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ABSTRACT

This report discusses the growth of the National Information Infrastructure (NII), or the information superhighway, and its implications for people with disabilities. Advantages for people with disabilities include: increasing the ability of individuals with some types of disabilities to access and use information; decreasing personal isolation due to mobility and communication restrictions; allowing individuals to interact with others in a way that makes their disability invisible or irrelevant; and allowing convenient access to educational and medical services. The barriers to the NII include: socioeconomic barriers; the complexity in the design of many products; the use of graphic interfaces; the use of touchscreens and pointing interfaces where alternate input techniques are not available; virtual environments; sound; animation and interactive systems; and the sealed nature of public systems that must have built-in access accommodations if they are to be made accessible. The report makes recommendations on how facets of the NII can be modified to allow greater access by those with disabilities and strategies that can be used to achieve changes. A list of 17 additional readings is included. An appendix describes the mission of the National Council on Disability. (CR)

ACCESS TO THE INFORMATION SUPERHIGHWAY AND EMERGING INFORMATION TECHNOLOGIES BY PEOPLE WITH DISABILITIES

NATIONAL COUNCIL ON DISABILITY

September 30, 1996

National Council on Disability

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PREFACE

The National Council on Disability would like to remind the reader that the topic covered by this paper is dynamic and changes daily. Even as this document was being finalized, telecommunication legislation was passed that significantly rewrote the rules of the game. Although most of the changes were anticipated and incorporated into this document, the impact of the legislation is still being analyzed.

EXECUTIVE SUMMARY

Background

As part of its research agenda, the National Council on Disability (NCD) established a community-based, cross-disability consumer task force on technology in January 1995. Known as Technology Watch (Tech Watch), the 11-member task force provides information to NCD on issues relating to emerging legislation on technology and helps monitor compliance with civil rights legislation, such as Section 508 of the Rehabilitation Act of 1973, as amended.

This report falls under the purview of NCD's Tech Watch.

What Is the Information Superhighway?

In general, the National Information Infrastructure (NII), or the information superhighway, refers to a system of information networks and information services that will connect people across the country and internationally, and provide them with a variety of information. NII will connect the home, school, workplace, community, and eventually any other place on earth via local area network (LAN)-based, wireless, and satellite networks. Services will include all of those provided by the telephone, television, computer, and Internet systems today, plus many new services. NII should not be equated with the Internet. The Internet is the global network of computers that supports certain communication protocols, thereby facilitating electronic mail (e-mail), the World Wide Web, and other forms of information exchange. The Internet will be a major component, but in the long run, NII will be much more pervasive, much faster, and much more convenient.

Where Is NII Going?

Although no one knows exactly where NII is going, there are a number of clear trends, most of which have significant implications for individuals with disabilities.

One major trend is the convergence of the various communication, telecommunication, and computing fields. The lines between them are blurring rapidly. A second major trend is toward the client/server or net-centric model, in which the bulk of the program, data storage, and so forth, is located on a central system or a network, making available much more powerful capabilities at much lower expense. A related change is the development of "applets," small application programs that are downloaded from the network to the personal communicator/computer whenever they are needed. When the user is finished with them, they disappear, to be downloaded again when they are needed.

A close corollary to these developments is distributed serving, in which the product or service being purchased is made up of many components from different sources that are automatically combined.

Multimedia animation and virtual reality (VR) are also coming into much more frequent use. Although they have been somewhat limited to date because of slow network speed, use of both will be increasing as networks get faster. They will be appearing not just in entertainment, where their major use is today, but in education, shopping, and virtually every other aspect of daily life.

The form of access to NII is also changing and now includes information appliances and personal digital assistants, set-top boxes that provide access via the television set, public service terminals or kiosks such as automatic teller machines (ATMs), and public service vending/transaction terminals such as fare machines. Constraints for providing access will be slightly different for each of these forms.

In addition to these trends, the concept of a universal address or telephone number is beginning to be discussed. This number would be an identity that would follow people throughout their lives.

The concept of "smart cards," including wireless smart cards, is also being considered. These are small credit-card-sized devices with a computer in them. With the wireless variety, information about individuals and their preferences could be

communicated to a device simply by approaching the device. Products or services could also be paid for without handling currency.

Implications for People with Disabilities

NII has the potential to level the playing field in many areas of life, but it can also pose new barriers.

Advantages

For people with disabilities, NII provides all the advantages provided to everyone else, plus some special ones. The special advantages include the following:

- Drastically increasing the ability of individuals with some types of disabilities (including visual, hearing, physical, and cognitive/language impairments) to access and use information.
- Decreasing the personal isolation that individuals experience because of restrictions in their ability to move about, communicate, or get together with others sharing their interests or situation.
- Allowing individuals to interact with others in a way that makes their disability invisible or irrelevant.
- Allowing convenient access to educational and medical services.

Disadvantages

Anyone who cannot afford or who cannot physically access and use NII will be at a severe disadvantage. Inaccessibility poses a special risk for individuals with disabilities. If access depends on third-party developers' ability to create special interfaces, people with disabilities are likely to always be left 6 to 12 months behind. In addition, multimedia trends pose difficulties for individuals with visual impairments, and pointing and gesture interfaces are difficult for individuals with physical impairments. Voice input can create problems for both individuals with hearing impairments and those with physical/speech impairments if no alternate input options are provided.

Barriers and potential barriers

Barriers to use of emerging communication and transaction technologies include

- The standard socioeconomic barriers;
- The complexity in the design of many of the products;
- The use of graphic interfaces;
- The use of touchscreens and pointing interfaces where alternate input techniques are not available;
- Virtual environments;
- Sound;
- Animation and interactive systems;
- The sealed nature of public systems, which must have built-in access accommodations if they are to be made accessible.

Although all of the above are potential barriers to people with disabilities, strategies are available today to provide access to the various types of environment. In some cases, the techniques are quite good, and provide complete and efficient access to the information/service. In other cases, rudimentary strategies have been developed, but further work is required. The interface field generally is evolving rapidly, and new technology and interface developments are creating new challenges.

General Accessibility Guidelines

Some general access strategies can be applied across all information systems. In the list below, the major disability groups that would be affected by each strategy are shown in brackets.

1. ***Visual information***—All information that is presented visually (or stored as an image), should have an alternate or supplemental presentation (or storage format) that does not require vision (e.g., auditory format or ASCII text). [blindness, cognitive/language impairment]

2. ***Auditory information***—All information that is presented auditorily (or stored as a sound file), should have an alternate or supplemental mode of presentation (or

storage format) that does not rely on hearing (e.g., visual mode or ASCII text file). (Auditory information includes beeps or any other sounds that convey information.) [hearing impairment, deafness, cognitive/language impairment]

3. ***Eye-hand coordination controls***—All controls that require eye-hand coordination (mice, trackballs, ordinary touchscreens), should have an alternate or supplemental mode that does not require eye-hand coordination (e.g., keyboard, Talking Fingertip touchscreen). [blindness, physical impairment]

4. ***Physical requirements***—Any input or control mechanisms that require fine movement control, physical dexterity, reach, or strength should have an alternate mechanism (such as scanning or keyboard navigation) that does not have such physical requirements. Mechanisms that require simultaneous activation of two buttons, latches, and so forth, should be avoided. Timed responses should be avoided, or a mechanism provided for extending the times. [physical impairment, cognitive/language impairment]

5. ***Operation***—The operation of the device/system should be as simple, predictable, and error tolerant as possible. [cognitive/language, low vision, physical disability, blindness]

6. ***Connectivity***—Wherever possible, provide an external standard connection point should be available to connect alternate displays and/or alternate input/control mechanisms (e.g., infrared link or RS232 port with alternate display and control capability). [blindness, physical impairment]

Goals Regarding Accessibility and NII

Goal 1: Products should be both accessible and **USABLE** by people with disabilities.

Goal 2: Source materials (print, audiovisual, multimedia, VR) should be presentation independent or multimodal.

Goal 3: Public systems should be directly accessible by the widest possible constituency.

Goal 4: To the extent feasible, accessibility to all products should be direct (built-in), rather than requiring the user to modify the product or purchase assistive technologies in order to use the product.

Goal 5: Devices and systems should be flexible enough that people who lack one or more of the following capabilities can still use them: Vision; hearing; speech; fine movement control; reach; average cognitive skills; average ability to concentrate.

Although these goals may seem ambitious, some products already come close to achieving or do achieve all of these objectives. Achieving these goals would also increase the general usability and flexibility of next-generation systems for all users.

Options

Two general options exist for making products and systems accessible by people with disabilities. One is to design the products so they are directly usable by people with disabilities. The other is to design them so they can be adapted or used with assistive technologies. A third, hybrid option is to design products with both characteristics.

1. ***Built-in access***

Built-in access has a number of advantages. It does not require individuals with disabilities to purchase or own special equipment. It is convenient because it does not require individuals to carry special assistive technologies with them. There is no delay between the moment a device is released and in general use and the moment that third-party manufacturers can develop access adaptations. The user is not left without access because third-party manufacturers deem the market for access devices too small. Individuals who are progressively losing their abilities (e.g., because of aging), and who may be in denial, are able to successfully access and use the systems for which they would not purchase or use an assistive technology because of the stigma. Built-in access is particularly effective if the access features are a natural part of the adjustability of the device and are routinely used by others.

The major difficulty with this approach is that it is not always practical to build access for every type, degree, and combination of disability directly into every instance of a product (e.g., dynamic braille displays for individuals who are deaf-blind).

2. *Adaptation or use in conjunction with assistive technologies*

This approach also has advantages. Individuals can use an interface that is familiar to them for controlling different appliances. Such an interface provides an access mechanism for individuals with severe or multiple disabilities, where building access directly into the product is not currently practical. On small or inexpensive systems, for which direct built-in access may be extremely difficult, a small connection link may be quite practical.

The disadvantages of this approach are the need for individuals to wait for assistive technologies to be developed for each new product, then to purchase those technologies and carry them about.

3. *Hybrid approach*

The hybrid approach is to build as much direct access into a product as is practical, and to work with assistive technologies as a fallback for individuals for whom direct access is not possible or practical. It combines the advantages of the first two options, while circumventing most of their individual disadvantages. The primary issue is to determine when accessibility should be directly built in, and when the device should be used with third-party assistive technologies. Usually it is not optimal or even realistic to expect users to carry special assistive technologies with them. However, for individuals with severe and multiple disabilities (e.g., deaf-blindness), there may be no other practical approach for some products. There may also be limitations on extremely small or inexpensive products.

Forces That Cause Change in Design and Accessibility

Three major factors can cause change:

1. *Awareness* that there is a problem and that solutions can be implemented economically.

Almost without exception, when researchers have visited companies to encourage more accessible (more universal) designs, executives were either unaware of the problems their current designs posed or unaware that cost-effective solutions could be easily implemented to make their products more accessible. (In many cases, executives were unaware that people with disabilities use their products.) Basic awareness is essential to progress.

2. ***Knowledge*** of specific, acceptable and effective solutions.

Once industry has been made aware of a problem, there have frequently been requests for more specific information related to the problems and solutions. Specific, detailed ideas and options have been requested, along with as much flexibility as possible. (Some industry members who have been embarrassed by moving forward with one implementation only to be criticized for not doing it right, also want some assurance of consensus within the disability community before proceeding.) Specific, practical, flexible and cross-disability approved guidelines are needed to move forward with any speed in this area.

3. ***Motivation*** to move the priority high enough to get it acted on.

Almost all company representatives have commented that both internal and external motivations were necessary to either get accessibility programs moving or keep them moving. A surprising number have said that legislation requiring accessibility would be helpful to their efforts by

- Raising the priority from "really should do this, really want to do this" to "really must do this" so that accessibility programs can compete with other "must do" priorities within the company; and
- Leveling the playing field by requiring the competition to also take the time initially to build the features in or to learn how to design more universally.

Other motivating forces mentioned included larger market (usually deemed negligible for any one feature); demand by customers; recognition in the press (e.g., if all

product reviews in the press also evaluated product accessibility); and right thing to do (usually not enough by itself to move from "want to do" to "must do").

Strategies for achieving change

If the agents of change are awareness, knowledge, and motivation, then the strategies for causing change should be based on these agents. The strategies include those presented in the document "Policy Recommendations from the Universal Access Project," by Deborah Kaplan. There are recommendations specifically for government, for industry, for technical/research groups, and for consumers. All are considered key to bringing about the changes necessary to ensure NII access for everyone.

Strategies for increasing awareness

The need for increased awareness of access issues and strategies is not limited to industry designers and engineers. Researchers in both the public and private sectors must to be included in activities to increase awareness. Likewise, policy makers and people with disabilities must be more aware of the issues and strategies surrounding access to information systems.

Government agencies, such as NCD, can employ strategies such as defining access as a policy goal; ensuring that the topic of access is a high priority; including at least a section discussing disability access issues in any documentation on NII; assuming a leadership role in publicizing the benefits of access; including access in policy initiatives regarding universal service and universal access; and requiring that all grants dealing with NII include a statement describing how recipients will address issues of disability access. Agencies can also support efforts to secure broad input from disability groups, bring the different groups together to identify acceptable cross-disability access strategies, and promote activities that can heighten public and industry awareness of access issues.

Private industry can establish company-wide policy on accessibility, establish and implement internal disability access teams, encourage collaboration across all company divisions and segments to explore access issues, and ensure that product support

mechanisms exist to allow appropriate communication and interaction with people with disabilities.

Technical and research groups can publish professional papers describing research and development efforts regarding disability access issues, publicize access-related research and development efforts, and participate in and disseminate information at disability- and nondisability-related conferences.

Consumers and disability constituencies can make access needs known to providers and give both positive and negative feedback, provide input to government and industry regulatory and policy boards such as NCD's Tech Watch, closely consider cross-disability access issues in contrast to those of their own particular constituency, work cooperatively with other disability constituencies, and participate in government- and industry-sponsored activities to promote awareness of access issues.

Strategies for Creation and Dissemination of Knowledge

The creation and dissemination of knowledge pertaining to access have two major components. First, research must be sponsored to develop answers and solution strategies to the many access issues posed by emerging technologies. Second, the knowledge obtained must to be disseminated to researchers, developers, manufacturers, policymakers, and consumers.

Government can create funding programs that target accessibility research, recognize that much government-funded research is conducted in areas that are complementary to accessibility research and require that accessibility be included in such research, foster university-industry research and development efforts, promote efforts between disability-oriented technology research groups and research groups focused on next-generation information system and human-computer interfaces, work at all levels to disseminate information to agencies having direct contact with individuals with disabilities, disseminate information to disability advocacy and consumer groups, publicize new information in appropriate journals and media, encourage consumer and

user participation in educating policymakers regarding access issues, and include consumer feedback mechanisms for all NII development activities.

Industry can include people with disabilities in human factors and product design research and in alpha and beta testing cycles, provide access to early product betas and developer support for third-party access developers and manufacturers, and provide adequate training to product support staff.

Technical and research groups can, in addition to the strategies listed for government and industry, work closely both with groups representing a variety of disabilities and with industry.

Consumers and disability communities can educate themselves and others regarding existing and future technologies and related access issues, educate product and service providers as to specific product-and service-related access needs, and work within the framework of government and industry concerns.

Strategies for increasing motivation

Although legislating change is not the only mechanism for motivating change, a surprisingly large number of company executives have confidentially suggested legislation as the most effective mechanism for causing change within their companies. They have cited two key factors in coming to this conclusion.

First, without some type of forcing factor (i.e., legislation), providing access to people with disabilities falls into the important or very important category and not into the urgent or critical category. Second, almost all companies involved in information technology are in fierce competition with multiple rivals. Legislation or regulations that require everyone to address these issues have the effect of leveling the playing field, so the company that does address them does not risk potential disadvantage.

However, executives are quick to follow with an admonition that setting such legislation or standards in this area must be done carefully, or it could be very problematic. Unlike public telephones, elevators, and restrooms, which tend to be

standard in appearance today, communication and information appliances and systems take on myriad different forms. Moreover, it is expected that the technologies in this area will continue to advance and evolve at an astonishing rate, making it difficult to predict what form, size, or shape the technologies of the future will have. Conversely, if access regulations are sufficiently general to allow for endless implementations, it becomes difficult to judge exactly what constitutes compliance. Probably the most effective strategy, therefore, is to set performance standards based on a reasonableness test. For example, a product should be usable by all individuals with disabilities whenever building such capabilities into products is reasonable and achievable. A measure of reasonable and achievable can then be based on whether other companies or competitors include such features in their products. This approach provides great motivation for companies to step forward and be among the first, since in doing so they demonstrate that accessibility is reasonable and achievable, thus compelling their competition (under the regulations) also to address the issue. Unlike their competitors, however, innovative companies will not have to consider redesign of their system to provide access. Thus, moving first provides companies a competitive advantage and saves them time and redesign.

NOTE: The legislation passed by Congress uses the term "readily achievable," which is not as strong as "undue burden" or "reasonable and achievable" but still applies in the situations described above.

Legislative or regulatory action is a critical strategy for providing motivation. It is not the only strategy, however, and is therefore presented along with other recommendations below.

Government can increase motivation by updating regulations to the Americans with Disabilities Act (ADA) to better account for information technology, adopt performance benchmarking for accessibility, encourage the private sector to work collaboratively with experts designing technological solutions to access barriers, include access and universal design requirements in existing or new legislation, set standards according to legislative mandates, apply standards and requirements to all government

efforts, and include requests or requirements for disability access in all federal and state purchase requests.

Motivation can be increased by all players by providing documentation to industry of any increase in market size or market penetration that would result from incorporating access, stimulating customer requests for access features, promoting and achieving the inclusion of disability access features in product reviews, providing recognition or awards for particularly well-designed products or services, and developing cross-disability consensus regarding recommended access features.

BRIEFLY, WHAT IS THE NATIONAL INFORMATION INFRASTRUCTURE, AND WHAT CAN I DO WITH IT?

What is the National Information Infrastructure, or the information superhighway?

When people speak of the National Information Infrastructure (NII) or the information superhighway, they have various ideas of what the terms refer to. In general, NII refers to a system of information networks and information services that will connect people across the country and will provide them with a variety of information resources and services. Eventually, NII will be part of a much larger Global Information Infrastructure, or GII.) Connectivity will be possible in the home, school, workplace, community, and beyond, and will be accomplished via terrestrial, satellite, and wireless networks. Information that will be available includes print materials, sound recordings, graphics/pictures, movies, databases, and software. Services such as telemedicine, distance learning, publishing, and telecommuting will be possible; and federal, state, and local government services will be provided via
these networks.

Much more than the Internet

Although many people equate NII with the Internet (our current electronic information highway system, which is a global network of computers that supports certain communication protocols, thereby facilitating e-mail, the World Wide Web, and other forms of information exchange), the envisioned and developing NII system is much broader than this. The information superhighway will allow information to be accessed in a variety of environments and via a variety of technologies, including the computer, the telephone, the television (via set-top boxes), and public information systems such as touchscreen kiosks.

As NII development progresses, a diverse range of industries will be involved in development efforts, including

- broadcast television,
- cable television,
- cellular and personal communications,
- computer hardware and software,
- consumer electronics,
- infotainment and advertising,
- publishing,
- local and long distance telephone companies,
- electric utilities,
- satellite providers, and
- wireless cable.

What use would I have for NII?

An extremely wide variety of things can be done on the current NII (let's call it a limited access highway), and even more will be possible on the NII that is emerging (let's call that the information superhighway, plus all its feeder roads and the driveways leading up to your house, school, company, etc.).

Following are some things that can be done using today's technologies, as well as some future capabilities. Many of the items listed under "tomorrow" are being demonstrated in laboratories today, but we do not yet have the bandwidth or connections to implement them. The situation is continually changing.

Technologies available today

Below are some services and activities that are possible on NII using today's technologies. In some cases, services and activities are possible using existing in-

formation infrastructure. In other cases, the technology is available to support the activity or service, but the connectivity (e.g., the wiring into homes and schools) is not.

Have a hobby?

Use the Internet to subscribe to newsletters about your hobby or to create and distribute your own newsletter. Participate in interactive discussions on topics of interest with people from your town or from anywhere in the world.

Need to communicate with your family in an emergency?

Send an emergency alert to everyone in your family simultaneously and have it arrive moments later. Various members of the family can easily contact other family members to make arrangements or to provide regular updates.

Trouble with your taxes?

Get any forms you need from the system. Complete the forms—the system can do all the math for you—and submit them. If you need help, you can make inquiries to the IRS or seek advice on assistance online from consultants or companies doing tax work. Or you can do the work yourself, tapping into public domain tax help systems.

Need a job, or simply curious about whether you could get a better job?

Use the system to confidentially search massive job databases. Set up a search that will automatically check the job postings every day, and alert you only if it finds job postings that meet your criteria. Or put your name, resume, and qualifications in a confidential job bank that prospective employers can search.

Want to buy a particular type of car?

Post the make, model, year, and other characteristics. Have the system return a list of all cars meeting your criteria that are for sale, with sellers listed in order by their distance from you. The list can include pictures, and the system can be customized to perform tasks such as periodic searching for a particular rare car.

Hungry?

Order a pizza via your system.

Paying bills?

Use your system to collect, list, and pay bills; transfer money between accounts; and quickly check any or all of your account balances.

Want to read a book?

Have full access to your library's card catalog to see which books are available. In the future, download any book instantly to a small reader the approximate size and weight of a paperback.

Want to travel?

Have the system describe various travel destinations and options. Tell the system where you want or need to go and obtain a list of all accommodations in the area. Customize the listings you order by distance from your destination, by cost, or by both. Get descriptions of the places that interest you, including pictures of the exterior, lobby, and rooms. Book a room with a keystroke or a click of the mouse.

Next, have the system find all the flights and list them with their costs. Pick a flight, and have the system show you all the available seats. Choose your own seat, and have the tickets sent to your house (or just log into an itinerary so that you need only identify yourself as you get on the plane). Making changes is easy, since your system knows all your arrangements.

Looking for a rare tool or stamp, or a hard-to-find pen or utensil?

Electronically search through hundreds of thousands of related products and have the system show you the best matches, until you find what you want.

Want to know what the weather's like?

Have instant access, from any location, to weather conditions anywhere in the world.

Want to know what the traffic's like?

From any location (including your car), have instant access to traffic conditions in any monitored location.

Want to go to a movie or see a play?

Get a listing of all movies, plays, or other entertainment in town, including starting times and locations. View promotional stills or videoclips from movies or plays of interest.

Want to stay home and watch a movie?

Access any movie at any time on your own television. It's like having a video store at your fingertips, except the movie you want is never out of stock. You can locate the desired movie without wandering around searching, or you can browse by title, topic, actor, or whatever category suits you.

Have a security problem at your home?

Set up a system with a surveillance camera that automatically calls you and lets you see what's going on if any sensors (fire, smoke, burglar, etc.) are triggered. If you see something suspicious or a problem, call the local authorities and patch them in so they can observe as well.

Need to send a message with explicit directions?

Send a message to anyone from almost any location, with voice, writing, or signed communications, along with sketches or drawings if needed.

Want to catch up on the news, but always miss the newscast?

Check on the status of any news stories at any time.

Need to conduct some research for school, work, or your hobby?

Ask your system to collect information from the millions of databases on NII and prepare a compilation of materials for you to peruse. Set the parameters of the search as narrowly or as broadly as you wish, and include parameters for how you'd like the information sorted. Ask your system to bring back articles, pictures, sound recordings, or videoclips/movies as needed.

Have a confidential medical question but feel awkward talking about it even anonymously?

Log into computer-assisted help lines that guide you to information on just about any topic, completely anonymously, with no human involvement.

Have a child in school?

Find out what the evening homework assignment is. Check on the school lunch for tomorrow (or for the week). Check on the school calendar for scheduled parent-teacher conferences, extracurricular activities, tutoring opportunities, and so forth.

Are you in school?

Use the net to learn about various schools, programs, or courses of study. Have the system compare the courses you've taken with those required for any degree, and get a report of what would still be needed to complete that degree. See what courses are offered and which ones still have openings. Register for courses and pay fees. Apply for financial aid. Use the system to communicate with your professor, and perhaps even take some online courses. Tap into any of a vast array of libraries and other resources on the net. Use the simulation programs on the net to carry out laboratory exercises, and so on, either on campus or at home. Use online tutoring services.

Having trouble finding someone?

Find any listed phone number or address anywhere in the United States.

Want to get a divorce?

Use the divorce kiosks in Nevada. (They work so well that even lawyers are using them to prepare filing papers for clients.)

Are you a scientist?

Use NII to connect massive computer systems across large distances. Study the stars; predict the weather; study molecular physics; run simulations of nuclear, biological, or other systems. Use high-speed, high-bandwidth communication channels to carry out experiments on equipment located across the country or across the globe; tie together remote scientists, equipment, and sites in collaborative efforts.

Are you a business person?

Use the system to link employees around the city, the state, the country, or the world to allow rapid exchange of documents and information and to carry out collaborative activities. Have an integrated data processing system, make information on your products available to anyone at any time, allow people to order (and possibly ship) your products to them at any time, and eventually (see below) conduct live virtual meetings.

Have a disability?

See all of the above for easier and more accessible ways of doing many of the things you do through slower or more travel-intensive means today.

Can't read the label on a can (because you are blind or have low vision, or the label is written in a foreign language)?

Call a friend and hold the can up so the friend can read the label to you. Or, in the future, use your system to grab an image of the label and send it to a service to read it back to you electronically (all without human intervention).

Want to have one mailbox where you get all your faxes, e-mails, voice messages, and so forth?

With centralized translators, you can have faxes, voice mail, e-mail, and so on, all changed into whichever form of communication is most accessible to you or most convenient for you—including print, electronic form, voice, and so on. You can also choose in what form you'd like to have the information presented at any time. Information can be presented in voice while you're driving your car, for example, or in print for your files or for tucking into your pocket.

Tomorrow's technologies

Want to travel to and see places you don't have the time, money, or physical ability to visit?

Travel to and explore places throughout the world, where you are able to see and hear everything exactly as if you were there and to move about freely. If you are older or have a mobility impairment, you can just point and move about

effortlessly—even visiting with people, having dinner with them, and so on. (You supply your own food).

Want to communicate with someone in another country, but you don't speak the language?

Carry on a conversation with someone from another country, where you hear each other speaking in your own native tongues.

Want to carry on a face-to-face conversation with someone who is deaf, but you don't know sign language?

Speak to the person who is deaf, and have his or her terminal device convert your speech to text or sign language. When the individual communicates back using sign language, have your terminal device convert the sign language into speech.

As you look through the list, you will probably find many things you have no interest in, or would not be interested in paying for. However, you will likely find other activities that do interest you. Some of these activities are things you are able to do today, but in other ways. Others represent new capabilities that you would have—if you had access to NII.

For all the information, services, and capabilities that NII has to offer, it is important to recognize that people who have access will be able to do many things faster, easier, and during more hours of the day, but people without access will enjoy none of those advantages.

COMPONENTS OF NII

To make NII accessible and to better recognize existing and potential access issues, it is important to understand the various components. Although there are numerous ways of classifying NII components, for this discussion NII is divided into four categories:

1. Sources of information;
2. Transmission mechanisms (pipeline);
3. Translation and other services during the transmission process; and
4. Viewer-controllers.

1. Sources of information

The first component of NII is the information provider. Providers are the people who create the information or data that are sent over NII to others. Information must be produced either in accessible formats or in formats which can be easily translated into accessible formats. Examples of information sources include

- Publishers (books, magazines, newspapers, special newsletters)
- Libraries
- Government services (information on employment, financial aid, taxes, hours of service, services available)
- Most commercial companies (information on products, prices, deliveries, stock, hours)
- Companies whose products can be sent over the wire (movies, advice, newsletters, product or topic information)
- Local schools (homework assignments, homework aids, schedules, meetings, school lunch menus)

- Universities (course schedules, financial aid information, program descriptions, research opportunities, job openings)
- Clubs (announcements, newsletters, meetings)
- Online information services (CompuServe, Prodigy, Genie, eWorld)
- Your family (plans, schedules, coordination of emergencies, group letters/updates, gift lists at holidays)
- You (things you want to sell, your resume, services you can provide to others, personal newsletters, advice or information on a variety of topics)

2. Transmission mechanisms

Once connected to the information highway, the user has no idea exactly what channels the information will take, either coming or going. In most cases, the information will travel over many different transmission mechanisms along the way.

Some examples of different transmission mechanisms are:

- Telephone line
- The Internet
- Cable television wiring
- Special fiber optic links
- Microwave
- High-speed telephone/data lines (ISDN)
- Satellite
- Cellular telephone
- Radio carrier or subcarrier

3. In-transmission services

In the past, some telephone operating systems were barred from altering the signal in any substantive way between origin and destination. With the new Telecommunications Act, however, such barriers have been removed. As more general

NII services unfold, information may be translated between the sender and the receiver in many different ways. In many cases, these mechanisms increase accessibility options. Some examples of translations include

- Translation of fax or e-mail to voice
- Translation of voice to e-mail or fax
- Translation of fax to e-mail
- Translation of e-mail into fax
- Translation from one language to another
- Translation of text telephone (TT/TDD) to voice, or voice to TT/TDD (providing more direct, secure, and confidential communication)
- Frequency shifting (to better match the hearing profile of the receiver)
- Speech filtering (to increase the intelligibility of some types of speech)

With these translators, information can be made available in the form most convenient at any particular time (e.g., via voice for someone who is driving a car, but in printed form at home or at the office). It is also possible to convert information from a form that is inaccessible to some people into other forms that are accessible (e.g., converting a fax into e-mail or voice for someone who is blind).

4. Viewer-Controllers

This category includes all systems or devices used to receive and display information. (The sender of information is a source, as described above.) To be accessible, the viewer-controller must both be able to display the information in a form compatible with the person receiving it and have controls that are compatible with the individual's physical, sensory, and cognitive capabilities.

Viewer-controllers can take a wide variety of forms, including

- Computers
- Television sets (with special set-top adapter boxes)
- Standard telephones

- Telephones with video or touchscreens
- Kiosks (public information systems that look like a touch-sensitive television screen mounted in a cabinet)
- Ordinary fax machines
- Cellular telephones with built-in display screens
- Text telephones
- Special information appliances

How it will feel to use NII

The look and feel of information systems will vary greatly, depending upon their design, intended use, and the target audience. Some Internet-based systems will be quite sophisticated and will provide powerful search and retrieval software and techniques. They will be intended for use by people with more experience and knowledge who require exact or powerful tools.

Other systems will require no training and will be easier to use than a VCR or a microwave oven. In some cases, operation will be similar to changing channels on a television and then making selections from choices presented on the screen. Some systems will have as few as two or three buttons, while others will be activated by a touch on the particular items or topics on screen that are of interest. Other systems under development will allow you to talk to them and explain what topic is of interest.

WHERE IS NII GOING?

No one knows exactly where NII is going, although a lot of money is changing hands as people try to find out. A number of trends are clear, however, and most of them have significant implications for individuals with disabilities, as will be discussed in a later section. In this section, some terms and directions are introduced.

Convergence

One definite trend is toward a convergence of the various different telecommunication and computing fields. While people now might carry a cellular phone, a daily organizer, and a pocket or notebook computer, and use fax machines or desk computers for e-mail, printing, or writing, a merging of these technologies is beginning to develop. Small, portable devices will have the ability to connect people via voice, picture, transmitted documents (fax and e-mail), and so forth. In some cases, the functions will be carried out by small multifunctional portable computers. In other cases, the devices will look more like touchscreen telephones with a touch-sensitive display screen. Movies, telephone calls, documents, television shows, and more will all be going over the same channels, which may be run by the cable company, by the phone company, via satellite, or by combinations of these. Users, however, will not be aware of which mechanism is being used, and most won't care, as long as they can maximize quality and minimize price. As this convergence occurs, fax machines, phones, pagers, computers, and so on, will be seen less as devices and more as functions. Multiple devices or the same device may be used to carry out these functions at different times and in different environments.

Client/server model

Currently, most software that runs on personal computers is loaded onto the computer and run on the computer. No connection or communication with other

computers is necessary to run the program. The program, the data, and the computing power are all resident directly in the personal computer.

The trend is increasingly toward a client/server model, where the computer in front of the user is connected via a network (over a local area network, via phone lines, or via wireless transmission) to other computers. When the user runs a program, part of the program may be running on the computer in front of the user, and part on the computer(s) at the other end of the connection. Similarly, the data or information the user is working with may be stored on the local device or may be stored on one of the other computers. Thus, when the user looks up a phone number, the local device may in fact be accessing databases stored on computers located anywhere in the world.

To look up something in an encyclopedia, the researcher would generally access large store of information on a remote computer. As the user looks at entries, individual pages may be temporarily sent to the computer for viewing. In addition, the user might find that small application programs or "applets" (see below) are downloaded to the computer where the user can run them to view simulations, access additional search capabilities, or experiment with a topic. When that page or experiment if finished, the information and applet(s) may be "thrown away," and easily accessed again at another time.

For any applications that need a lot of computing power, the processing may actually be done on a remote computer, with only the results sent back to the local computer to be displayed.

The result is an ability to have a much simpler and lower cost device in front of the user. This device can tap into and have available any amount of computing power or storage necessary, by simply taking advantage of computing power and storage at other locations connected via a network and available on request.

With smaller, more portable, and lower cost systems, it is possible to have terminals or access screens located around the house or to have systems that are small enough to be easily carried about.

Applets

The term "applet" comes from "application," with the suffix "et" added to signify smallness. An applet is a tiny application or program. When used today, it generally refers to a small application program that is downloaded over the network (usually the Internet) and that runs on a personal computer. The Java programming language developed by Sun Microsystems and recently licensed by Netscape, Apple, Microsoft, and others for inclusion in their Web browsers has greatly increased the focus on applets. Although it is difficult to characterize the immense potential of this technology in a few sentences, an example might give a glimpse of its potential impact.

> Imagine browsing through a Web site on science education or automobile repair. You come to a location where a small demonstration might be the most effective means of communicating information to you. You could download a movie showing a simulation of a science experiment or automobile engine, but this would take a long time over your phone modem (perhaps 20 minutes to half an hour). Instead, a small applet or mini-program is downloaded, which you can then run. The applet would generate the simulation of the experiment or engine function. Now imagine that the same simulation allows you to not just watch the presentation, but actually interact with it. You are able to change the experiment (e.g., make the support beams wider or narrower) and see how that change affects the strength of the system; make adjustments to the engine and see how that affects its performance; and see how either system might fail under circumstances you can control. This type of interaction, of course, would not be possible with a video or film and would not be possible if you tried to run the application on a remote system, because of transmission delays.

All of these capabilities, including the ability to provide full motion, interactive video environments in two and three dimensions, are possible today using the Java, VRML (virtual reality mark-up language), and other extensions which are currently being released in the Netscape 3 browsers.

Multimedia animation

As more and more companies vie for people's attention on the information superhighway, competition is increasing. Only companies that can capture and hold people's attention are going to make money and survive. Four of the strategies they are using to do this involve creating

- A genuinely useful service;
- A fascinating and attractive appearance;
- An intriguing or interesting presentation; and
- A comfortable, easy-to-use, familiar feel.

Most of these strategies are tending toward graphic, multimedia interfaces. The major limitation that inhibits more use of multimedia approaches is the time it takes to transmit the multimedia information over phone lines. As faster mechanisms are developed to transmit information, and as techniques such as applets are allowing multimedia presentations that do not require as high a bandwidth, three-dimensional graphic- and sound-based interactive materials are increasingly used. Although the cost of creating such materials will keep them from dominating much of the public information portion of the network, this type of information is likely to increase on the commercial portions of the network. This increase will have clear ramifications for individuals with low bandwidth connections to the information superhighway(s), just as the move by CompuServe, America Online, etc., from text-based to graphic-based browsers has.

Virtual reality

The ability to create a virtual world on screen (or, using a special headset, all around the user), in which the user can move about and manipulate things, has many ramifications and uses. Some of the first applications, as one would imagine, are in the entertainment area. However, VR also has applications in travel, learning, and even in making systems more familiar and easier to use. For example, individuals who find it difficult to relate to computers and menus might find it much easier to go shopping via

computer if all they had to do was to push a shopping button, point to a picture of a grocery store on the screen, and then find themselves standing in the front of a grocery store. They would be able to move up and down the aisles, as they are used to doing in a real store, and see the store products arranged on the shelves. To buy something, they would simply point to the product on the screen and pull it down to the basket at the bottom of the screen. They could point to different objects on the shelves and have the prices automatically shown. They could also obtain a price comparison between two similar products by simply drawing a line between them with their finger. A running total shown in the corner of the screen could show them how much they have spent. When they are finished, they would simply go to the virtual checkout counter, and the groceries would be charged to their account and delivered to their home.

Schools may use this technique to allow students to conduct physics and chemistry experiments as well as to study geography, world culture, history, and so on. The technologies will allow students to carry out individual experiments on virtual apparatuses and using virtual chemicals that would be too expensive or elaborate for individual schools to own, but which cost virtually nothing (in comparison) as simulated lifelike interactive presentations.

Information appliances and personal digital assistants

Advances in both electronic technologies and information architectures are allowing systems to become smaller and smaller. Already there is a small device called a Simon, which is the size of a fat cellular phone. The Simon is a cellular phone, a calendar, a to-do list, an address book, a sketchpad, a calculator, and a notepad. It sends and receives e-mail, has filing capability, can show local and international time, can send and receive faxes, has a PC-card (the credit card-sized modules that slip into the side of modern computers), and of course has a game. These and other personal digital assistants (PDAs) will increase in number and will decrease in size and cost. As they incorporate voice interaction, they can become indispensable tools for maintaining and

organizing personal information as well as handling all types of communication and interaction, including Internet or NII/information superhighway interactions.

In addition to information appliances in portable forms, such appliances will begin to appear around the home. The United States already has more televisions than flush toilets. Eventually, an information screen may be found in most rooms of the house. Families and individuals will use these screens to view movies or television programs; look up information; store and retrieve recipes; talk to others using voice or voice and image; do our homework; and/or just read. Some of these screens will be mounted on walls; others will be on small tablets. As the display screens become fine enough to simulate the size and appearance of a regular printed page, it will be convenient to have something the size of a paperback book but a third the thickness and weight, without a cover to fold back, and which can be used to display, at any moment, a book currently being read or one that was just recommended to you by a friend.

This book tablet may be a single-function device (e.g., for displaying books) or may provide all of the other communication and personal organization functions described above (as could any of the wall or desktop panels).

Set-top boxes

The first steps toward these information systems are represented by the television set-top boxes. These are small boxes that sit on top of the television set and connect the television set to special information services via cable, telephone, or satellite. Such set-top box information systems are currently being piloted in a number of areas of the country. Although the systems are limited by the relatively poor display resolution of current television sets and a low information bandwidth, they represent the first step toward the true next-generation information systems. Although these systems can give some initial glimpses of what might be possible, it is important not to confuse the Internet and these cable-based information roads with what will be possible nor with what will happen as true information superhighways come into place over the next decade or two.

Public service terminals (kiosks)

As more and more services, especially government and public services, are made available via electronic channels, a problem of equity of access occurs. That is, how can access to these channels of communication be provided to individuals who do not have computers or "personal information terminals"? Two strategies are currently being used. One is to provide access via terminals in public libraries. A second is to provide information kiosks in public settings. These public information or service terminals allow access by everyone using those public facilities, regardless of personal resources.

In addition to providing access to information that might be available over electronic networks, electronic information kiosks are being used as building directories, as directories in shopping malls, and even to help locate products in individual supermarkets, department stores, and so on.

Public service vending (fare and ticket machines)

Another use of kiosks is to dispense products or tickets. Public kiosks are now being used to sell everything from baseball tickets to subway cards to renewal stickers for license plates. As kiosks that provide multiproduct or service vending are being developed, the interfaces on the kiosks tend to get more complicated and involve technologies such as touchscreen displays.

As more and more services are available via public terminals, the hours and locations at which the services are available via direct human contact tend to decrease. This decrease has implications for individuals who may have difficulty using the public service terminals/kiosks.

Universal address

The idea of a universal address or phone number has been a controversial topic. Rather than having a phone number or address tied to a particular phone or location, such universal phone numbers or addresses would be tied to an individual. As people traveled (during hotel check-in, for example), they could log in and let a central resource

know where they were. Phone calls made to their phone number would then cause the phone in their hotel room to ring. An individual might have multiple phone numbers to provide different levels of access: for example a personal phone number, a public phone number, and a private business phone number. Notification of location could also be done automatically. Thus, if a person were wearing a badge and moving about an office building, phone calls could come to whichever phone was closest at the time of the call. For many individuals, the closest phone would be the small wallet-sized information appliance with phone function in their pocket.

Wireless smart cards

Another controversial item is a smart card that can be read from a distance. With such a card, a person can transmit information to another device without removing the card from a pocket. Prototype smart cards are approximately the size of a fat credit card. Unlike standard cards, however, these cards would contain electronics that allow them to store information about their user, store financial credit (or electronic cash), and store information about preferences. Many different functions have been proposed for such a smart card. One application would allow people who had purchased passage on an airline to forgo the use of a paper ticket and instead have their presence noted and their electronic ticket validated as they walked through the doorway to board the plane. Individuals could also set personal preferences and cause kiosks or other devices to behave according to those preferences by simply walking up to them. For example, the device would speak in the proper language, use spoken instead of printed instructions, or printed instead of spoken instructions, and so forth. Individuals could also pay for services or products without having to physically take out and manipulate their card (e.g., passing it through a card reader).

Distributed serving

In addition to the more straightforward applications and characteristics of the next-generation information systems are a number of other more subtle capabilities that

may also have a significant impact on the types of services that are possible and which are delivered. For example, a shopper typically purchases a product from one location, and the product comes with all of the parts delivered from that location. As information is purchased over the networks, in a single order for a company's product, different components may be sent electronically from different sources. For example, if a person ordered a movie from Paramount Pictures and asked for it to be sent with captions, the digital information for the movie may come from Paramount Pictures and the captions from a captioning center. The two components would arrive essentially simultaneously at the purchaser's terminal/viewer, where they would be linked and the movie could then be viewed along with the captions. Simultaneously, a bill may be sent from the captioning center to Paramount Pictures for use of the captions. Similar arrangements could be made for ordering movies with sound tracks or captions in different languages. The same technique could be used to substitute descriptions for pictures or to provide other specialized services. Users may be able not only to select different levels of captions to go with their movie, but to select their preferred captioning service or language translation service whose price may be either included in the film or available as a surcharge if the individual wants something beyond what is standard.

IMPLICATIONS FOR PEOPLE WITH DISABILITIES

NII has the potential to level the playing field in many areas of life for people with disabilities. Because it has this high potential, the consequence of not making next-generation information system technologies and systems accessible is a serious one. This section will consider the benefits and advantages that will be available to people with disabilities in a highly accessible NII. It also looks at what might be some of the disadvantages for individuals with disabilities should NII not be accessible to them, as well as the potential barriers to providing access.

Advantages posed by the developments in NII

General Advantages

First and foremost, the advances in NII have the potential for providing a vast number of benefits to everyone, including people with disabilities. If the systems are designed in a way to make them accessible, they will yield the same myriad benefits discussed in the previous sections of the report.

Disability-Related Advantages

In addition to advantages for the general population, the next-generation and emerging technologies will provide additional benefits for people with disabilities. These technologies (if acceptable and usable) will be able to address some of the barriers and problems currently faced by individuals with disabilities and afford them special advantages. These advantages include the following:

- Drastically increasing the ability of individuals with some types of disabilities to access and use information.
- Decreasing the personal isolation that some individuals experience because of restrictions in their ability to move about, to communicate, or to easily congregate with others sharing their interests and situation.

- Allowing individuals to interact with others in a way that makes their disability invisible or irrelevant.
- Providing opportunities to participate in distance learning programs or to receive medical services from a remote location when travel is difficult.

Individuals with mobility or travel impairments will be able to shop, learn, travel, receive medical services, and work from their homes or other facilities. In some cases, NII developments may allow individuals with mobility impairments to go to their local office and carry out business that normally would have required them and their colleagues to travel around the country, which would be more difficult for them. This "mobility" can open new horizons for learning on all levels and allow individuals to "travel" to environments that they might not be physically able to get to or explore.

Individuals with physical manipulation difficulties can use the simulations or virtual environments to participate in activities they wouldn't be physically able to do. For example, an individual with severe athetoid cerebral palsy would not be able to easily construct mechanisms, operate delicate instruments, and carry out chemical experiments in the laboratory using fragile glassware. However, if the mechanisms, instruments, and glassware were all simulations on the screen (or in a virtual environment), these individuals would be able to participate in such activities using keyboard control or whatever other interface worked best for them.

With today's technologies, it is already possible to create new circuits, designs, and experiments using only simulators that can be replicated in real life with the same results. Thus, these strategies can be used not only in learning environments, but also in professional activities.

Individuals with sensory impairments can access information that was previously unavailable to them. For example, the vast libraries of books that exist in printed form but are inaccessible to people who are blind (except for the small portion of the libraries available in braille or on audio tape) will all be available and accessible when the primary mode for their distribution is in electronic form. Similarly, as speech recognition systems

improve, it will be possible to transform materials that are spoken (e.g., recorded speeches) into print.

Individuals with cognitive impairments can request that information be presented at different levels of complexity or in different primary formats—techniques that will find increasing use in the attempt to create systems that are appropriate for individuals with a wide range of cognitive and language skills. The new systems also present the opportunity to have online help available at any time while a user is operating any of these technologies. Online help can take the form of computer-based help files, artificial intelligence assistance, or live contact with an expert or resource person (for an extra charge).

In addition to all the standard uses that NII technologies are designed for, it is possible to combine these new technical capabilities in ways that can provide even more powerful new capabilities and opportunities for individuals with disabilities. Three potential examples are provided: "Lean Cuisine," "Listening Pen," and "The Companion."

Lean Cuisine

Persons who are blind might sign up for a service offered by their phone company that will automatically convert any fax sent to them into electronic text, which is then sent to their e-mail; they might sign up for another service that provides voice access to their e-mail. Although such features might be used primarily by businesses wanting extremely high quality OCR (optical character recognition) translation and access to e-mail by phone, the person who is blind could also use these features to get access to the cooking instructions on the back of a Lean Cuisine frozen dinner. He would simply take the Lean Cuisine dinner and fax an image of its back (where the directions are) to himself. The fax would automatically be routed through the fax-to-e-mail converter (since that is the way he has it set up) and converted to e-mail. He would then dial up

his e-mail and have the fax read to him. In this case, he would hear the directions from the back of his frozen dinner package.

Listening Pen

Persons who are deaf may carry a small directional microphone that looks like a pen or is worn as part of their eyeglasses. When talking with someone, they would point the pen toward the person's mouth. The speech would be picked up and sent out digitally over the net to powerful filter and speech recognition software running on a large computer. The result could be sent back to a small virtual display mounted on the deaf person's glasses, which would project the image so that it appeared to float in front of them. In this fashion, speakers would have their words literally written all over their face. Using voice print technology, it would even be possible for the speaker to be identified, if for example a person was sitting at a meeting where different people around the room were speaking in turn. By using remote computing connected via wireless networks, individuals who are deaf could have access to much more powerful speech recognition algorithms than they would be able to or care to carry with them all day. Instead, they may pay a small service charge to use search recognition algorithms, owned and maintained by a network service bureau, which would otherwise be too expensive for an individual to afford and changing too rapidly for an individual to keep up with.

The Companion

One hypothetical device, called "The Companion," brings together many of these concepts to show how a personal assistive technology in the future could help people with cognitive impairments. The device provides the following functions:

- Calendar reminder system that can awaken its users, remind them of appointments and their schedule for the day, alert them to items on the schedule that are different from their routine (a doctor's appointment or a regularly scheduled event that doesn't occur on this day).
- Cueing system that can help sequence users through their morning routine—dressing, simple meal preparation, and so on.
- Artificial intelligence to adapt the above functions to what is actually going on, to help detect when the users appear to be having a problem, to help them problem-solve when it detects a problem (or when users indicate they have a problem by pressing a "Help" button).
- GPS (Global Positioning System) that uses satellite information to pinpoint users' location at any time, so the system can answer questions and better understand where it and the users are.
- Access to the city and major building maps so the system can help provide directions on request.
- Camera and optical character recognition system that users can point at any sign or text, press a button, and have the sign or text read to them.
- Infrared link for communicating with similarly equipped computers, kiosks, information systems, ATMs, and so on.
- Electronic smart card/debit card for cashless money transactions.
- Communication link to a central resource service that has complete information about users and can link them to a resource person for more serious problem-solving and for all

the situations in which the limited artificial intelligence of the current device is not able to help.

The use of such a system could best be exemplified via a short scenario:

Tim is awakened in the morning by his Companion, which reminds him what day it is, and what is the first thing he needs to do. It also reminds him that he has a meeting tonight with his counselor, and that he is supposed to show up at the alternate worksite this morning. Tim has worked out a routine with his Companion in which he sort of mumbles what he's doing as he goes through his morning routine, and the Companion notes whether any important activity seems to be missing or out of order and asks him simple questions that also act as reminders. Tim walks to the bus stop. As the buses pull up, he aims the Companion at the name on the bus windshield display and pushes the trigger. The Companion reads the name of the bus to Tim, notes the bus, and gives Tim some cues about whether the buses seem to be ahead or behind schedule. Tim's Companion knows exactly which bus stop they're standing at (from the satellite GPS) and what time it is, so that it can be sure Tim is where he should be and also give him some idea of when to expect the bus.

When the proper bus arrives, Tim gets on board, authorizes his smart card by voice to transfer the proper fare to the bus, and takes his seat.

On his way home from the meeting with his counselor, Tim is tired, falls asleep on the bus, and rides past his normal transfer stop. The Companion detects this and tries to awaken him, but it is tucked between Tim and the wall of the bus, where it is muffled, and Tim doesn't hear the signal over the noise of street construction. When Tim wakes up, he is in an unfamiliar neighborhood. He panics and gets off the bus, which drives away. He further panics and presses the Help

button on his Companion. The Companion runs through a standard set of questions and comments to calm Tim and help him apply his own problem-solving skills. Tim aims the Companion at a number of street signs, pushing the button to have them read to him. The Companion knows where they are, but it is late, and the Companion does not have any information for this neighborhood with regard to the safety or potential resources for Tim. It advises Tim to call in, so Tim pushes the button to contact the central resource point. A specially trained resource person appears on the Companion's screen; by using the Companion's camera, Tim is also visible to the resource person. All of Tim's information is displayed directly on the screen in front of the resource person, along with whatever information the Companion can provide on the situation, including Tim's exact location. The resource person directs Tim to a local building that will be safe and calls a cab, since there are no buses that will easily get him back home from that location at this time of night.

Such a system would make a profound difference for the many people who are essentially able to live independently as long as they have some mechanism for helping them over rough spots, assisting them with specific activities they may have difficulty with (such as reading), and helping them get out of situations when things go wrong.

Great care must be taken, however, in designing these systems, to ensure that they function in the form of a benevolent companion that facilitates and amplifies the natural decision-making skills of the individual and that operates in either facilitative or suggestive mode rather than directing the individual. While many disabilities can be facilitated through the use of a prosthetic device that replaces the lost function with an artificial version (e.g., an artificial arm, an artificial ear, artificial vision), trying to replace an individual's cognitive abilities with an artificial brain

risks a situation of providing an artificial intelligence with a body, rather than providing an individual with intelligence. However, a device that helps to strengthen or maximize the abilities of the individual while minimizing the impact on free will and decision making (or perhaps enhancing it) could significantly facilitate the ability to function and enhance the person's opportunities in life.

Devices such as the Companion do not exist today, but many of the components do. Also, the same principles apply for using the assistive technologies and setting up the daily routines and support structures of individuals with cognitive impairments. Further, with the rate at which technology, miniaturization, and artificial intelligence are progressing, it is likely that all of the capabilities described here will be available early in the next century (which is just a few years off)—and long before we are ready to program and apply them effectively.

Disadvantages posed by the developments in NII

General disadvantages

People who are unable to access and use the new communication, information, and transaction systems while their colleagues (and competitors) can will be at a severe disadvantage. This is true whether they cannot afford access or cannot physically attain it. However, the lack of access generally has greater impact on people with disabilities because they cannot effectively use many of the alternate strategies available today.

Disability-related disadvantages

In addition to the large potential disadvantage described above, other disadvantages arise that are unique to people with disabilities. The extremely rapid rate of development in this area makes it difficult or impossible for third-party vendors to create access technologies to keep up with the new information technologies. For example, individuals who make screen readers for people who are blind just cannot keep up with the different computer operating systems as they are released. On NII, we see

even more rapid development, with Java, PDF (portable document format), and Macromedia Director all released as new presentation technologies on the Internet over a span of six months, with no access solutions, or even clear definitions of the potential access approaches, existing for any of them. Part of this problem can be addressed by building in accessibility rather than relying on third parties to try to catch up and add it later. Much work needs to be done in this area, as discussed below.

Another problem is that some of the multimedia technologies are being developed in a manner that makes access extremely difficult for people with any type of disability. Strategies are being developed to address this issue, but developers of these new multimedia technologies have limited awareness of the problem.

If accessibility is not built in, individuals with disabilities who try to secure the various third-party access hardware or software adaptations face a significant cost that often exceeds the price of the software or hardware for which access is sought.

Barriers and potential barriers to access and use by people with disabilities

Standard socioeconomic status barriers

Many individuals with disabilities are unemployed or underemployed, making it difficult for them to access and use some of these new technologies. The socioeconomic barrier is not unique to people with disabilities, however, and is treated in depth in other studies.

Complexity

A problem with current electronic systems is the level of complexity in their designs. Although some progress is being made in this area, the introduction of these systems increases the complexity of carrying out many tasks. For example, individuals who were previously able to operate simple fare machines are now find the more modern and flexible, multipurpose machines much more complicated and difficult (and in some cases impossible) to operate. The same thing is happening with phone systems; individuals who used to be able to call up and make a doctor's appointment or ask a

question are finding themselves lost in touchtone-based phone routing systems they do not understand.

Graphic user interfaces

Graphic user interfaces on newer communication and information systems are somewhat complex, with subtle but important issues complicating a full understanding.

Graphic user interfaces can provide a significant barrier to individuals who use screen readers to access information on computers or other devices if information is rendered in purely graphic (i.e., not textual) form, which the screen reader cannot recognize.

The situation is quite different for the person who is not blind. Graphics can simplify the user interface for those who can see and can reduce the cognitive and language skills needed to operate devices, thus increasing their accessibility by individuals with cognitive and language disabilities.

On public systems such as ATMs, building directories, fare machines, information kiosks, and so on, it makes no difference to a person who is blind whether the information on the screen is displayed in textual or graphic form. Since an individual who is blind is unable to install a screen reader on these systems (e.g., an ATM), the systems are equally inaccessible in graphic or textual format. The only way to provide access in these cases is either to build a voice output mechanism directly into the system or to send a textual description of the screen contents to (and allow commands to come back from) some external access device via a connector such as an infrared link. In either case, it does not matter if the information is presented on screen in graphic form if it can also be presented in verbal (spoken text or braille) form either directly or via an assistive device using a standard external connector.

For example, a kiosk that displays the temperatures across the country only as different colors on a map of the United States poses a significant barrier to access. Unless the information is also available by specifying a location (via text), the temperature information is in all probability be completely inaccessible. Here, the differentiation between source, pipeline, and viewer is very important. If the weather information created by Company A is being displayed on a public kiosk designed by

Company B, it will be impossible for Company B to make the temperature information accessible, unless Company A also provides the information in a fashion which can be queried and present in textual format. If the information is present from the source in an inherently graphical format, there is generally little that can be done at the viewer end, except as a very custom solution to a particular application.

There is, or course, some information which is inherently visual in nature, and which we do not know how to easily convey. For example, da Vinci's *Mona Lisa* or Picasso's *Guernica* are inherently visual, in the same way that Beethoven's Fifth Symphony is essentially auditory. However, these issues of access are not the issues of concern here. We are primarily concerned with those situations where a) information that is not inherently visual is translated into visual format to facilitate presentation to those with sight, and b) where the nonvisual format of the information is not preserved or made available so that those individuals without vision can also access the information.

Thus, graphic user interfaces are a two-edged sword. They can provide a benefit to individuals with some types of disabilities. If properly implemented, they may also be used by people who have visual impairments without imposing significant barriers. However, they are often implemented in ways that unnecessarily reduce access to or interpretability of information by individuals with visual impairments.

Touchscreen kiosks and products

The use of touchscreens on kiosks, portable electronic devices, cellular phones, and so on, poses another potential barrier to access. This type of interface has historically been particularly difficult to use by individuals who are blind, since the number and location of the keys or hot spots on the screen continually change during use, and there are no tactile indicators of the number or location of such keys. Recently, however, strategies have been developed to allow individuals with reading difficulties, low vision, and even complete blindness to directly and efficiently access and use touchscreen-based kiosks. Techniques such as the Talking Fingertip (described below), developed under funding by the National Institute on Disability and Rehabilitation

Research (NIDRR), provide a means to access virtually all of the information and interface types on present-day touchscreen-based kiosks.

- ***Talking Fingertip***: This feature enables users who have low vision, have print or language disabilities, or cannot read well due to literacy or second-language problems to gain access to all information displayed on a touchscreen. The Talking Fingertip feature causes a kiosk or other touchscreen-based information system to read aloud any words, phrases, buttons, or other objects on the screen whenever the user touches such objects. A special button below the touchscreen can be used either to temporarily invoke the feature (for people who have trouble seeing/reading only some items on the screen) or to confirm selections (if the Talking Fingertip is locked on). Users with poor motor coordination may choose to confirm selections in this manner, to avoid inadvertent selections.
- ***Talking Fingertip SpeedList***: This feature allows people who have no vision to use any touchscreen kiosks or devices. Users can access all screen information (words, buttons, on-screen number pads, on-screen keyboards, etc.) by sliding a finger (or mouthstick, head pointer, prosthesis, or other assistive device) up and down the left edge of the touchscreen, where a list of all items on the screen is displayed and read aloud. To select an item on the SpeedList, the user moves a finger up and down the list and presses the button mounted below the touchscreen when the desired SpeedList item is reached. This feature can be used by people with vision, print, or language impairments, who otherwise couldn't see or understand the information on the screen. The SpeedList feature also facilitates use by people with upper extremity weakness, incoordination, or other mobility impairments.

Infrared data links

Now common on most new computers, this feature also has the potential to allow individuals with assistive devices to easily link to and operate kiosks and other public

information systems. Using a modified Talking Fingertip technique, along with an assistive device with an infrared link, access to a kiosk has been demonstrated via infrared technologies.

Virtual environments

Although VR environments are most commonly thought of in connection with games or specialized research applications, they can also be used to render remote transaction systems much more user friendly by making them resemble people's existing shopping experiences.

For example, users may approach a store in a VR shopping environment. Moving forward, they enter the store and find themselves standing in the vestibule with various aisles arrayed in front of them, each with a different label designating the type of products in that aisle (housewares, hardware, lawn and garden, etc.). Moving forward and steering left or right, they can scan the products as they move down the aisle. If shoppers see something of interest, they can touch it and ask for a demonstration. The "store" fades away, leaving only the interested shoppers and the product (for example, a lawn mower or hedge clipper); a person who seems to appear out of thin air begins to demonstrate the product. At any point, shoppers can stop the demonstration. They then find themselves standing back in the store aisle, at which time they can select the item for purchase, having it show up at their door a few days later, or they can put it back on the shelf. Throughout the process, as shoppers move through the store, little cherubs fly in and out of their vision, carrying product or special offers.

NOTE: This type of multimedia visual, interactive, virtual environment can be made accessible and usable by individuals who are blind (even individuals who are deaf-blind) using strategies such as the Talking Fingertip SpeedList technique or the SpeedList technique combined with an assistive device and information system having infrared capabilities. Such strategies would give the user a verbal (text or braille, etc.) list of the items or choices available at any given moment without having to deal with the visual representation on screen. These same structures and strategies, which can be built into the system as it is constructed, can be used to allow power shoppers or

users with slower systems to more quickly enter information, search information, make selections, and purchase products or services within this same virtual environment.

Sound

The increased use of sound on systems that used to be silent may pose another barrier. Signs, building directories, and computers used to be completely silent or involve fairly simple alerting sounds. As text-to-speech, digitized speech, and other sounds are increasingly incorporated into these systems, individuals who have hearing impairments or are deaf are finding it increasingly difficult to successfully use them. Add-on technologies are usually of limited value. Unless access is built into these systems directly, most of them probably will not be accessible or usable by the large and growing number of individuals with hearing impairments. Fortunately, strategies exist to provide access to almost all types of auditory information used in information and transaction systems. Features such as closed captioning, ShowSounds, SoundSentry, and others can provide on-screen visual indicators of any application program or computer-generated sound event. In addition, since NII is a digital environment, it is possible to attach text or other visual representations to any audio event that occurs on a public information system. Attaching such representations ensures that all auditory information is accompanied by captioning or some other visual event, thus rendering the information accessible to people with hearing impairments. However, these features will be functional only if the providers of the original content also supply the captions or text to be shown when the ShowSounds flag is active. The ShowSounds flag per se is only a partial solution; it provides a mechanism to allow the user to request captions, but it cannot create captions if none were provided in the original material.

Advances in speech recognition also hold promise for providing increased access to information systems. For users unable to operate a touchscreen or keyboard, whether the impairment is physical, sensory, or cognitive, speech input offers yet another alternative information access method. The use of such strategies, however, is spotty at present, except where some type of legislative mandate exists.

Animation and interactive systems

Animation is increasingly being used to create more interesting and attractive multimedia systems. Although the gratuitous use of animation is usually considered to be as being of dubious lasting value (particularly if it slows down the use of the system), use of animation and graphics within interactive sites and situations is growing. While some situations can be addressed using strategies similar to those discussed above in relation to kiosks and VR, effective strategies have not yet been identified in other interactive environments. This is a serious concern that needs to be addressed if individuals with low vision or who are blind are not to face significant barriers in education, training, and employment environments.

Sealed nature of public systems (making them difficult to adapt)

Public systems present a unique access problem. Unlike personal systems, which often can be adapted to meet the needs of the individual owner, public systems must be directly usable by individuals with a wide range of abilities or disabilities, without requiring modification. For example, it would not be possible for individuals with a physical or sensory disability to open an ATM and reprogram the computer inside to install a screen reader or other specialized software to provide access. Similarly, officials in charge of electronic building directories, fare machines, or even computers in libraries generally do not want individual users to open or otherwise modify their systems. Even the cable companies who install set-top boxes on television sets in homes generally do not want their users to open or physically modify or reprogram those boxes. Where such boxes are used to buy and sell products over the air or to provide information and services, this concern becomes even greater. Finally, for many small hand-held or mass-produced products (such as the communication tablets discussed previously), it may not be easy or even possible to open or modify the system.

Two forms of accessibility

In all of these cases, accessibility must be built into the product. This accessibility/usability usually takes one of two forms:

- *Direct access*: A set of features or optional settings that allow the product to be used directly by individuals with a wide range of abilities. For example, the set might include a volume control and headphone jack; a feature to cause all speech to also be displayed as text on screen; a mechanism to allow any words that appear on screen to be spoken for those with reading difficulties; and a Talking Fingertip SpeedList with voice output to allow access by individuals with visual impairments or blindness.
- *Standard access connection*: A mechanism to allow individuals with severe or multiple disabilities (deaf-blindness, high-level spinal cord injury, etc.) to easily connect special assistive input or display devices without having to open or modify the product (e.g., using low-cost infrared link).

Recent work has shown that building cross-disability access features into a product can involve little or no increased hardware cost and low software costs if the features are considered from the beginning of the design process.

Two Case Examples

Kiosks

Electronic kiosks are devices found in public spaces, from which the user can get information, purchase things, or carry out other transactions. They are a rapidly growing phenomenon used increasingly by government agencies, public services, and private industry as a quick and convenient way to make services available in multiple locations around the clock.

Probably the most familiar kiosk at present is the automated teller machines. These machines, which are maintained by various banking entities, allow people to walk or drive up and make deposits, withdraw money, pay bills, check account balances, transfer money between accounts, and so on.

How are kiosks being used?

Other kiosks are being used today in all of the following ways

By government agencies:

- To provide information about government services;
- To allow people to apply for government services;
- To provide information on jobs;
- To allow people to schedule court dates;
- To allow people to pay fines;
- (In Nevada) To allow a person to prepare all the paperwork needed to file for divorce.

By airports and hotels:

- To provide information about where to find things in the airport or hotel;
- To provide a directory for the locations of restaurants, hotels, and so on;
- To allow people to make reservations;
- To provide information on tourist sites, travel information, and so on.

By vending companies:

- To provide the ability to buy almost anything via video catalog;
- To allow travelers to send gifts or flowers;
- To sell tickets to sporting events, allow people to check the view from any given location before buying a ticket, and get information on schedules and players.

As building directories:

- To provide a convenient way to search for people by name, agency, and so on.
- To provide floor and room number as well as specific directions for finding people.

By universities to allow students:

- to locate buildings on campus maps,
- to locate rooms within buildings,
- to explore interests and get suggestions for courses of study,
- to find out about courses of study,
- to look up information about classes,
- to register for classes,
- to view and/or print their transcript,
- to conduct an audit of their current courses,
- to determine what additional courses they would need to complete any given course of study,
- to apply for financial aid,
- to check on the status of their financial aid application,
- to get advice on course loads,
- to get answers to commonly asked questions,
- to check on university policy,
- to find out about extracurricular activities,
- to sign up for university or extracurricular programs,
- to check on availability of books in the library,
- to check the availability of workstations at various laboratories around campus.

What do kiosks look like?

Kiosks can take a wide variety of forms. Some of them look like desks; others are built directly into a wall. Most kiosks today consist of a touchscreen display that resembles a television screen. The display may sit on a counter or may be mounted in a cabinet about 3 feet square and 5 or 6 feet tall. If the kiosk accepts payments for goods,

fines, and so on, it typically includes a credit card reader. Sometimes it has a printer to allow the user to have a printout of the information.

Touchscreens may have a number of characteristics. Among them are the following:

1. To get people to use the kiosks, the information is presented in a user-friendly fashion. Pictures and talking heads usually appear to explain what is available and help the user to operate the kiosk.

2. To minimize the learning and cognitive demands, simple screens with just the number of choices needed are usually presented. For example, if only two choices are needed at any point, two large buttons are provided. If it's necessary to enter some numbers, a keypad appears on the screen. If the user must enter his or her name, an entire keyboard might appear.

3. To provide flexibility, a touchscreen may have any number of keys, buttons, or controls. As new programs are created, new buttons, keys, and other controls can be added without changing the hardware. Entirely new programs can be downloaded to the kiosks over phone lines without touching the kiosks at all.

How accessible are kiosks?

Kiosks pose a number of issues for people with disabilities. They must be positioned so that people who are using wheelchairs or people who are shorter than average can access them. Although touchscreens used to be a barrier for people with disabilities, it is now possible to create usable touchscreens (see the section on the Talking Fingertip). However, most kiosks do not incorporate this strategy and are currently not usable by people with low vision or blindness. Talking heads make the kiosks easier to use by people with cognitive impairments, but they can create problems for people with hearing impairments or deafness if they are not implemented with text alternatives to the speech output. Similarly, use of graphics onscreen and systems that require fine motor control can cause problems if alternative access strategies are not provided.

Interactive Television and Set-Top Boxes

Interactive television is another emerging electronic device. With regular television, a single signal is broadcast, which everybody sees on the television set. There is no way for individual viewers/controllers to send any information back to the source.

With interactive television, the user is able to send information back to the source as well as to receive information from it. In the simplest form, the information sent to the user does not change, but the user can respond to the source with information such as a desire to purchase a particular item. With true interactive television, however, the image that users see on their television set is a function of what they do. Interaction with the television is similar to a user's interaction with a computer.

How is interactive television being used?

Interactive television can be used for any of the services and activities described earlier for NII. It can also be used to carry out any of the functions mentioned for uses of Kiosks, except for dispensing tickets, cash, or actual products. However, with a credit card, it would be possible to order any of these items and have them delivered.

Essentially, interactive television can allow a television to act as a multimedia access point to the information superhighway. As a result, the information superhighway is not just for people with computers and modems, but also for anyone having a television set and the requisite connection devices.

What does interactive television look like?

To have interactive television services, the user needs some type of controller box and a connection to the information services. The controller box functions something like the cable television controller boxes did, except that it has additional circuitry that allows it to generate more specific graphics on the screen and to work with the information services. Since the controller box would probably sit on top of the user's television set, it is often called a "set-top box."

The set-top box, of course, must be connected to a company or companies providing the various information and other services. A number of companies and industries are currently scrambling to be the ones to provide these services. The telephone company would like to install higher speed telephone lines and provide the services (as well as videophone and other services) through these lines. Cable television companies would like to expand their systems and provide the services. Satellite broadcasters are also interested, and are exploring technologies that would operate in conjunction with phone or cable as well as independently. How the signals get to the user, however, is not as relevant as whether the signal is available at all and whether users can afford to pay for it. Both of these are hot topics at present, in the same way that the availability of electricity to all parts of the country was once a hot topic of debate. Eventually, however, like electricity, connections to the information superhighway will be inexpensive and plentiful, with connections available in most rooms (or every room) of the house.

Probably the best way to envision what interactive television will look like is to consider what CD technology looks like today, especially children's programs and games on CD ROMs. What appears on screen varies tremendously from one vendor to another. Each tries to look different to clarify its identity and to provide an interface that is easy to use and attractive. Buttons and menus may appear on screen that are controlled with either arrow or number keys on the remote control or by talking to the screen with the control. In some cases, choices are listed on the screen. In other cases, pictures of the products appear on screen as an announcer describes or demonstrates them. Systems that can support high bandwidth (lots of information available to each household) would allow users to wander through a simulated shopping mall, enter stores, look over items, request more information, launch small videos that demonstrate items, and pay for items that would then be shipped to them (or downloaded from the network if they were movies, music, or other products that could be converted into electronic form and transmitted).

How accessible is interactive television?

The systems will undoubtedly use graphic user interfaces. However, even if the interfaces were all in textual format, they would be inaccessible to people with low vision or blindness because there is currently no mechanism to load a screen reader onto a television set-top box. It is possible, however, to build voice modes into any of these systems, which would make even the graphic user interface accessible.

The graphic content of the systems, however, is another matter. Whether the interface is graphic or text based, if graphic content (pictures, movies, etc.) is presented there will be an access problem for people with visual impairments unless an alternative form of the information is also presented.

Interactive television systems are also likely to contain extensive audio information, usually as a part of an audiovisual presentation. Access for individuals with hearing impairments or deafness can also be provided if alternative presentation is available.

For the most part, these systems will be designed to be as simple as possible to operate, thus limiting the cognitive requirements as much as possible. As more choices are provided, however, the cognitive requirements will go up. Simple adjustable interfaces and interoperability will help to provide diversity of interfaces, including customizable interfaces to better match people's cognitive abilities.

In general, interactive television will be operated using a remote control of some type, with voice commands introduced as voice recognition gets better and cheaper. People with physical disabilities or speech impairments may have some trouble with such interfaces. Again, the ability to use different physical interfaces with the system, as well as the ability to operate the systems with either speech or a physical interface, would be helpful.

GENERAL ACCESSIBILITY GUIDELINES

Various general access strategies can be applied across all information systems. They are presented below, along with the major disability groups that would be affected by the use of these strategies.

1. **Visual information**

All information presented visually (or stored as an image) should have an alternative or supplemental presentation (or storage format) that does not require vision (e.g., auditory format or ASCII text).

- **Blindness**
- **Cognitive/language impairment**

2. **Auditory information**

All information presented auditorily (or stored as a sound file) should have an alternative or supplemental mode of presentation (or storage format) that does not rely on hearing (e.g., visual mode or ASCII text file). Auditory information includes beeps or any other sounds that convey information.

- **Hearing impairment, deafness**
- **Cognitive/language impairment**

3. **Eye-hand coordination controls**

All controls that require eye-hand coordination (mice, trackballs, ordinary touchscreens) should also be provided in an alternative or supplemental mode that does not require eye-hand coordination (e.g., keyboard, Talking Fingertip touchscreen).

- **Blindness**
- **Physical impairment**

4. **Physical requirements**

Any input or control mechanisms that require fine movement control, physical dexterity, reach, or strength should also be provided in an alternative mechanism (such as scanning or keyboard navigation) that does not. Mechanisms that require simultaneous activation of two buttons, latches, etc., should be avoided. Timed responses should also be avoided, or a mechanism provided, that would extend the times.

- **Physical impairment**
- **Cognitive/language impairment**

5. **Operation**

The operation of the device/system should be as simple, predictable, and error tolerant as possible.

- **Cognitive/language**
- **Physical disability**
- **Low vision**
- **Blindness**

6. **Connectivity**

An external standard connection point that can be used to connect alternative displays or alternative input/control mechanisms (e.g., infrared link or RS232 port with alternative display and control capability) should be provided whenever possible.

- **Blindness**
- **Physical impairment**

GOALS

The final sections of this report explore the options and strategies that might increase the ability of people with disabilities to use the emerging communication, information, and transaction technologies. A number of general goals or objectives are presented first, followed by a discussion of options and strategies that might be used to achieve these goals.

Goal 1: Products should be both accessible and USABLE by people with disabilities.

The word accessible is used in two ways in the area of information systems, particularly NII. The first refers to the ability of any individual to afford and have access to the new information devices and systems. Although this type of accessibility does not relate specifically to persons having a disability, a disproportionate number of them are unemployed or underemployed. Economic limitations to accessibility are not experienced by wealthy individuals with a disability. Since this topic is treated extensively in other places, it is not addressed further in the options and strategies section of this report. However, it is a real issue and poses a barrier for many individuals with disabilities.

The second way that the word accessible is used is in relation to the ability of a person who has a disability to actually operate the new information-transaction systems and to receive and perceive the information that is presented or displayed by the systems. A goal in designing next-generation information systems should be to maximize the number of individuals who are able to access the systems and information regardless of the type, degree, or number of disabilities they have.

A separate but equally important goal is to ensure that these systems are *usable* by these same people. It is not sufficient to have accessible systems if the means of access are so difficult or roundabout that it takes the individual five or ten times longer than

their colleagues without disability to use the system. Such differences in efficiency can put individuals with a disability at a disadvantage that prevents them from competing in educational or employment situations involving the use of these systems. A goal, therefore, should be to ensure that next-generation systems are both accessible and usable with a comparable degree of efficiency by people with the widest possible range of abilities or disabilities. It is, of course, important to achieve such access for individuals with various disabilities without interfering with the access and usability of the systems by individuals with other disabilities or by people who do not have disabilities.

Goal 2: Source materials (print, AV, multimedia, VR) should be presentation independent or multimodal.

There is no single presentation mode that is optimal across disabilities. Information presented in a visual information format works well for individuals who are deaf, but is inaccessible by people who are blind. Information presented auditorily yields exactly the opposite result. One goal therefore should be to have all information available in a form that allows it to be presented in different modalities (visually, auditorily, tactually), allowing users to choose the form that works best for them.

Two strategies for doing this are to make information available in presentation-independent form and to have information available in multimodal form. ASCII text is an example of presentation-independent information. ASCII text is pure data that can be presented visually as letters on a screen, sent to a voice synthesizer and presented auditorily, or fed to a dynamic braille display and displayed tactually. A picture, on the other hand, is a visual presentation of the information. To make it multimodal, a picture would have to be accompanied by a textual description. A movie presents some information visually and some auditorily. To make a movie multimodal, there should be a text description of the auditory information (which can be rendered visually) and a description of the visual information (which can be presented auditorially). The resulting package would allow an individual to view the information in visual, auditory, or tactile form.

Goal 3: Public systems should be directly accessible by the widest possible constituency.

By nature, public systems do not allow people with disabilities to open or modify them. Systems such as kiosks, ATMs, electronic building directories, and fare machines therefore need to be directly usable by people with disabilities. Whenever possible, individuals should be able to approach and use a system without having to carry special assistive devices or technologies with them. Where it is not known how to do this in commercially practical fashion, mechanisms should be provided to allow people with disabilities to easily connect the necessary assistive technologies to the system for access.

Goal 4: To the extent feasible, accessibility to all products should be direct (built-in), rather than requiring the user to modify the product or purchase assistive technologies in order to use the product.

This goal is directed to all information products used in the home, education, employment, or community environments. While it is much more practical to modify products purchased for personal use than it is to modify public systems, the need to modify each device in order to make it accessible presents a considerable burden and in some cases is not possible.

First, it is financially difficult to modify every product one purchases. Second, many of the newer telecommunication devices being proposed are small, sealed, highly integrated units that do not lend themselves to disassembly and modification in the same way that personal computers do. For some products, such as television set-top boxes, systems are sealed to prevent customers from tampering with them. The extremely rapid rate of development also makes keeping up with hardware and software innovations difficult, if not impossible. Often, new versions of software and products are released before third-party vendors can distribute access solutions to the previous version. The goals here, therefore, are to ensure that all products are designed to take advantage of all known, practical access strategies and to increase the number of practical strategies that are known.

Goal 5: Devices and systems should be flexible enough that people who lack one or more of the following capabilities can still use them.

Vision

Hearing

Speech

Fine movement control

Reach

Average cognitive skills

Average ability to concentrate

Universal benefits

Although the goals may seem ambitious, some products already come close to achieving or do achieve these objectives. Achieving these goals would also increase the general usability and flexibility of the next-generation systems for all users. Features that make systems usable by people who are blind would also make it easier for people to look up information or use the systems while they are driving their cars (for example, to look up an address or phone number for a client, or to book an airline flight). Features that make systems usable by people who are deaf would allow the systems to be used by others in noisy environments or in environments where sound is not allowed (libraries, during a meeting, etc.). Features that make systems usable by people with motor impairments might allow use by individuals who are wearing gloves or holding an unruly child. Features that make systems usable by people with low vision could be used by people who left their glasses in the other room. Features that make systems usable by people with cognitive impairments would reduce errors and decrease the learning curve for all of us and help us to use systems when we are distracted.

Thus, striving toward the above goals is not counter to standard design practice, but rather an extension of it. This is a critical issue that is too often overlooked or is dismissed as propaganda due to lack of information.

OPTIONS

As discussed earlier, two general options exist for making products and systems accessible by people with disabilities. One is to design the products and systems so that they are directly usable by people with disabilities. The other is to design them so that they can be adapted or used with assistive technologies. A third option is to design products with both characteristics. Each of these options is discussed briefly, along with its corresponding advantages and problems or issues.

Option 1: Built-in access

With this approach, products or systems are designed so that a user does not need any assistive technologies or adaptations to use the device or system. Instead, the systems allow sufficient flexibility to adapt to or accommodate individuals with a wide range of abilities or preferences.

Built-in access applies both to the operation of systems and devices and to the information that is presented through them. For example, a kiosk may use a touchscreen graphic interface with recorded sound. However, a user may choose to turn on captions to have auditory information presented visually or turn on a voice to allow visual information to be presented auditorily. Speedlists along the edge of the screen may allow individuals who are blind rapid access to the contents of the screen, while a step selection option may allow access by individuals with severe motor impairment. Multimedia information presented on the screen might include a description track and a caption track, again allowing individuals with different abilities or limitations to choose the presentation format that best matches their abilities.

Advantages

- The built-in access approach does not require an individual with a disability to purchase or own any special equipment to operate the system. This feature reduces the cost of accessing the system and allows access by persons who do not have the financial resources to secure special assistive devices.

- The technique is more convenient, since it does not require that users carry the special assistive technologies with them to access the systems or devices they encounter.

- There is no need for a delay between the time a device is released and in general use and the time that third-party manufacturers can develop an access adaptation compatible with it.

- Individuals are not left without access to systems because third-party manufacturers believe the market is insufficient to warrant an access device.

- Individuals who are progressively losing their abilities (and may be in denial) are able to successfully access and use the systems for which they would not purchase or use an assistive technology. Built-in access is particularly effective if the access features appear to be a natural part of the adjustability of the device or system, and if they are also routinely used by others.

Problems or issues

The major difficulty with this approach is that it is not always practical to build access for every type, degree, and combination of disability directly into every instance of

a product. For example, it is difficult to build a dynamic braille display (at an average cost of $2,000 to $5,000) into a $50 or $100 product, or even into a $10,000 kiosk. Also, a dynamic braille display may be too fragile to survive in a public outdoor environment. A similar problem may arise for individuals with high spinal cord injuries who use sip-and-puff or eyegaze techniques as their primary interface.

Option 2: Adaptation or use in conjunction with assistive technologies

The most straightforward example of this approach is products that include a universal link, which allows people with a disability to connect their own personal assistive technologies. One candidate for this universal link would be the new infrared standard developed by the Infrared Data Association (IrDA). Infrared links appear on almost all new laptop and next-generation desktop computers and provide a valuable and essentially no-cost tool for access. As this infrared link capability appears as a part of standard laptop and desktop computers, it becomes a relatively simple matter to use the link as a mechanism to allow individuals who are deaf-blind or who have severe physical disabilities to link into and use public kiosks, building directories, and other information systems.

For example, individuals who are deaf-blind could carry a small dynamic braille or other tactile device with them that would couple to the kiosk using the infrared link. This capability has already been implemented on a college campus demonstration kiosk.

Individuals who have no movement below the chin could drive up to an electronic information directory using their sip-and-puff wheelchair and, using the sip-and-puff mechanism and an infrared link, operate the directory to find out where they need to go. With remote access smart cards, they could also approach an e-cash-capable ATM and operate the system, withdrawing money without having to touch the ATM.

A second example is an open system in which users could install their own software or hardware modifications within a product to make it accessible to them. The installation of screen-reading software on personal computers is an example. Adding software or hardware modifications to a product, however, is usually a viable approach

only with computers or products owned by an individual. Most places where devices are used by the public do not allow the public to open or modify their systems, especially if electronic transactions (ticket machines, ATMs, etc.) are involved. In such cases, the external (alternative interface) connection would be the most viable.

Advantages

- Individuals can use the interface that is familiar to them in controlling the different appliances. (However, this advantage might be reduced or mitigated somewhat if the appliances used some standard practices and conventions with any built-in access strategies.)
- This strategy can provide a mechanism to allow individuals with much more severe or multiple disabilities to access and use public and in-home information systems and appliances.
- On some small or inexpensive devices, it may be extremely difficult to build some types of access features directly into the product. A small infrared link, however, may not be impractical.

Problems or issues

Most of the advantages listed under Option 1 would be lost under Option 2. Individuals would have to own a special interface and have it with them whenever they wanted to operate such systems.

Option 3: A hybrid approach

Option 3 is a hybrid that strongly encourages the approach described in Option 1 but includes the universal link described in Option 2 as a fallback for individuals for whom direct access cannot be built in.

Advantages

This combines the advantages of both Option 1 and Option 2 above.

Problems of issues

The primary issue here is where to draw the line. If a universal link is provided to allow individuals to connect assistive technologies, but very little or no attempt is made to build direct access into a device, should the device be considered accessible? This problem arises primarily in trying to set minimum accessibility standards (e.g., an ADAAG (ADA Accessibility Guidelines) that covers electronic information and transaction devices). It may be difficult to define exactly how much effort should be expended in implementing Option 1 (direct access) approaches.

This problem is considerably compounded by the diversity of forms, shapes, sizes, and configurations of information appliances. In fact, the trend is not toward devices dedicated to particular functions (e.g., a device called a phone and a device called a fax, or a device called an ATM and a device called a ticket vendor), but rather toward devices that carry out many or all of these functions. When users can withdraw e-cash and electronically reset the cash counter card in their smart cards using an e-cash dispenser built into the dashboard of their rental car (for travelers' convenience), it will become more difficult to define what an ATM is and which rules should apply. Rules being considered for present-day ATMs, which are quite large and sedentary, may not make much sense when an entire electronic ATM is the size of a paperback book mounted sideways in the dashboard of a rental car.

FORCES THAT CAUSE CHANGE IN DESIGN AND ACCESSIBILITY

Awareness that there is a problem and that solutions can be implemented economically.

Almost without exception, when researchers have visited companies to encourage more accessible (more universal) designs, executives were either unaware of the problems their current designs posed or unaware that cost-effective solutions could be easily implemented to make their products more accessible. (In many cases, executives were unaware that people with disabilities use their products.) Basic awareness is essential to progress.

Knowledge of specific, acceptable, and effective solutions

Once industry has been made aware of a problem, there have frequently been requests for more specific information related to the problems and solutions. Specific, detailed ideas and options have been requested, along with as much flexibility as possible. (Some industry members who have been embarrassed by moving forward with one implementation only to be criticized for not doing it right, also want some assurance of consensus within the disability community before proceeding.) Specific, practical, flexible and cross-disability approved guidelines are needed to move forward with any speed in this area.

Motivation to move the priority high enough to get it acted on

Almost all company representatives have commented that both internal and external motivations were necessary to either get accessibility programs moving or to keep them moving. A surprising number have said that legislation requiring accessibility would be helpful to their efforts by

- Raising the priority from "really should do this, really want to do this" to "really must do this" so that accessibility programs can compete with other "must do" priorities within the company; and
- Leveling the playing field by requiring the competition to also take the time initially to build the features in or to learn how to design more universally.

Other motivating forces mentioned included larger market (usually deemed negligible for any one feature); demand by customers; recognition in the press (e.g., if all product reviews in the press also evaluated product accessibility); and right thing to do (usually not enough by itself to move from "want to do" to "must do").

STRATEGIES FOR ACHIEVING CHANGE

If the agents of change are awareness, knowledge, and motivation, then the strategies for causing change should be based on these agents. Some recommended strategies are given below. The strategies listed include those presented in the document "Policy Recommendations from the Universal Access Project," by Deborah Kaplan. Recommendations are made specifically for government, industry, technical/research groups, and consumers, as all of these are considered key agents to bring about the changes necessary to ensure NII access for everyone.

Strategies for increasing awareness

The need for increased awareness of access issues and strategies is not limited to industry designers and engineers. Researchers in both the public and private sectors must be included in activities to increase awareness. Likewise, policymakers and people with disabilities must be made more aware of the issues and strategies surrounding access to information systems.

Strategies government can use to increase awareness:

- Define access as a policy goal.
- Ensure that the topic of access is a high priority on national agendas, public forums, and other environments where NII and next-generation information systems are discussed or publicized.
- Include at least a section discussing disability access issues in any documentation pertaining to NII or next-generation technologies and systems (including not only the Internet or home-based systems, but also high-performance computing, visualization research, etc.).

- Assume a leadership role in publicizing the benefits of access, along with access issues and strategies. Provide publicity through the popular press and through television exposure, in addition to regular information dissemination channels.
- Include access in policy initiatives regarding universal service and access, such as
  - National Telecommunications and Information Administration inquiries,
  - Federal Communications Commission Notices of Inquiry,
  - Information Infrastructure Task Force Policy Papers,
  - NII Advisory Council Final Reports.

- Require that all grants dealing with NII or next-generation information systems include a statement on how recipients are addressing issues of disability access their research. Even if recipients do not have complete or ready answers, such requirements would push them to consider looking at the central issue involved: that people with disabilities will need to use the systems being developed.
- Support efforts to secure broad input from the myriad disability groups that will be using the information systems and devices.
- Support efforts to bring the various groups together to identify acceptable, effective, compatible cross-disability interface strategies.
- Promote any activities that can be used to heighten public and industry awareness of access issues.

Strategies private industry can use to increase awareness:

- Establish a company-wide policy on accessibility.
- Establish and implement internal disability access teams.

- Include members from different segments of the company, such as engineering, product design, ergonomics, marketing, etc.
- Allow such groups to collaborate with all appropriate divisions within a company. Do not expect them to function in isolation.
- Ensure that product support mechanisms exist to allow appropriate communication and interaction with people who have disabilities.

Strategies technical and research groups can use to increase awareness:

- Publish professional papers describing research and development efforts directed toward or related to disability access issues.
- Publicize access-related research and development efforts in trade journals and other industry publications.
- Participate in and disseminate information at disability- and non-disability-related conferences.

Strategies consumers/disability constituencies can use to increase awareness:

- Make product, service, and information access needs known to product, service, and information providers. Provide both positive and negative feedback.
- Provide input to government and industry regulatory and policy boards.
- Closely consider cross-disability access issues, not just those of a particular constituency.
- Work cooperatively with other disability constituencies.
- Participate in government- and industry-sponsored forums or activities to promote awareness of access issues.
- Monitor the field to provide advisories to consumers, industry, and government agencies about problems, progress, and issues regarding accessibility.

Strategies for creating and disseminating knowledge

The creation and dissemination of knowledge pertaining to access have two major components. First, research must to be sponsored to develop answers and solution strategies to the many access issues posed by emerging technologies. Second, the knowledge obtained must to be disseminated to researchers, developers, manufacturers, policymakers, and consumers.

Strategies government can use to create and disseminate knowledge:

- Create funding programs that target accessibility research. Such research should specifically address access issues surrounding current and emerging information and telecommunication technologies.
- Recognize that much government-funded research is conducted in areas that are complementary to accessibility research. Require large research and development programs that conduct such research to include a component addressing accessibility issues.
- Foster joint university-industry research and development efforts.
- Promote joint efforts between disability-oriented technology research groups and research groups focusing on next-generation communication, information, and human-computer interface research.
- Work at local, state, and federal levels to disseminate information to agencies having direct contact with individuals with disabilities. This educates professionals in the field and enables them to pass along the information to the consumers they work with.
- Disseminate information to disability advocacy and consumer groups. By distributing information at a grass-roots level, information providers get feedback directly from end users.
- Publicize new information in appropriate trade journals, newsletters, electronic resources, and so on, and in government-sponsored conferences,

consumer education programs, and radio/television/Internet announcements.

- Encourage consumer and user participation in educating policymakers regarding access issues and strategies.
- Include consumer feedback mechanisms for all NII development activities.

Strategies industry can use to create and disseminate knowledge:

- Include people with disabilities in human factors and product design research.
- Include people with disabilities in alpha and beta testing cycles for products and services.
- Provide access to early product betas and developer support for disability access (third-party) developers and manufacturers, who are usually too small to warrant the access that is given to larger businesses.
- Provide adequate training to product support staff to ensure familiarity with the specific problems that people with disabilities might have in using company products or services.

Strategies technical and research groups can use to create and disseminate knowledge:

- Follow (almost) all of the strategies listed for government and industry.
- Work closely with groups representing a variety of disabilities.
- Work closely with industry.

Strategies consumers/disability constituencies can use to create and disseminate knowledge:

- Educate selves and others to existing and future technologies, and to related access issues and strategies.
- Educate product and service providers about specific product- and service-related access needs.

- Work within the framework of government and industry concerns. Learn about the problems and issues facing government and industry, and propose practical, achievable solutions.

Strategies for increasing motivation

Although legislating change is not the only mechanism for motivating change, a surprisingly large number of company executives have confidentially suggested legislation as perhaps the most effective mechanism for causing change within their companies. They cited two key factors in coming to this conclusion.

First, almost all executives say they spend a large percentage (or the majority) of their day handling crises and putting out fires (or trying to light them under others). In this environment projects that are considered merely important or very important fall victim to urgent and critical issues. Without some type of forcing factor (e.g., legislation), providing access to people with disabilities falls into the important or very important category, not into the urgent or critical category.

Second, almost all companies involved in information technology are in fierce competition with multiple rivals. Executives fear that work they perceive as potentially slowing or adding constraints to projects might result in a loss of competitive edge.

Even if building accessibility or universal design features and capabilities into company products would result in a more robust, easier-to-use product, slowing down projects to bring staff and designers up to speed in access areas is frightening to members of industry.

Companies find it helpful to rely on external researchers to provide predeveloped, tested, and proven techniques. They also like to know that there is consensus among disability groups as to particular access strategies. Such assistance still leaves the topic of access in the "very important" category, however, with the need to invest staff time before access strategies can be effectively understood and implemented.

Executives say that legislation or regulations that require all companies to address these issues have the effect of leveling the playing field, so the company that does

address them does not risk a potential disadvantage. However, these same executives are quick to follow with an admonition that adopting such legislation or standards must be done carefully, or it could be problematic. Unlike public telephones, elevators, and restrooms, which tend to be somewhat standard in appearance today, communication and information appliances and systems take on myriad different forms. Moreover, technologies in this area advance and evolve at an astonishing rate, making it difficult to predict what form, size, or shape they will take in the future.

For example, it is not clear whether the telephone of the future will be a device or just a function which may be included with a variety of other functions in a device that looks more like a watch, a pocket calculator, or a small earphone. Already, there are small devices that can be inserted into the ear, to act as both a microphone and an earphone. There are also voice-controlled telephones. Thus, it is difficult to say that all telephones must have a particular physical configuration, button size, or anything else when it is not clear that all telephones will even have buttons, or that it will be possible to physically identify a device as a telephone, even if it is used to make phone calls. It is already possible to make phone-like calls to others using a multimedia computer and the Internet, without using telephones, the telephone company, or telephone lines.

Conversely, if access regulations are sufficiently general to allow for endless implementations, it becomes difficult to judge exactly what constitutes compliance.

Probably the most effective strategy, therefore, is to set performance standards that are based on a reasonableness test. For example, a product should be usable by all individuals with disabilities whenever building such capabilities into products is reasonable and achievable. A measure of reasonable and achievable can then be based on whether other companies or competitors include such features in their products. This approach provides great motivation for companies to step forward and be among the first, since in doing so, they demonstrate that accessibility is reasonable and achievable, thus compelling their competition (under the regulations) also to address the issue. Unlike their competitors, however, innovative companies will not have to consider redesign of their system to provide the access. Thus, moving first provides them a competitive advantage and saves them time and redesign.

NOTE: The legislation passed by Congress uses the term "readily achievable," which is not as strong as "undue burden" or "reasonable and achievable" but still applies in the situations described above.

Legislative or regulatory action is a critical strategy for providing motivation. It is not the only strategy, however, and is therefore presented along with other recommendations below.

Strategies government can use to increase motivation:

- Update ADA regulations to better account for information technology .
- Adopt performance benchmarking for accessibility and consider incorporating access certification into the National Institute of Standards in Technology systems testing and independent testing labs .
- Encourage the private sector to work collaboratively with experts designing technological solutions to access barriers. Government encouragement can be accomplished through actions such as issuing policy statements and hosting collaborative meetings, discussions, and other joint activities that would provide opportunities for creative problem solving.
- Include access and universal design requirements in existing or new legislation, such as
  - — Section 508 of the Rehabilitation Act of 1973, as amended (done),
  - — New language in ADA regulations (not done),
  - — Language in telecommunications reform bill (done),
  - — Telecommunications bill regulations (in process).
- Set standards according to legislative mandates, in functional terms:
  - — Establish performance standards that are dynamic and general enough to survive in an era of ever-changing technology;

— Set standards and performance goals, but leave room for innovative approaches that can be used to achieve such goals;

— Define accessibility in terms that are measurable but also dynamic, general, and flexible enough to apply to technology that is constantly changing;

— Encourage standard testing agencies such as the National Software Testing Laboratory to add accessibility to their testing criteria.

- Apply standards and requirements to all government efforts. For example, ensure that all federal Web sites are accessible, and that all federally funded kiosks and public information systems are accessible.
- Consider methods of ensuring 508 compliance in the future with respect to all federal entities charged with reviewing and evaluating on a continual basis the effectiveness of policies, programs, and activities concerning individuals with disabilities, such as the National Council on Disability. This review becomes particularly important as changes in federal procurement policies, occur.
- Include requests or requirements for disability access features in all federal and state purchase requests.

Strategies government/industry/technical and research groups/consumers can use to increase motivation:

- Provide documentation to industry of any increase in either market size or market penetration that would result from incorporating access features into products. Studies documenting the percentage of major customers (e.g., large companies) that have employees with disabilities they would like to be able to accommodate would be particularly useful. (Most large companies would fall into this category.)

- Stimulate customer requests for access features. One mechanism for accomplishing this is to increase the awareness of consumers (both individuals with disabilities and companies that have employees with disabilities) so that they can ask sales force representatives about the availability of such features.
- Promote and achieve the inclusion of disability access features in trade magazine product reviews. Companies vie fiercely for high scores in product comparison reviews, and a low rating can have significant ramifications.
- Provide recognition or rewards for particularly well-designed products or services and publicize such achievement.
- Develop cross-disability consensus regarding recommended access features, so that industry will feel secure in incorporating such features.

CONCLUSION

There are many potentials and many potential problems regarding access to the information superhighway by people with disabilities. Past work has indicated that where consumers, researchers, and industry work together, effective and practical solutions can be found. Much work needs to be done, however, to identify solutions to problems of access to newly emerging technologies and to disseminate both the known and new solution strategies to those building NII. Readers of this report are encouraged to review the following documents for additional NII history, background information, and perspective.

ADDITIONAL READINGS

Bergman, Eric, and Johnson, Earl. 1995. Advances in human-computer interaction, Volume 5. *Toward accessible human-computer interaction*. Ablex Publishing Corporation. Norwood, NJ.

Brummel, Susan. 1994. "People with disabilities and the NII: Breaking down barriers, building choice." Included in the September 1994 report, *The information infrastructure: Reaching society's goals*. Report of the Information Infrastructure Task Force, Committee on Applications and Technology, National Institute of Standards and Technology, U.S. Department of Commerce. Washington, DC.

Edwards, Alistair D.N. (Editor). 1995. *Extra-ordinary HCI*. Cambridge, England: Cambridge University Press.

Goldberg, Larry. 1995. "Universal access project: Source (content) issues." CPB/WGBH National Center on Accessible Media. Boston, MA.

Hagins, Jerry. 1995. "Benefits and barriers: People with disabilities and the National Information Infrastructure." Thesis. Austin, TX: Center for Research on Communication Technology Society, University of Texas at Austin.

Kaplan, Deborah. 1996. "Policy recommendations from the Universal Access Project." Oakland, CA: World Institute on Disability.

Kaplan, Deborah, and DeWitt, John. 1993. *Telecommunication and persons with disabilities: Building the framework*. Second report of the Blue Ribbon Panel on National Telecommunications Policy. Oakland, CA: World Institute on Disability.

Kaplan, Deborah, DeWitt, John, and Steyaert, Maud. 1992. *Telecommunication and persons with disabilities: Laying the foundation*. Report of first year of the Blue Ribbon Panel on National Telecommunications Policy. Oakland, CA: World Institute on Disability.

Mazaik, Cheryl L. 1993. "Guidelines for producing accessible multimedia for deaf and hard of hearing students." Boston, MA: WGBH.

Microsoft Corporation. 1995. *Designing accessible applications: Considerations in the design of applications for the Microsoft Windows operating system*. Redmond, WA: Microsoft Press.

National Council on Disability. 1996. *Guidance from the graphical user interface (GUI) experience: What GUI teaches about technology access*. Washington, DC.

National Information Infrastructure Advisory Council. 1995. *Common ground: Fundamental principles for the National Information Infrastructure*. Washington, DC.

Pacific Bell. 1994. "Report and recommendations from Pacific Bell's Advisory Group for People with Disabilities and Pacific Bell's response." Berkeley, CA.

Tobias, J. 1995. The information industry and customers with disabilities: Results of a benchmarking study. Matawan, NJ: Inclusive Technologies.

Vanderheiden, Gregg C. 1994. *Application software design guidelines: Increasing the accessibility of application software to people with disabilities and older users*. Madison, WI: Trace Research and Development Center.

Vanderheiden, Gregg C. 1995. "Universal Access Project: NII infrastructure." Madison, WI: Trace Research and Development Center.

Vanderheiden, Gregg C. 1996. "Design of HTML (Mosaic) pages to increase their accessibility to users with disabilities, Version 1.6." Madison, WI: Trace Research and Development Center.

APPENDIX

MISSION OF THE NATIONAL COUNCIL ON DISABILITY

OVERVIEW AND PURPOSE

The National Council on Disability (NCD) is an independent federal agency led by 15 members appointed by the President of the United States and confirmed by the U.S. Senate.

The overall purpose of NCD is to promote policies, programs, practices, and procedures that guarantee equal opportunity for all individuals with disabilities, regardless of the nature or severity of the disability; and to empower individuals with disabilities to achieve economic self-sufficiency, independent living, and inclusion and integration into all aspects of society.

SPECIFIC DUTIES

The current statutory mandate of NCD includes the following:

- Reviewing and evaluating, on a continuing basis, policies, programs, practices, and procedures concerning individuals with disabilities conducted or assisted by federal departments and agencies, including programs established or assisted under the Rehabilitation Act of 1973, as amended, or under the Developmental Disabilities Assistance and Bill of Rights Act; as well as all statutes and regulations pertaining to federal programs that assist such individuals with disabilities, in order to assess the effectiveness of such policies, programs, practices, procedures, statutes, and regulations in meeting the needs of individuals with disabilities.
- Reviewing and evaluating, on a continuing basis, new and emerging disability policy issues affecting individuals with disabilities at the federal, state, and local levels, and in the private sector, including the need for and coordination of adult services, access to personal assistance services, school reform efforts and the impact of such efforts on individuals with disabilities, access to health care, and

policies that operate as disincentives for individuals to seek and retain employment.

- Making recommendations to the President, the Congress, the Secretary of Education, the Director of the National Institute on Disability and Rehabilitation Research, and other officials of federal agencies, respecting ways to better promote equal opportunity, economic self-sufficiency, independent living, and inclusion and integration into all aspects of society for Americans with disabilities.
- Providing the Congress, on a continuing basis, advice, recommendations, legislative proposals, and any additional information that NCD or the Congress deems appropriate.
- Gathering information about the implementation, effectiveness, and impact of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.).
- Advising the President, the Congress, the Commissioner of the Rehabilitation Services Administration, the Assistant Secretary for Special Education and Rehabilitative Services within the Department of Education, and the Director of the National Institute on Disability and Rehabilitation Research on the development of the programs to be carried out under the Rehabilitation Act of 1973, as amended.
- Providing advice to the Commissioner with respect to the policies and conduct of the Rehabilitation Services Administration.
- Making recommendations to the Director of the National Institute on Disability and Rehabilitation Research on ways to improve research, service, administration, and the collection, dissemination, and implementation of research findings affecting persons with disabilities.
- Providing advice regarding priorities for the activities of the Interagency Disability Coordinating Council and reviewing the recommendations of this Council for legislative and administrative changes to ensure that such recommendations are consistent with the purposes of NCD to promote the full integration, independence, and productivity of individuals with disabilities;

- Preparing and submitting to the President and the Congress an annual report titled *National Disability Policy: A Progress Report*.
- Preparing and submitting to the Congress and the President an annual report containing a summary of the activities and accomplishments of NCD.

CONSUMERS SERVED AND CURRENT ACTIVITIES

While many government agencies deal with issues and programs affecting people with disabilities, NCD is the only federal agency charged with addressing, analyzing, and making recommendations on issues of public policy that affect people with disabilities regardless of age, disability type, perceived employment potential, economic need, specific functional ability, status as a veteran, or other individual circumstance. NCD recognizes its unique opportunity to facilitate independent living, community integration, and employment opportunities for people with disabilities by ensuring an informed and coordinated approach to addressing the concerns of persons with disabilities and eliminating barriers to their active participation in community and family life.

NCD plays a major role in developing disability policy in America. In fact, it was NCD that originally proposed what eventually became ADA. NCD's present list of key issues includes improving personal assistance services, promoting health care reform, including students with disabilities in high-quality programs in typical neighborhood schools, promoting equal employment and community housing opportunities, monitoring the implementation of the Americans with Disabilities Act, improving assistive technology, and ensuring that persons with disabilities who are members of minority groups fully participate in society.

STATUTORY HISTORY

NCD was initially established in 1978 as an advisory board within the Department of Education (Public Law 95-602). The Rehabilitation Act Amendments of 1984 (Public Law 98-221) transformed NCD into an independent agency.

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