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Education of the VISUALLY HANDICAPPED

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MICROCOMPUTERS For the Visually Impaired

Education of the Visually Handicapped

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Abstracted by: *Blindness, Visual Impairment, Deaf-Blindness: Semiannual Listing of Current Literature, Exceptional Child Education Resources, Psychological Abstracts,* and *Current Index to Journals in Education.*

The Editors Talk . . .

I am pleased to have the opportunity to edit this special issue of *Education of the Visually Handicapped*. I have had a career-long interest in applications of technology to the problems of blindness. I am pleased to be joined by students and colleagues to report research and related developments in this interesting area.

The first article provides an overview of our most recent research project, research on multimedia access to microcomputers for visually impaired persons. It includes a definition of access technology we coined, a list of the types of access devices utilized, and a set of suggested supplemental criteria for evaluating software when used with visually impaired students.

The second article is by Dr. Sandra Ruconich, now director of educational technology at the Hadley School. Sandy did her doctoral work at Peabody /Vanderbilt and served as research assistant in our multimedia microcomputer research. She emphasized technology in her doctoral studies. Sandy's article presents an analysis of strengths and weaknesses of devices used in access technology for microcomputers.

Phyllis Brunken has been pioneering work with microcomputers at the Nebraska School for the Visually Handicapped. Phyllis uses much of the same technology utilized in the Peabody/Vanderbilt project. The Nebraska school progam she directs serves as a field test site for materials and procedures developed in the project. Her article reports exciting applications of microcomputers and access technology that we hope will be widely emulated in other programs for visually impaired students.

LaRhea Sanford, now serving as an itinerant teacher in the metropolitan schools of Nashville, Tennessee, is completing her doctoral studies at Peabody/Vanderbilt and has also served as a research assistant in the project.

Her article on a formative evaluation of an instructional program designed to teach visually impaired students to use microcomputers is based on her soon-to-be-completed dissertation.

All of us who have contributed to this special issue of the journal hope that readers will find it helpful in extending the benefits of microcomputers to visually impaired students.

Finally, we hope readers will want to share their experience and information with us. We would be pleased to correspond with individuals or to communicate via the SpecialNet Bulletin Boards on vision or computers.

S.C. Ashcroft, Guest Editor

Research on Multimedia Access to Microcomputers for Visually Impaired Youth

S. C. ASHCROFT

This special issue is about microcomputer technology. Technology is one of the blind person's most powerful allies in overcoming the detrimental impact of blindness. It ranks with effective education and positive attitudinal change in its potential to ameliorate some of the negative consequences of blindness. Linked synergistically with education, technology can enable blind people to become more effective individuals, to function as capable, coping members of society, and to improve their own self-esteem. As confident, self-reliant individuals they will elicit more positive responses from significant others. It is the lack of such positive reactions from others that blind people decry as the most negative and debilitating factor in their lives. Although technology in itself is not a panacea, linked with effective education it can reduce disability, enhance ability, and facilitate more effective interaction with other people and the environment.

According to John Naisbitt (1982), "we are living in the time of the parentheses, the time between eras. As we move from an industrial to an informational society, we will use our brain power to create, instead of our physical power, and the technology of the day will extend and enhance our mental ability . . . yet the most formidable challenge will be to train people to work in the information society."

Naisbitt (1982) also indicated, "by one estimate, 75% of all jobs by 1985 will involve computers in some way—and people who don't know how to use them

will be at a disadvantage . . . although computer use in public education is still in its infancy, schools around the nation are beginning to realize that in the information society, the two required languages will be English and computer."

Scadden (1983) enumerates expanded employment opportunities for visually impaired people that can be made available in the information society if appropriate attention is given to providing access. However, as yet, too little is being done to enable visually impaired persons to enter this era of technology and an information society.

According to Market Data Retrieval (Gregory, 1983), a national firm which keeps annual track of the computer market, "there are now 96,000 computers in 24,000 American public schools—60% more than last year and three times as many as two years ago." By contrast, a recent survey of 46 schools for visually impaired students elicited 42 responses indicating that only 55% have computers and only 40% are using them with students in some type of instructional capacity (Kapperman, personal communication, 1983).

Other surveys (Young & Ashcroft, 1981) indicated that only 3% of visually impaired students in schools surveyed were learning about computers in 1980; however, a year later, the figure had risen to only 23%. According to Don Senese (U.S. Government Printing Office, 1983), "Today we no longer ask, 'will computers be used in the schools?' We know that they are, and that they are being purchased by schools faster than we can keep count. Indeed, surveys of computers in schools are outdated by the time they are published. The computer has excited administrators, teachers, students, and parents in a way that no other educational tool, theory, or curriculum has before."

The report of the Office of Technology Assessment (1982) indicates that, "modern society is undergoing profound technological and social changes brought about by what has been the information revolution." Their report continues, "A key element of all of these educational needs is that they will constantly change. In a rapidly advancing technological society, it is unlikely that the skills and information base needed for initial employment will be those needed for the same job as a few years later. Lifelong retraining is expected to become the norm for many people."

Unfortunately, the "thin" sales market represented in the low incidence of blind persons militates against the development and marketing of technology specially designed for blind persons. Thus special reading machines and mobility aids remain "out-of-sight" in price, while technology that serves the nonhandicapped is relatively cheap. This problem is compounded by the fact that those who work with blind persons have failed to exploit fully both regular and specialized technology's potential to mitigate the problems of habilitating, educating, and rehabilitating blind persons.

The inexpensive silicone chip and microprocessor technology have the potential to improve this situation. Microcomputers, cassette braille reading machines, and other already available microcomputer-based devices are becoming increasingly available and accessible. What is now needed are knowledgeable people who can work with this equipment and make it useful to their visually impaired students. This special issue provides some information that should be of help.

Since 1977, the author has been working with cassette braille equipment thanks to Josephine Taylor, then of the U.S. Bureau of Education for the Handicapped. The present phase of this research program is designed to study visual, auditory, and tactual means to give visually impaired youth access to microcomputers for curricular, prevocational, and avocational purposes. Previous projects in the program of research (Ashcroft & Bourgeois, 1980), included an evaluation of paperless braille recorders and the linking of them with microcomputers.

Five objectives are pursued in this project:

1. To study microcomputer systems to be made accessible to visually impaired youth through touch, voice, and enlarged print.
2. To develop and evaluate instructional programs for teaching visually impaired youth to use these multimedia microcomputer systems through access technology.
3. To develop and evaluate related instruction for the inservice and preservice training of special education personnel who work with visually impaired youth.
4. To evaluate selected, adapted, or specially developed computer-assisted instructional (CAI) programs.
5. To disseminate the results and products of the research program, local day school programs, and programs at institutions of higher education. Teachers in residential and local day school programs and college students preparing for careers in special education of visually impaired children and youth also participate in appropriate aspects of the research program.

In studying ways to make microcomputers accessible to visually impaired students, the Apple II Plus, the Apple IIe, the TRS-80 Model III, and the IBM Personal Computer have been chosen because of their low price, popularity, and wide availability. These microcomputers have been found largely, but differentially, satisfactory for linking with access technology because of their reliability and adaptability in accommodating the software and peripheral equipment of access technology. The greatest success has been with the Apple and TRS-80; more difficulty has been found with the IBM-PC.

Visually impaired students are largely precluded from using microcomputers effectively without special means of access. Fortunately, several means of providing fuller access have become increasingly available. These means are grouped in what is called access technology. Access technology is defined as the equipment, equipment interfacing, software, and instruction and instructional materials enabling independent use of microcomputers by visually impaired persons. Equipment includes those devices providing tactual or auditory output and/or enlarging visual output. Interfacing is linking the special access equipment with the microcomputers and enabling visually impaired persons to use both the access equipment and the computers. Software includes the software adaptations or supplements required by access technology as well as the microcomputer software. Special instruction and instructional materials are needed to enable visually impaired students to use both the equipment and the access equipment independently.

This work has been limited to the use of commercially available access technology including both peripheral equipment and software for access rather than developing such devices and materials. Figure 1, titled "Access Technology for Microcomputers for Visually Impaired Students," indicates the range and variety of peripheral equipment and software included in the access technology used. As indicated in Figure 1, the students worked with have vision ranging from approximating normal to no vision. About 80% of those who come within the accepted definition of blindness have some remaining vision. The access technology ranges from standard, nonspecialized equipment requiring little adaptation for learners with visual impairments to nonstandard and highly specialized equipment required by learners who need specially designed or adapted equipment. As Figure 1 indicates, the access technology ranges from equipment providing regular computer displays on cathode ray tube screens or hard-copy printout in normal print size to complex cassette braille machines and optical recognition devices. Regular computer displays can be used by students with good central vision approximating normal but with vision impairments that qualify them for special education. Enlarged print on the CRT screen generated either through hardware or software is utilized by students with partial vision. Such students can also utilize regular displays enlarged externally by stand-mounted or hand-held magnifiers. Other students with partial vision find it necessary to use the electronically enlarged CRT displays provided through closed-circuit television.

Voice synthesis can be used either to augment visual or tactual access or as the sole medium of access. Voice synthesis is available in special terminals such as those specially designed for blind persons and distributed by Maryland Computer Services. These terminals provide a great deal of flexibility in rate, pitch, and tone under control of the visually impaired user. Voice synthesis readouts are also available through print character recognition devices such as the Kurzweil Reading Machine, the only such equipment as yet currently available.

Equipment for access through tactual means has become increasingly available during the past five years. The newest device in this category is the Cranmer Modified Perkins Brailler, a cassette braille machine with paper readout and utilizing a braille keyboard. This electronic braille reading and writing equipment is an adaptation of the familiar Perkins Braille Writer and is marketed by Maryland Computer Services. Its present cost of $2750 makes it the least expensive cassette braille device yet available. In addition to its relatively low price in contrast to other cassette braille machines, it enjoys the great advantage of graphics capabilities.

Figure 1. Access Technology for Microcomputers for Visually Impaired Students*

Number of Persons Served	Visual Acuity Continnum	Microcomputer Access Devices and Arrangements	Degree of Specialization Continuum	Primary Modality Utilized-Vision Audition or Touch *V*	*A*	*T*	Input/Output Capability of Device	Graphics Capability/ Accessibility
Potential to Serve Most Users	Normal Vision	Regular computer display (CRT) or hard copy (paper) print-out, normal print size	Least Nonstandard and Specialized Equipment Required	X			I/O	Visual graphics only
↑	↑	External adjustable or adaptive devices to put CRT display in vision range	↑	X			O	Could provide enlarged visual graphics
		Voice synthesis as supplemental mode of access		X			O	Requires specialized software to be developed
Least Learner Adaptation and Special Instruction Required		Clear, good contrast and/or enlarged print on CRT screen		X			O	Could provide enhanced graphics
↑		Hardware or ROM-generated large type		X			O	May require graphics enlargement
	Partial Vision	Software-generated large type		X			O	May require graphics enlargement
		Externally magnified large type—optically magnified by stand- or hand-held magnifiers		X			O	Could enlarge parts of graphics
		Electronically enlarged type—via closed circuit TV		X			O	Could enlarge graphics
	Low Vision	Voice synthesis as sole mode of access; special terminal—e.g., Maryland Computer Services ITS or Total Talk			X		O	Would require supplemental specialized graphics
		Print character recognition with voice synthesis readout—e.g., Kurzweil Reading Machine			X		O	Probably lacks potential
		Cassette braille machine—paper readout—Perkins terminal—braille keyboard				X	I/O	Can reproduce tactile graphics from CRT visual graphics
		LED-120—braille print machine and terminal—paper readout—regular keyboard				X	O	Has potential (needs software to be developed) to fully reproduce graphics
↓		Cassette braille machines—movable pin displays—VersaBraille, Microbrailler, and others				X	I/O	Cannot facilitate graphic use
Most Learner Adaptation and Special Instruction Required	No Vision	Proposed tactile graphics display—as stand-alone device or as dumb terminal—no keyboard or possible braille keyboard	Most Nonstandard and Specialized Equipment Required			X	I/O	Could reproduce graphics from the screen in tactile form
Potential to Serve Fewest Users	↓	Optical-to-tactile converter—Optacon—with CRT lens—no computer input capability	↓			X	O	Could view small part of graphic

Braille printing machines and terminals have been available for some time, but up to now have been extremely expensive and lacking in portability. They provide a paper readout and regular computer keyboard terminal input.

Cassette braille machines with movable pin readout, such as VersaBraille and Microbrailler, first became available in 1977 (Ashcroft, 1979). They have improved rapidly in sophistication and reliability but remain scarce and expensive.

There is a proposed tactile graphic display being developed by the American Foundation for the Blind as a stand-alone device or as a dumb terminal. Such a device will be an invaluable addition to access technology for microcomputers as well as having numerous other applications. Currently, microcomputer software programs including graphics are virtually inaccessible to visually impaired students without remaining vision.

The last and most specialized mode of access listed is the Optical-to-Tactile Converter (OPTACON). This device presents, through vibrating pins, a tactile counterpart of visual symbols detected by a small hand-held camera which, when used with a CRT lens, can make the CRT display accessible in tactual characters to the visually impaired person.

At the current stage in the development of access technology much remains to be learned about interfacing access equipment and microcomputer equipment. Distributors rarely provide adequate information in a form useable by naive persons so that equipment can be readily interfaced for reliable operation. Personnel with computer programming expertise are essential, and it is highly desirable to have available expertise in communications and electronics. There are frequent needs for technical assistance to avoid the frustrations of balky or malfunctioning equipment. Much also remains to be learned about how to facilitate learning on the part of visually impaired students and their teachers.

In pursuing the first objective, to make microcomputer systems accessible, the researchers have used the access technology included in Figure 1. Thus, the first findings of this research program relate to selecting and linking the various elements of access technology responsive to the diverse needs of visually impaired learners.

With respect both to the microcomputers and access technology, it is difficult to keep abreast of the rapid changes and developing technology. Furthermore, the access equipment remains extremely expensive because of the thin market demand for it. Thus, the Total Talk terminal is approximately $6000; cassette braille equipment ranges from about $4000 to $7500. An OPTACON and CRT lens costs approximately $3000.

In pursuing the second objective, to develop and evaluate instructional programs, a three-module instructional program has been developed for student use. The pilot for these modules was studied in the laboratory and at the Tennessee School for the Blind; the modules were placed for field study at five schools and programs for the blind. The first module is entitled, "Module One: Introduction to Operation of Apple II Plus Microcomputer System." The purpose of this

module is to familiarize the student with the major components and features of the Apple II Plus microcomputer system, so that the student can independently access microcomputer programs. Mastery of this module is demonstrated by passing a performance test to the criterion level of 100%. "Module Two: Access Technology for Visually Impaired Microcomputer Users," provides information to visually impaired students regarding several modes of access to the microcomputer. This module includes four objectives with a master test for each objective. The criterion for completion of each objective's test is 100%. "Module Three: Introduction to Basic Programming" introduces the computer language BASIC commands and learns to analyze simple programs.

In pursuing the third objective, a teacher education workshop pilot has been developed and studied at the Tennessee School for the Blind and presented in other residential and day-school programs. This workshop provides an overview of microcomputer technology and current educational applications. Teachers also learn about the special access technology and emphasis is placed on allaying teachers' anxieties about technology and its applications in special education.

In pursuit of the objective to evaluate selected, adapted, or specially developed computer-assisted instructional (CAI) programs, a policy has been adopted and criteria have been developed to be used in connection with software evaluation procedures. As a matter of policy, software to be utilized with visually impaired students should first meet those criteria which are relevant to the selection of quality software for any student and any educational application. However, there are additional criteria that must be utilized if visually impaired students are to benefit from microcomputers and software. Following are criteria proposed and distributed to a number of computer and education experts, some themselves blind, for criticism and suggestions:

- Is the software copy-protected so that program instructions cannot be modified to include addition or deletion of program lines? Can the output of the program be directed to a serial port for peripheral equipment?

  As a protection against unauthorized copying of software programs, some software contains its own disk operating system (DOS) which does not permit the use of access devices, editing, and listing of the source code, or modification of large print.

- Does the software contain pictures, nonstandard characters, nonprint symbols, or other graphics, and to what extent are these graphics essential to understanding and benefitting from the program?

  Braille and voice synthesis devices cannot convey graphic information. While large-print graphic characters are helpful for some low vision students, they may not be able to be displayed adequately on other access devices.

- Does the software present material in columnar or other unusual format and to what extent is the format of material essential to understanding and benefitting from the program?

  Braille machines and voice synthesis devices only produce material line-by-line. If two or more columns of material are presented or unusual formats are used, the material becomes much more difficult to read and understand through braille and voice devices.

- Are there user support materials that would have to be provided in braille, audio, or large-print form, along with the software for the effective independent use of the program? Further, are there copyright constraints against adapting the program or documentation?
  Software without user supporting materials (in a readable medium) is often useless.
- Does the program use time as a constraint (e.g., quicker answers receive higher points)? Can this timing be controlled by the user?
  Longer examination and time for study may be required by users needing access devices. The slower display of material required by access technology may produce an immediate disadvantage for the visually impaired user.
- Are provisions made for users to interrupt and save their work prior to completing the program and to restart the program at the point it was interrupted?
  Access devices slow the output and extend the duration of programs, thus stressing the need to be able to interact with the program in meaningful parts.
- Does the program use sound to supplement or reinforce material presented visually?
  Sound cues can often facilitate access to the program for visually impaired students. Also, if the program is to be mediated for visually impaired users solely by the use of voice synthesis devices, how will original auditory material work with the voice synthesis mediation?
- Does the software use commands that can only be entered from the keyboard of the microcomputer on which the program is running?
  Input to programs using these commands cannot be made from access devices such as cassette braille machines.
- Does material scroll off the screen beyond the control of the user?
  Longer examination may often be required by OPTACON or large-print readers.
- Does the program use Inverse video to highlight key concepts?
  The OPTACON with CRT lens has difficulty reading material that switches between Normal and Inverse.
- Does the program present unusual color/background combinations?
  Some color graphics nearly blend with the background when presented on monochrone monitors, thus providing insufficient contrast for low vision and OPTACON readers.
- Is the program modified by the use of access devices so that visually impaired users cannot independently use the program along with the required access technology?
  The addition of access technology may make the use of the program more complex (e.g., graphics helpful to sighted users might be eliminated when using voice or braille output).
- Is the program reliability likely to be changed by the use of access technology?
  Electronic interfacing of peripheral equipment required for access technology may change the reliability of operation of certain programs.
- Can intended users independently use the program along with the required access technology?

The addition of access technology may make the use of a program more complex than it would otherwise be.

The proposed criteria have been revised by viewers and now have elicited widespread agreement. They now need to be validated further through additional use. The researchers are promulgating them and seeking feedback on them from broader use in the field. Additional suggestions are solicited for needed amendments, improvements, or alternatives.

The fifth objective of this project is to disseminate information. It is expected that the research program will continue in order to stay abreast of the state of the art in microcomputer technology and to develop further the access technology required to enable visually impaired students to use microcomputers. The project will continue to link state-of-the-art microcomputers with access technology in the laboratory, to develop student-use instructional materials designed to teach its use, and to pilot test equipment configurations and instructional materials, before field testing them and evaluating them for dissemination. The project also continues to seek to identify needed competencies for teachers and students for the use of microcomputers and access technology and to develop, pilot test, disseminate, and evaluate instructional and informational materials for preservice training and inservice education programs that will facilitate attainment of such competencies. The project is especially eager to develop a dissemination program using such means as telecommunications, teleconferencing, and computer conferencing, along with more conventional means of disseminating information so that personnel can be effectively prepared for the use of microcomputers with visually impaired students.

NOTE

Plans are being developed to distribute the three student instructional modules including a floppy disk for their use on Apple computers. Sets of the modules will be available for $12.50 to cover the costs of duplication, floppy disk, packaging, and mailing. Write Multi-Media Microcomputer Project, c/o S.C. Ashcroft, Box 328, Peabody College, Nashville, TN 37203.

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S.C. Ashcroft, the guest editor for this issue, is at Peabody College, Vanderbilt University, Nashville, Tennessee.

We would like to give credit to David Boyanchek, of St. Louis, Mo., for the photographs used on the cover of our Summer 1983 issue. These photographs also appeared on pages 53, 54, and 55 of the same issue in conjunction with the article "The Learning Center" by Laura Gray of the Delta Gamma Foundation for Visually Impaired Children of St. Louis, Mo., Inc.

Education of the Visually Handicapped publishes materials of interest to educators, researchers, parents, and all others concerned with visually handicapped children, youth, and young adults including multihandicapped and deaf-blind children. The journal reports on useful practices, research findings, experiments, professional experiences, and controversial issues. Consideration is given to articles dealing with educational trends and philosophy; administrative practices curriculum; teaching strategies; staff and parent needs, counseling, educational technology, and aids; federal, state, and local programs; litigation, legislation, and regulation; and international education. Regular features include editorials, book reviews, and letters to the editor.
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Evaluating Microcomputer Access Technology for Use by Visually Impaired Students

SANDRA RUCONICH

ABSTRACT: A variety of devices exist which enable visually impaired students to gain access to microcomputers. In an effort to provide guidance for students, professionals, and others in the field who may be called upon to evaluate the merits of such devices, this article outlines the advantages and limitations of each generic kind of microcomputer access technology used by visually impaired persons. Factors such as how the device is to be used are also considered.

The computer revolution is here. There are computers and microprocessors everywhere—in grocery-store checkout lines, microwave ovens, cars, drink vending machines, and a host of other places. This special issue of *Education of the Visually Handicapped* is evidence that computers are being used by visually impaired students as well as by their seeing peers.

Many kinds of technology—electronic braille, paper braille, Optacon, synthetic speech, and enlarged print—currently enable these visually impaired students to access computers. Each possesses unique advantages as well as unique limitations, and it can be difficult to identify them all. This article is therefore an attempt to outline the advantages and limitations of each kind of computer access technology in order to enable professionals, students, and others in the field to make a more informed choice of the technology which best meets their needs.

Electronic Braille

Visually impaired students who use braille as their primary reading medium have had the most difficulty gaining access to microcomputers. One way students who read braille are now able to gain such access is through electronic braille devices. These microprocessor-based devices use magnetic audio cassette tapes or disks to store and retrieve information written in braille. The six keys ordinarily employed in braille-writing devices allow the user to send information to the computer. Information sent from the computer is displayed to the user through a refreshable braille display of 20 or more characters in a line of movable pins representing braille dots. An example of such an electronic braille device is the VersaBraille, manufactured by Telesensory Systems, Inc.

Advantages

One of the greatest advantages of electronic braille devices is the ability to send as well as receive information through a single instrument. As will become apparent later in this article, not all kinds of computer access technology used by visually impaired persons are so versatile. A second advantage of electronic braille is its extensive and compact storage capability. Whereas each paper braille character requires 1/4 inch of horizontal line space and each line requires 2/5 inch of vertical page space, an ordinary 60-minute cassette tape can store the equivalent of 400 pages of bulky paper braille. Disk capacity is even more extensive. In addition, electronic braille provides a one-to-one print-to-braille representation at a high rate of accuracy. By contrast, synthetic-speech computer access devices may correctly pronounce a misspelled word or incorrectly—and perhaps misleadingly—pronounce a correctly spelled word. Another advantage of electronic braille is the speed at which it can be read and produced. Students can generally read electronic braille significantly more rapidly than they can read tactile counterparts of print as produced by the Optacon. In addition, the VersaBraille produces characters sent from the computer at approximately 100 characters per second, a rate significantly faster than is possible with some other access devices.

Limitations

Like any access technology, electronic braille has limitations as well as advantages. Currently available electronic braille devices present information only in displays of 20 to 40 braille cells on a single line, so that only one line of information is available at any time. Thus, although it is possible to search for information, the tactile information search process is more difficult and time-consuming than it would be if an entire screenful of information was immediately accessible for scanning and searching. An additional constraint is that all information is provided in computer braille, a combination of grade 1 (uncontracted braille), Nemeth code numbers, and selected punctuation marks and other symbols unique to the computer braille code. This fact, together with the short line length of electronic braille devices, means that users read computer information more slowly and with a different style of touch reading than they do when reading paper braille. The single-line format also precludes the display of tactile graphics (drawings composed of raised dots or lines) which are essential to many computer programs and games. A further disadvantage is that the stored information is not interchangeable among different brands of electronic braille devices. A tape made on an electronic braille device from one manufacturer will not necessarily be readable on an electronic braille device from another manufacturer. Furthermore, not all devices use precisely the same computer braille code. The "carriage return" message, for example, is not sent in the same way from all electronic braille devices. The lack of portability of such devices is an additional problem. Even the smallest and lightest electronic braille machine is heavy (about 9 pounds) and difficult for a young student to transport. Finally, electronic braille devices are expensive, ranging in price from $4850 to $13,000. Since the low incidence of visual impairment precludes quantity production, a price decrease is not likely. Thus, it may not be possible for every braille-reading student who needs computer access to use electronic braille devices.

Paper Braille

Until the advent of electronic braille, computer access through braille was limited to paper braille provided on large paper-braille printing devices such as the LED-120 printer from Triformation Systems, Inc. Now the Cranmer Modified Perkins Brailler (CMPB) allows students to send information to the computer using a Perkins-brailler-style keyboard and to receive information from the computer in paper-braille form on the page inserted into the machine.

Actually a modification of the conventional Perkins brailler, the CMPB simply adds electronics (housed in a box beneath the brailler) which enable the device to provide computer access. The CMPB incorporates solenoid-operated keys, an electronically driven carriage return, and line-spacing functions. The braille embossing head writes while moving right to left as well as left to right, embossing at the approximate speed of 10 characters per second.

The CMPB includes a standard RS-232C connector, so that it may be linked to peripheral devices. It utilizes conventional cassette tape equipment to store and retrieve information. Word processing, the ability to change control parameters from the keyboard so that the device can be connected to a wide variety of computers, and other features similar to those available on electronic braille devices are also included. Perhaps one of the CMPB's most exciting features is its ability to produce tactile graphics. The CMPB is manufactured by Maryland Computer Services, Inc.

Advantages

Foremost among the CMPB's advantages is its full-page display capability. It is highly desirable, particularly when comparing lines of computer programs, to have easy and immediate access to an entire page, as opposed to a single line, of information. This full-page display capability also means that material in columns can be read rapidly and inefficiently. Priced at $2750, the CMPD is significantly less expensive than presently marketed electronic braille devices. Since braille-reading students are accustomed to using the Perkins Brailler, the transition to the CMPB can be made easily. Finally, the device can draw and label curves, graphs, maps, and other graphic displays, increasing the number and variety of programs available to braille users. Since this capability has not been available on other braille computer terminals, its use and potential have yet to be explored.

Limitations

A significant limitation of the CMPB is its slow printing (embossing) speed of 10 characters per second—far slower than the VersaBraille's approximately 100 characters per second. This speed limitation becomes important when many pages are to be brailled. The CMPB's use of braille paper presents two limitations. First, braille paper is a much bulkier and more costly storage medium than is an audio cassette or a disk. Second, the device cannot currently utilize continuous fan-fold or a roll of paper as do conventional inkprint printers. Thus, each page must be inserted and removed by hand, necessitating virtually constant monitoring and time-consuming paper handling. Care must also be taken to keep the pages in usable order. In addition, the CMPB is hampered by some of the limitations of electronic braille terminals. Computer braille code output further reduces reading speed. The device is heavier than desirable and does make some noise. CMPB tapes cannot be read on other braille devices and vice versa.

Optacon

Because of its early availability, the Optacon is at present probably the most widely used computer access technology. Introduced in 1971 (Bliss & Moore, 1974), the device is currently priced at $4295. The Optacon uses an array of 144 electronically activated pins to translate printed material into raised vibrating print readable by touch. A computer paper printout can be read using the regular

lens of the Optacon camera. A cathode ray tube lens which can be easily attached to the Optacon camera makes it possible to read computer video displays.

Advantages

The Optacon's primary advantage is its versatility. A computer's output can be read either from a printed version generated by a computer printer or from an electronic version on the computer's video display. As is true of paper braille devices, the Optacon allows the user immediately to access any information on a full page of computer output. Thus, immediate search capability is not limited to a single line as with electronic braille devices, and material in columns can be scanned easily. In addition, the Optacon can provide access to graphics.

Limitations

Perhaps the Optacon's chief limitation is the speed at which material is generally read. Average Optacon reading speeds range from 20 to 60 words per minute (Telesensory Systems, Inc., 1978). In addition, the Optacon is a one-way communication medium. Although information received from the computer can be read directly with the Optacon, information cannot be sent to the computer via the Optacon but must be entered from some separate device with a keyboard. The Optacon also requires the user to know how or to learn to read various styles of upper case letters, lower case letters, and numbers, necessitating a higher level of training than that required simply to master the mechanics of using the device. Good bimanual coordination is necessary to orient the Optacon camera properly and to move it straight across the line of print. Faulty camera alignment and poor tracking produce slanted, hard-to-read letters and slow or preclude Optacon use by some otherwise capable students.

Synthesized Speech

Voice-synthesis devices have become widely and inexpensively available. They provide a very promising means of access to microcomputers for visually impaired persons. Although digitized (pre-recorded) speech is used in some applications, the most popular type of speech access technology uses synthetic speech to enable the computer to talk. Synthetic speech involves the putting together (concatenation) of electronically generated sounds to form words. Some methods of producing synthetic speech use a computer program to generate the speech. Others employ a special terminal and computer hardware for this purpose. In general, all information received from the computer can be spoken as words, spelled letter by letter, and/or reviewed. Synthetic speech devices range in price from $150 (Echo II speech synthesizer, manufactured by Street Electronics) to $8000 (the Information Through Speech computer, manufactured by Maryland Computer Services, Inc.).

Advantages

A significant advantage of computer access through synthetic-speech technology is speed. One manufacturer claims that users of its synthetic-speech terminals and computers routinely read at 360 words per minute (Gilson, personal communication, 1982). Equally important, synthetic-speech users may include but are not limited to the braille-reading population. Those who find computer braille output frustratingly slow, partially seeing students who want an alternative to enlarged print, and students with normal vision can all benefit from this technology and can use it to work on games and assignments together.

Limitations

Probably the primary limitation of current synthethic-speech devices is the limited information review capabilities of the equipment. Some synthetic speech devices have no review capability, so that information is completely ephemeral; other devices retain less information in memory than do electronic braille devices. A second limitation is the relatively low quality of speech output which requires a period of learning and accommodation to understand. New devices promising higher speech quality continue to be developed, but current quality remains unacceptable to some users. As noted earlier, words can be pronounced correctly even though they are spelled incorrectly. Alternatively, some correctly spelled words are incorrectly pronounced. However, some devices allow users to make program changes which correct particularly troublesome mispronunciations. In addition, like the Optacon, synthetic-speech devices provide only one-way communication. Information can be received but not sent using synthetic speech. Finally, as is true of other kinds of access technology, synthetic speech is incapable of displaying graphics.

Enlarged Print

Since about four-fifths of those who come within the accepted definition of blindness for legal purposes retain some useful vision, enlarged print is an important means of computer access. Enlarged print is, of course, a particularly helpful medium for partially seeing and low vision students. On a computer it can be generated through read only memory (ROM) or by using a program (RAM). Enlarged print can also be made available by means of computer terminals, computers which employ closed-circuit television, or hand-held or stand-mounted magnifying devices. The cost of enlarged print can be as inexpensive as the price of the program which generates it or as costly as the price of a closed-circuit television computer system.

Advantages

Since such a large proportion of visually impaired students have useful vision, enlarged print's chief advantage is the high percentage of the visually impaired

population it can serve. Enlarged print can also be a comparatively inexpensive access technology, since it already comes as a part of some computers and requires only the purchase of computer programs to provide the capability for others. Finally, graphics in standard size—or, in some cases, enlarged—can be displayed using this medium.

Limitations

Enlarged print's variety of presentation formats is a mixed blessing. Computers equipped with enlarged print capability may generate only one size print. Thus, the needs of those who find it easiest to read some other size print might remain unmet. If a program is used to enlarge the print, every piece of material to be enlarged requires initial modification. Finally, extremely enlarged print is virtually impossible for Optacon users to read because it is so much larger than the Optacon camera's zoom lens can handle.

Conclusion

No single mode or medium of access technology is ideal or meets the needs of all visually impaired users. Indeed, a user might ideally choose to use one device for one task and a different device for another. A braille reader, for instance, might like to read columnar material using the Optacon or a full page of braille produced on the CMPB, but use synthetic speech to read textual material because of its greater speed. Thus, in addition to the careful evaluation of the advantages and limitations of each device, other factors must also be considered if realistic choices of access technology are to be made. Factors which deserve consideration include how the device is to be used, the cost-benefit ratio, how portable the device must be, user speed, and other requirements. Wherever possible, the user's capabilities, preferences, and opinions should be taken into account. In summary, the technology which can provide visually impaired students access to computers now exists. It is likely to exist in even greater abundance and variety in the future. Our task as educators is to be certain that lack of computer access—and, by implication, lack of computer literacy—do not make our students multiply handicapped in this increasingly technological era.

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