment. Proper design can help increase accessibility for computer users with various cognitive and language impairments.
- **Seizure disorders.** People with some forms of epilepsy might experience minor or severe seizures when they see visual signals flash at certain rates or hear certain types of random or repetitive sounds.

- **Speech impairments.** Although difficulty speaking does not normally affect a person’s ability to use a computer today, it can be a problem in using telecommunications and voice menus. Difficulty in speaking might affect normal computer usage more if voice recognition becomes a common form of input in the future.

What Is Accessibility?

Accessibility means making computers accessible to a wider range of users than would otherwise be the case. Special needs can be addressed in several ways:

- New features built into hardware and operating systems that help make them accessible to users with and without specialized needs. These solutions are often referred to as “electronic curb cuts.” These solutions are preferred because the features are available on all workstations and can be used with all applications.
- Usability features that can be built into mainstream products, making them easier to use for people with disabilities. Examples include customizable colors and keyboard accelerators. In many cases these features also benefit people who do not have disabilities.
- Utilities that modify the system to help make it more usable by more people, but are not installed on all computers. Examples of utilities include Braille output systems for people who are blind or software that modifies the behavior of the keyboard and mouse.
- Specialized applications, such as a word processor designed to integrate voice and text, to help individuals with limited reading and writing skills.

A wide variety of hardware and software products have been designed to help people with disabilities make use of personal computers. Among the different types of products available for the Microsoft Windows operating system are the following:

- Programs that enlarge or alter the color of information on the screen for people with visual impairments
- Programs that describe information on the screen in Braille or synthesized speech for people who are blind or have difficulty reading
- Hardware and software utilities that modify the behavior of the mouse and the keyboard
- Programs that enable users to “type” using a mouse or their voice
- Word or phrase prediction software that allows typing more quickly with fewer keystrokes

- Alternate input devices, such as single-switch or puff-and-sip devices, for those who cannot use a mouse or a keyboard

The following sections summarize issues of computer design directly related to a wide range of individual needs for lowering barriers to computer use.

Visual Displays and Indicators

Visual display is the predominant form of display on today's computers. This includes the standard display screen, LED or LCD icon displays on or near the keyboard, and special visual indicators on peripheral devices. For people with low vision or blindness, these displays can pose a barrier to computer use.

When information is displayed on the standard computer screen, special screen-magnification software can increase the image size for people with low vision. Similarly, software "screen readers" can access the information and read it aloud to users who are blind. Information provided by indicator lights or small LCD mini-displays, however, must also be made available and readable by using screen readers or another mechanism.

Hardware design strategies for providing greater access to information presented visually includes the following:

1. Minimize glare.

   Glare caused by reflections or mismatched color combinations, overly bright indicators, and so on, might present problems for users with low vision. Minimizing glare allows these users greater access to displays.

2. Avoid 5 to 50 Hz range for the refresh rate or flicker rate.

   Allows users with photosensitive epilepsy, who might have a seizure if exposed to strong stimuli in the 50 Hz range, to more safely use the system.

3. If possible, make LCD and LED indicators, warning lights, and alert lights readable from software.

   Allows users who are blind to use their screen reading-software to access important indicators, warnings, and notices.

The following standard design practices also facilitate access and use by users with disabilities:

4. Provide contrast and brightness control.

   Important for users with low vision and color blindness so they can adjust the display to accommodate their needs and preferences.

5. Provide a display connector for an external or additional monitor.

   Users with low vision often need to augment the system with a larger monitor to take full advantage of their screen enlargement software. This is especially true for users of mobile PCs.

6. Make the monitor position and angle adjustable.

   Users with physical disabilities adjust the monitor to suit their seating position and approach to the system. Other users with low vision often adjust the monitor to reduce any glare that results from ambient light sources.

Sound

Sound is increasingly being used to convey information important to the operation of a computer. This includes alerts in addition to speech and other complex audio feedback. This can pose problems for any user on an airplane or in other noisy environments, and it can pose a problem for those who are deaf or hard of hearing.

Hardware design strategies for providing greater access to information presented in this fashion include the following:

1. Provide a headphone jack.

   Allows users with reduced hearing to block out background noise and make the output louder by using headphones or by directly connecting their hearing aids.

2. Maximize the range of volume adjustment.

   Allows users with reduced hearing to adjust the volume to suit their needs.

3. Face speakers towards the user.

   Maximizes the signal-to-noise ratio for all users. This is especially important for users with hearing loss.

4. Provide a visually distinct indicator for all alerts or warning sounds created by hardware.

   Makes recognizing alerts easier for users working in loud environments or for users with deafness or reduced hearing. (Software-generated alerts should be handled by software.)

5. Provide visual indication of important sounds generated in normal computer operation.

   Some natural sounds, such as those generated by a disk drive or printer, can be important to operation of the systems. Where this is true, some visual indication of the sound should be provided that accomplishes the same purpose so users in loud environments or users with reduced hearing or deafness can effectively use these systems.

6. Send hardware-generated beeps to the operating system.

   Allows visual display of the beeps for users in loud environments, located in another room, or with reduced hearing or deafness. Examples include beeps related to the keyboard and printer.

7. Place microphone in the orientation recommended by the microphone manufacturer.

   Along with speech recognition software, this makes the computer more accessible to users who are blind, have low vision, or are physically disabled (including those with Repetitive Strain Injury [RSI] and carpal tunnel syndrome), and for others who have difficulty writing.

8. Include a speech-capable sound system.

   Provides speech capabilities for nonspeaking persons and also the necessary hardware support for a speech-based access system for people with low vision, blindness, or reading problems.

9. Make operation of internal components quiet.

   Increases ability of users with neural hearing loss or hearing aids to converse or use computer sound-based features.

Manipulation and Physical Design

Often the focus of accessibility efforts is on the input or display components of a computer. However, many of the physical design characteristics of the computer are equally important. For example, if the person is unable to operate the latches to open a portable computer, the other aspects of the computer's design are of little practical importance.

Some users have conditions that result in weakness or poor movement control. Some have use of just one hand. Some have reduced range of motion or reach.

Hardware design strategies for providing greater access to the physical design of products include the following:

1. Eject media a sufficient distance for grasping.

   Ejecting 0.5 to 0.75 inch or more is helpful for those with reduced hand functions.

2. Sculpt or bevel entry slots and so on (including compact disc trays).

   Assists guiding the disk into the slot for those with reduced motor control. This also gives a tactile indicator, which helps those with low vision locate the slot. Compact discs should seat themselves properly if dropped into trays. (That is, no fine positioning is required from the user.) The disc should also be easy to grab from the tray (that is, allow slots at the sides of the tray for placing a finger under the disc to lift it out).

3. Make latches operable with one hand.

   Allows those who do not have use of limbs or those who use assistive pointing devices to operate the latch.

4. Keep force required for operation to a minimum (that is, less than 2 Newtons) for inserting and retrieving media.

Assists those with reduced strength and grasp capability. A maximum force of 2 Newtons is advised, but it is preferable to have the mechanism “suck” the disk in for insertion and not require a force of over 2 Newtons for pulling it out of the slot.

5. Ensure that media takes rough handling (use caddies for media that does not).

   Allows individuals with poor motor control to safely handle the media.

6. Provide error flags for misinserted media (especially compact discs).

   When it is not possible to block misinserted media (see description 8 below), the hardware could contain a disk-present detector to warn the user that a disk has been inserted but is unreadable because it is upside-down (and not just in an unreadable format). This would greatly assist users with visual impairments and also novice users.

7. Ensure that devices do not generate electromagnetic or RF fields that would affect users with hearing aids.

   Assists those users with hearing aids. Electromagnetic fields can couple with induction pick-ups in hearing aids, causing loud or disturbing noises. RF can affect all hearing aids. There are currently no industry standards for these levels, so reasonable care should be taken and testing is recommended.

The following design practices are fairly standard and also facilitate access and use by users with disabilities:

8. Use media misinsertion blocking.

   Assists all users as a memory aid, but helps especially those with low vision or cognitive impairments who might forget or misinterpret how to insert media (such as upside-down).

9. Have separate components that allow for use of alternative input devices.

   Assists those who use alternative input or output devices because of the nature of their reduced ability.

10. Provide adjustable height, swivel, and so on where appropriate.

    Assists those who do not have a full range of movement—displays and input devices can be oriented toward the user.

11. Have low noise operation.

    In general, quieter components (such as fans, disk drives, and so on) in computers are easier to use for those people with neural hearing loss or those who use hearing aids.

12. Have no hard edges or corners that could case injury or that could inhibit correct placement.

    Assists those with reduced motor control.

13. Have no material that can cause an allergic reaction.

    Chromium and nickel are known to cause allergic reactions in some users and should therefore be avoided in any part that users could contact with their skin during normal use.

Input and Controls

The ability to operate or use a computer depends directly on the ability to use its input devices and controls. For many people with physical or visual disabilities, using a computer depends either on the design of the input and control devices or on its ability to substitute other mechanisms for control (such as use different input devices or allow software control). Easier to operate controls are also appreciated by all users, as is the ability to connect and use alternative input devices of their preference.

Users who are blind cannot use input mechanisms that require eye-hand coordination, such as a mouse or a control with no tactile or auditory reference.

Hardware design strategies for providing greater access to input and control functions include the following:

1. Allow connection, substitution, or addition of alternative input devices (such as keyboards, pointing devices, and so on).

   A second serial port, for example, is helpful for those using SerialKeys software in Windows 95 to provide alternative access as well as for blind users who typically use speech synthesizers with serial connections. As another example, for users who cannot use standard input devices (even with software extensions such as StickyKeys), the availability of an external keyboard and mouse connection on portable systems allows them to substitute specially-designed keyboards or pointing devices.

2. Make all controls operate from the keyboard.

   This allows users with restricted reach or manipulation to operate controls on the computer, monitor, and so on, that they would otherwise be unable to use. It also allows them to operate the controls from any other keyboard they might use.

3. Have all controls mounted on the front of the device (that is, facing the user).

   Allows users who have reach limitations to access the controls.

4. Use push buttons primarily.

   Assists those with reduced motor control and those using head or mouth sticks or other alternative pointing devices.

5. Use concave buttons (especially where sustained force is required).

Assists those with reduced finger or motor control (such as tremor) and those who must use headsticks or other pointing devices to operate the buttons. Helps keep finger or pointer from slipping off the button while being pushed.

6. Avoid twisting motions (instead, use push buttons or edge controls).

   Users with some disabilities, such as cerebral palsy or arthritis, find twisting motions difficult or impossible.

7. Minimize the force required for operation (that is, less than 2 Newtons).

   Assists those with reduced strength. A maximum force of 2 Newtons for any operation is advised. For controls, use light touch or substitute manual mechanisms with power driven ones for sustained or heavy touch, and require push of less than 2 Newtons.

8. Make all controls operate with one hand (preferably with one finger or assistive pointing device).

   Allows individuals with use of only one hand or who use assistive pointing devices to operate the controls.

9. Avoid capacitance-based controls (that is, do not use controls that require skin contact).

   Capacitance-based controls require contact with the human skin. Avoiding these allows users with assistive pointing devices or artificial limbs to use the system.

10. Use functional grouping and layout of controls.

    Assists those with low vision or cognitive impairments in finding the right keys quickly. Examples of functional sets are direction keys and control keys. They can be grouped by color coding that takes account of color blindness or other design features such as shape or feel.

11. Make controls tactually discernible.

    This includes locator ridges or nibs on the home keys on the keyboard and the five key on the numeric keypad that assist those who have low vision or are blind. Also, flat membrane keypads with no tactile features should be avoided because these give no feedback on the location of the buttons.

12. Make the state of non-momentary controls tactually discernible.

    Allows those who have low vision or are blind to discern the state of a control.

13. Have tactile and audible actuation feedback for controls.

    Allows people who have low vision or who are blind to determine when a key has been pressed.

14. Avoid keys that cannot be read or simulated by software.

Allows the use of software programs that can convert simultaneous keystrokes into sequential keystrokes. Many users rely on software programs that either detect or simulate keystrokes. For example, the StickyKeys, SlowKeys, and SerialKeys features in Windows 95 rely on this ability when compensating for a user's difficulty with the keyboard. Blind users can also query the state of toggle keys using software. Any nonstandard keys should produce scan codes that trigger their functionality.

15. Maximize sizes of controls within the space available.

    Assists those with low vision, and also assists users with limited dexterity who might have difficulty manipulating small controls.

16. Make the distance between controls sufficient for tactile and visual discrimination.

    Facilitates access by users with visual impairments as well as assisting those with reduced motor control. On keyboards, for example, key top spacing should be approximately one half of the key width. For small controls, spacing can be higher, but functional grouping should be maintained to make it easier to avoid pressing several controls at once.

17. Have stable controls (for example, intended activation should not change the adjustment state of the control).

    Some users with reduced motor control or blindness might inadvertently change the setting of one control while activating another. Controls or input devices should be designed to avoid this.

18. Manufacture input guards or provide mounting for guards.

    Keyguards are guards that go over the keyboard and allow users to press one key at a time while resting their hand on the keyguard surface (which allows those with reduced strength and those with reduced motor control to have more control over their input). Guards can also be made for other input devices where applicable. The FilterKeys features in Windows 95 allows direct access for many users, but others benefit further from hardware guards. Manufacturers should also ensure grooves or holes are made in the edge of the device to allow for mounting of a guard.

19. Provide stable keyboards (for example, nonslip feet).

    Assists those with reduced motor control who might otherwise inadvertently move the keyboard when trying to use it.

20. Have no left-right bias.

    Assists those who have use of only one hand and those who are left-handed. Where this is not possible (for example, built-in numeric keypads) alternatives should be provided (for example, support for external numeric keypads).

Labeling

The ability to read labels is important to ensure that users are able to detect and recognize controls, connectors, and media interfaces. Users with low vision or blindness often have difficulty if these labels are simply printed in small or low-contrast type. All users have difficulty when these small printed labels are on the back or in hard-to-view areas of a product.

Hardware design strategies for providing greater access to labels include the following:

1. Use large, high-contrast, bold stroke, sans serif letters, and avoid artwork behind the text.

   Allows users with low vision and older users with reduced vision to more easily see the lettering.

2. Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch).

   Allows users who are blind to more easily discern an item's label by touch. Also allows any user to identify a component located out of view (such as connectors in the back of the unit).

3. Provide optional Braille and tactile labels.

   Allows users who are blind the option of customizing the labels on the items.

Documentation

Modern multimedia computers and peripherals require use of documentation more than ever. For users with low vision or blindness, standard print manuals might be unusable. Users with physical disabilities might be unable to hold perfect-bound manuals open. All users would find manuals that are easier to understand a welcome enhancement.

Some documentation design strategies for providing greater access and usability of documentation include the following:

1. Provide documentation in electronic form (ASCII).

   Enables generation of Braille, speech, and variable-sized text outputs for users with blindness, low vision, and cognitive or physical disabilities.

2. Provide verbal descriptions of graphical information.

Allows users with blindness or low vision access to the information contained in the graphic.

3. Use easily understandable language.

   Benefits everyone, but is especially useful to persons whose first language is sign language or for users with cognitive disabilities.

4. Use binding that allows the manual to lie open on the table.

   Allows the user to manipulate the document with one hand or a mouthstick.

5. Provide manuals in alternative formats such as large print (sans serif, 18 point) or Braille.

   Allows users with blindness or low vision access to the information.

6. Use high-contrast layouts.

   Allows users with color blindness or low vision access to the information.

7. Use colors that can be copied on copy machines.

   Allows users with low vision the ability to enlarge the information using a copy machine.

8. Provide online help.

   Allows users to access information without having to refer to manuals.

9. Avoid conveying information by color alone.

   Allows users with low vision or color blindness to perceive the information, and allows blind individuals to scan the documentation to convert it to ASCII text.

Accessibility Recommendations for PC Design

This section presents summary lists of recommendations for design issues related to access for persons with disabilities. Item numbers are based on lists in related sections in this appendix.

1. Accessibility recommendations for physical design (casing)
Recommended

Input and Controls:

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead use push buttons or edge controls)

7 Minimize the force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

11 Make controls discernible by touch

13 Have tactile and audible actuation feedback for controls

15 Maximize sizes of controls within the space available

16 Make distance between controls sufficient for tactile and visual discrimination

Manipulation and Physical Design:

2 Sculpt or bevel entry slots and so on (including compact disc trays)

3 Make latches operable with one hand

7 Ensure devices do not generate electromagnetic fields that would affect users with hearing aids

9 Have separate components that allow for use of alternative devices

10 Use adjustable height, swivel, and so on where appropriate

11 Have low noise operation

12 Have no hard edges or corners

Labeling:

1 Use large, high-contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in the Documentation section of this appendix

Accessibility for PC Card

This section presents a summary of recommendations for design issues related to access for persons with disabilities. Item numbers are based on lists in related sections in this appendix.

2. Accessibility recommendations for PC Cards
Recommended

Labeling:

1 Use large, high contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in this appendix

Accessibility Guidelines for Input Components

This section presents summary lists of recommendations for design issues related to access for persons with disabilities. Item numbers are based on lists in related sections in this appendix.

3. Accessibility recommendations for pointing devices
Recommended

Input and Controls:

1 Allow connection, substitution, or addition of alternative input components (that is, keyboards, pointing devices, and so on)

2 Make all controls operable from keyboard

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead, use push buttons or edge controls)

7 Keep force required for operation to a minimum (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

9 Avoid capacitance-based controls (that is, controls do not require skin contact)

10 Use functional grouping or layout of controls

11 Make controls tactually discernible

13 Have tactile and audible actuation feedback for controls

16 Make distance between controls sufficient for tactile and visual discrimination

17 Have stable controls (that is, intended activation should not change the adjustment state of the control)

18 Manufacture input guards or provide mounting for guards

20 Have no left-right bias

Manipulation and Physical Design:

9 Have separable and interchangeable parts

12 Have no hard edges or corners

13 Have no material creating allergies

4. Accessibility recommendations for keyboards

Recommended

Input and Controls:

1 Allow connection, substitution, or addition of alternative input components (that is, keyboards, pointing devices, and so on)

2 Make all controls operable from keyboard

3 Have all controls mounted on the front of the device (that is, facing the user)

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead, use push buttons or edge controls)

7 Minimize the force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

9 Avoid capacitance-based controls (that is, controls do not require skin contact)

10 Use functional grouping or layout of controls

11 Make controls tactually discernible

12 Make the state of non-momentary controls tactually discernible

13 Have tactile and audible actuation feedback for controls

14 Avoid keys that cannot be read or simulated by software

15 Maximize sizes of controls within the space available

16 Make distance between controls sufficient for tactile and visual discrimination

18 Manufacture input guards or provide mounting for guards

19 Provide stable keyboards

Manipulation and Physical Design:

9 Have separate components that allow for use of alternative devices

10 Use adjustable height, swivel, and so on where appropriate

12 Have no hard edges or corners

13 Have no material creating allergies

Visual:

3 Make LCD and LED indicators, warning, and alert lights readable from software

Labeling:

1 Use large, high contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in this appendix

Accessibility Guidelines for Display Monitors

This section presents summary lists of recommendations for design issues related to access for persons with disabilities. The following item numbers are based on lists in related sections in this appendix.

5. Accessibility guidelines for display monitors
Recommended

Input and Controls:

2 Make all controls operable from keyboard

3 Have all controls mounted on the front of the device (that is, facing the user)

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting options (instead use push buttons or edge controls)

7 Minimize force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

9 Avoid capacitance-based controls (that is, does not require skin contact)

10 Use functional grouping or layout of controls

11 Make controls tactually discernible

12 Make the state of non-momentary controls tactually discernible

13 Have tactile or audible actuation feedback for controls

15 Maximize sizes of controls within the space available

16 Make distance between controls sufficient for tactile and visual discrimination

17 Have stable controls (that is, intended activation should not change the adjustment state of the control)

Manipulation and Physical Design:

3 Make latches operable with one hand

7 Ensure devices do not generate electromagnetic fields that would affect users with hearing aids

9 Have separate components that allow for use of alternate devices

10 Use adjustable height, swivel, and so on, where appropriate

11 Have low noise operation

12 Have no hard edges or corners

13 Have no material creating allergies

Visual:

1 Minimize glare

2 Avoid 5−50 Hz range for the refresh rate or flicker rate

3 Make LCD and LED indicators, warning, and alert lights readable from software

4 Provide contrast and brightness control

5 Provide a video connector for an external or additional display

6 Make the display adjustable

Labeling:

1 Use large, high contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in this appendix

Accessibility Guidelines for Audio Components

This section presents a summary of recommendations for design issues related to access for persons with disabilities. All item numbers are based on lists in related sections earlier in this appendix.

6. Accessibility features for headphones
Recommended

Sound:

1 Provide a headphone jack

2 Maximize the range of volume adjustment

5 Provide visual indication of sounds generated in normal computer operation

6 Send hardware-generated “beeps” to the operating system

7. Accessibility features for microphones
Recommended

Sound:

7 Place microphone facing the user

Labeling:

1 Use large, high contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

8. Accessibility features for speakers
Recommended

Sound:

2 Maximize the range of volume adjustment

3 Place speakers facing the user

8 Include a speech-capable sound system

9 Make operation of internal components quiet

Accessibility Guidelines for Storage Devices

This section presents summary lists of recommendations for design issues related to access for persons with disabilities. Item numbers in the lists are based on items in related sections in this appendix.

9. Recommendations for 3.5-inch floppy disk drives

Recommended

Input and Controls:

1 Allow connection, substitution, or addition of alternative input devices (that is, keyboards, pointing devices, and so on)

2 Make all controls operable from keyboard

3 Have all controls mounted on the front of the device (that is, facing the user)

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead, use push buttons or edge controls)

7 Minimize force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

11 Make controls tactually discernible

Manipulation and Physical Design:

1 Eject media a sufficient distance for grasping

2 Sculpt or bevel entry slots, and so on

3 Make latches operable with one hand

4 Minimize force required (that is, less than 2 Newtons) for insertion and retrieval of media

5 Ensure that media takes rough handling (use caddies for those that cannot)

6 Provide error flags for misinserted media

7 Ensure that devices do not generate electromagnetic fields that would affect users with hearing aids

8 Use media misinsertion blocking

11 Have low noise operation

Sound:

4 Provide a visually distinct indicator for all alerts or warning sounds

5 Provide visual indication of sounds generated in normal computer operation

Visual:

3 Make LCD and LED indicators, warning, and alert lights readable from software

Labeling:

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in this appendix

10. Accessibility recommendations for CD-ROM drives

Recommended

Input and Controls:

2 Make all controls operable from keyboard

3 Have all controls mounted on the front of the device (that is, facing the user)

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead, use push buttons or edge controls)

7 Minimize force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

11 Make controls tactually discernible

13 Have tactile and audible actuation feedback for controls

15 Maximize sizes of controls within the space available

Manipulation and Physical Design:

1 Eject media a sufficient distance for grasping

2 Sculpt or bevel entry slots, and so on (including compact disc trays)

3 Make latches operable with one hand

4 Minimize force required (that is, less than 2 Newtons) for insertion and retrieval of media

5 Ensure that media takes rough handling (use caddies for those that cannot)

6 Provide error flags for misinserted media (especially CDs)

7 Ensure that devices do not generate electromagnetic fields that would affect users with hearing aids

8 Use media misinsertion blocking

11 Have low noise operation

12 Have no hard edges or corners

Sound:

4 Provide a visually distinct indicator for all alerts or warning sounds

5 Provide visual indication of sounds generated in normal computer operation

Visual:

3 Make LCD and LED indicators, warning, and alert lights readable from software

Labeling:

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in this appendix

Accessibility Guidelines for Printers

This is a summary liss of recommendations for design issues related to access for persons with disabilities. Item numbers in the lists are based on items in related sections in this appendix.

11. Accessibility for printers
Recommended

Input and Controls:

1 Allow connection, substitution, or addition of alternative input devices (that is, keyboards, pointing devices, and so on)

2 Make all controls operable from keyboard

3 Have all controls mounted on the front of the device (that is, facing the user)

4 Use push buttons primarily

5 Use concave buttons (especially where sustained force is required)

6 Avoid twisting motions (instead, use push buttons or edge controls)

7 Minimize force required for operation (that is, less than 2 Newtons)

8 Make all controls operable with one hand (preferably with one finger or assistive pointing device)

9 Avoid capacitance-based controls (that is, controls do not require skin contact)

10 Use functional grouping or layout of controls

11 Make controls tactually discernible

12 Make the state of non-momentary controls tactually discernible

13 Have tactile and audible actuation feedback for controls

15 Maximize sizes of controls within the space available

16 Make distance between controls sufficient for tactile and visual discrimination

20 Have no left-right bias

Manipulation and Physical Design:

1 Eject media a sufficient distance for grasping

3 Make latches operable with one hand

4 Minimize force required (that is, less than 2 Newtons) for insertion and retrieval of media

6 Provide error flags for misinserted media

7 Ensure that devices do not generate electromagnetic fields that would affect users with hearing aids

11 Have low noise operation

12 Have no hard edges or corners

13 Have no material creating allergies

Sound:

4 Provide a visually distinct indicator for all alerts or warning sounds

5 Provide visual indication of sounds generated in normal computer operation

6 Send hardware-generated beeps to the operating system

9 Make operation of internal components quiet

Visual:

3 Make LCD and LED indicators, warning, and alert lights readable from software

Labeling:

1 Use large, high contrast, bold stroke, sans serif letters

2 Use tactually distinct icons for controls, connectors, and legends (raised at least 1/32 inch)

3 Provide optional Braille and tactile labels

Documentation:

- All points in Documentation section in the “Accessibility” chapter

References and Resources for Accessibility

This section lists some of the references, services, and tools available to help build hardware and software that addresses accessibility needs.

Accessibility Publications

The following publications provide supplementary information.

Berliss, J. R. (1990). Checklists for implementing accessibility in computer laboratories at colleges and universities. University of Wisconsin-Madison, Trace Research and Development Center.
Fontaine, P. (1995). Writing Accessible HTML Documents. General Services Administration.
Lowney, G. C. (1995). The Microsoft Windows Guidelines for Accessible Software Design. Microsoft Corporation.
Novak, M. (Ed.) (1991). General Input Device Emulating Interface: Version 1. University of Wisconsin-Madison, Trace Research and Development Center.
Thoren, Clas (Ed.) (1993). Nordic guidelines for computer accessibility. Gotab, Sthlm.
Vanderheiden, G. C. (1988). Consideration in the design of computers and operating systems to increase their accessibility to persons with disabilities. University of Wisconsin-Madison, Trace Research and Development Center.
Vanderheiden, G. C. (1991). Making software more accessible to people with disabilities. University of Wisconsin-Madison, Trace Research and Development Center.
Vanderheiden, G. C. and Vanderheiden, K. R. (1991). Accessibility Design Guide I: Guidelines for the Design of Consumer Products to Increase Their Accessibility to Persons with Disabilities or Who Are

Aging. University of Wisconsin-Madison, Trace Research and Development Center.

Resources for Accessibility Design

This section lists some documents and services that can help with accessibility design.

Microsoft Windows Guidelines for Accessible Software Design
This publication describes techniques for developing software applications that are usable by people with disabilities. This document is included on the Microsoft Developer Network CD-ROM. To obtain additional copies or information about other Microsoft products and services for people with disabilities, contact:

Microsoft Sales Information Center
One Microsoft Way
Redmond, WA 98052-6393
Voice: (800) 426-9400
Text Telephone: (800) 892-5234
Fax: (206) 635-6100

Research and Product Information
For information on research and development concerning technology, communication and disability, or for catalogs of accessibility products and service providers, contact:

Trace Research and Development Center
Waisman Center and Dept. of Industrial Engineering
University of Wisconsin, Madison, WI 53705
E-mail: info@Trace.Wisc.Edu
Fax: (608) 262-8848
FTP, Gopher, and WWW servers at trace.wisc.edu

For a list of listserve discussions, send “LISTS” to listproc@trace.wisc.edu

Documentation in Accessible Formats
The organization Recording for the Blind and Dyslexic, Inc. can assist in preparing documentation in accessible formats, including electronic text and audio tape. Contact:

Recording for the Blind and Dyslexic, Inc.
20 Roszel Road
Princeton, NJ 08540
Voice telephone: (800) 221-4792
Fax: (609) 987-8116

For a list of organizations that can assist in converting documentation into large print or Braille, contact the Microsoft Sales Information Center at the address listed above.

Assistive Technology Programs
For general information and recommendations about how computers can help specific users, consult a trained evaluator who can best match the user needs with the available solutions. An assistive technology program in your area will provide referrals to programs and services that are available to you. To locate the assistive technology program nearest you, contact:

National Information System
Center for Developmental Disabilities
Midland Center
Education Building
8301 Sarrow Road
Columbia, SC 29203
Voice or text telephone: (803) 777-4435
Fax: (803) 935-5250

Closed Captioning and Video Description
The following services can provide assistance in adding closed captions or video description to video tape and film:

The Caption Center
125 Western Avenue
Boston, MA 02134
Voice/text telephone: (617) 492-9225
Fax: (617) 562-0590

National Captioning Institute
5203 Leesburg Pike
Suite 1500
Falls Church, VA 22041