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ABSTRACT

This document consists of all issues/pages of the electronic journal "Information Technology and Disabilities" published during 1996, i.e., a total of 13 ITD articles: (1) "New CSUF (California State University at Fullerton) Braille Transcription Center Promotes Access to Postsecondary Instructional Materials for the California State University System" (Daniel Hilton Chalfen and others); (2) "A Brief Historical Overview of Tactile and Auditory Aids for Visually Impaired Mathematics Educators and Students" (Evelyn Kubiak-Becker and others); (3) "Research Note: the Braille N Speak as a Laboratory Tool for Blind Students" (David Lunney and others); (4) "Ease of Use and Maintenance: A Note on Software Design" (Richard Plant); (5) "Adding Audio Description to Television Science Programs: What Is the Impact on Visually Impaired Viewers?" (Emilie Schmeidler); (6) "Teaching Lab Courses to Students with Disabilities" (Sheryl Burgstahler); (7) "Technology and Hands-On Strategies for Teaching Science and Mathematics to the Special Education Population" (Howard Kimmel and others); (8) "Accessible Internet Based Mathematics and Aeronautics Materials for 4th-7th Grade Children with Physical Disabilities" (Lewis E. Kraus); (9) "Teaching Science, Engineering, and Mathematics to Deaf Students: The Role of Technology in Instruction and Teacher Preparation" (Harry G. Lang); (10) "Assistive Technology and Learning Disabilities" (Carolyn Gardner); (11) "Teaching Science to the Visually Impaired: Purdue University's Visions Lab" (David Schleppenbach); (12) "Tactile Graphics: An Overview and Resource Guide" (John A. Gardner); and (13) "Computer Technology Education and the Deaf Student: Observations of Serious Nuances of Communication" (Curtis Robbins). Individual issues also contain news items, reviews, and calls for papers. (DB)

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Articles

New CSUF Braille Transcription Center Promotes Access to PostSecondary Instructional Materials for the California State University System
Daniel Hilton Chalfen, Ph.D., University of California, Los Angeles
Jeffrey C. Senge, M.S., California State University, Fullerton
Jamie Dote-Kwan, Ph.D. California State University Los Angeles

A Brief Historical Overview of Tactile and Auditory Aids for Visually Impaired Mathematics Educators and Students
Evelyn Kubiak-Becker, University of Wisconsin, Madison
Thomas P. Dick, Associate Professor, Oregon State University

Research Note:
The Braille 'N Speak as a Laboratory Tool for Blind Students
David Lunney, Margaret M. Gemperline, Angelo Sonnesso and David Wohlers, East Carolina University

Ease of Use and Maintenance:
A Note on Software Design
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Return to the EASI Homepage
Return to the ITD Homepage

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NEW CSUF BRAILLE TRANSCRIPTION CENTER PROMOTES ACCESS TO POSTSECONDARY INSTRUCTIONAL MATERIALS FOR THE CALIFORNIA STATE UNIVERSITY SYSTEM

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College students with print impairments face a double challenge in pursuing a quality education. First, they must obtain instructional text materials in alternative formats, ranging from large print and audio tape to Braille and electronic text. This in itself can be no small hurdle. But, satisfying this personal, and legal requirement, is of little use if students do not receive the alternative format materials at the same time as their non-disabled peers. Thus, timeliness is the second, and frequently overlooked, challenge of providing equal access to academic information.

A new project based at California State University, Fullerton, attempts to address both of these access challenges. The CSUF Braille Transcription Center (BTC) has recently been established with a $350,000 three-year grant from the U.S. Department of Education for a "Model Demonstration Project to Improve the Delivery and Outcomes of Postsecondary Education for Individuals with Disabilities (CFDA 84.078C)." Co-directed by Dr. Jamie Dote-Kwan, California State University, Los Angeles, and Jeffrey C. Senge, CSUF, the BTC presents a multi-campus model of service delivery that will be eagerly followed by all those who are responsible for and concerned with providing equal access to information in postsecondary education.

The CSUF Braille Transcription Center Project

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The purpose of this project is to create a center for the production of instructional materials in Braille. The Braille Transcription Center (BTC) will allow the California State University (CSU) system to provide blind students access to instructional materials in Braille at the same time as print reading students. A recent study of 18 of the 20 CSU campuses indicated that many campuses may not be providing a sufficient level of Braille accessibility for their Braille reading students (Senge & Dote-Kwan, 1995). Currently, instructional materials including course syllabus, class handouts, and examinations are not distributed in Braille at the same time these materials are distributed in print. While it is difficult to measure the precise effect such delays in access to instructional materials may have on a student's opportunity to achieve, this practice undoubtedly reduces program accessibility to one degree or another.

The basic design of the BTC project is as follows: Students, faculty, or staff located on a participating CSU campus will send the instructional materials they desire transcribed into Braille to the BTC. The information may be sent by conventional mail, over-night courier, fax, or electronically over the Internet. Once the instructional material has been received, the staff of the center will convert the information into Braille. This task will be accomplished by utilizing state-of-the-art computer-based Braille production systems. All embossed documents will be checked for formatting and errors in transcription by a Library of Congress certified Braille transcriber. After the transcription process has been completed, the embossed documents will be returned to the appropriate party by conventional mail or over-night courier.

Since the primary mission of the BTC will be to provide Braille access in a timely manner, an outreach program will be included in the project. This essential component will focus on making students, faculty, and staff in the CSU system aware of the BTC and what their responsibilities will be in making the program successful. Every effort will be made to encourage and support the use of existing technologies, including fax machines and E-mail, to expedite the transfer of information and materials. Emphasis will be placed on the importance of submitting instructional materials to the BTC far enough in advance to allow for sufficient time to transcribe and return the instructional material by the desired date.

The final function of the BTC will be to act as a resource. Technical support and training will be provided to CSU campuses that already have on-site Braille production equipment. The BTC will also conduct evaluations of computer-based technologies related to the Braille transcription process. All findings will be documented and made available to other campuses in the CSU system.

This innovative project offers a solution to the problem of providing individualized instructional materials in Braille to students throughout the CSU system in a timely manner. The creation of the BTC will not only provide an increased opportunity for students who use Braille to achieve but will undoubtedly raise the CSU system's level of compliance with existing civil rights laws.

For more information on the BTC contact:

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References:

Senge, J.C., & Dote-Kwan, J. (1995). "Information accessibility in alternative formats in postsecondary education." Journal of Visual Impairment and Blindness, 89, 120-128.

Return to itdv03n1 Contents Page

Return to Journal Volumes Page

A BRIEF HISTORICAL OVERVIEW OF TACTILE AND AUDITORY AIDS FOR VISUALLY IMPAIRED MATHEMATICS EDUCATORS AND STUDENTS

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"I have been totally blind since birth and have studied algebra, geometry and calculus. I found geometry especially difficult because I lacked the understanding of many spatial concepts...I found I had difficulty understanding concepts such as how four walls meet the ceiling, and I actually stood on a chair to study this."

- Bev Wieland, Programmer/Analyst, University of Delaware

"Teachers, as well as institutions, need to understand that if the tools are provided for people with disabilities, they become abled. I believe that the question should be answered in this way. If the tools are provided for people with disabilities, standards will have to be raised, not lowered. We are a pretty hungry bunch."

- Dick Banks, Adaptive Technology Consultant, Library Learning Center (University of Wisconsin, Stout)

For many blind individuals, learning math can be a frustrating endeavor. Few educators are prepared to teach mathematics to a child who is blind, and as mainstreaming efforts expand, increasing numbers of teachers will encounter blind students. Hopefully, this article will help to better prepare teachers for the challenge presented by mathematics education for blind students.

The National Council of Teachers of Mathematics Curriculum and Evaluation Standards advocates the use of graphing calculators. As a visual learning tool, the graphical calculator has stirred a good deal of excitement. Unfortunately, graphing calculators are not accessible to the student who is blind or visually-impaired. This article chronicles a portion of the history of mathematical and graphing aids for the blind and presents a glimpse of the future.

Computational Aids for the Blind

The Taylor slate was one of the earliest manipulative/tactile aids for visually impaired students of mathematics. It measures about 11 by 17 inches, has a tray to hold pegs and an array of holes to contain these pegs. There are 22 holes across and about 20 holes in a column. These holes are shaped similar to a plus sign overlying a "X" and the pegs have the same shape. Additionally, at each end of the one inch pegs, to one side, is a bar and at the other end two conical projections. The angle of insertion determines the numerical value, with the bar side up the positions run one through 8 and flipping the pegs over the values 9 and 0, with the remainder of the positions determining the operation. The Taylor slate was used through the 1930s and early 1940s (Garvin 1994).

The Brannan slate came into use in the late 1940s or early 1950s and is still available. This slate consists of a 16 by 16 array of square holes. These hold small dice-like cubes which have raised Braille numbers. The position of the cube determines what Braille number is being used. One side of the cube indicates the operation. Thus, blind children can set up their own problems. If the problem entails carrying or borrowing, the top row is left empty (Garvin 1994).

Circa 1960, Tim Cranmer adapted the abacus to serve as a calculating tool for the blind and visually impaired. This abacus is snugly mounted on a red felt board which prevents the beads from unintentionally slipping. The use of white beads as counters provides high contrast for the visually impaired (Garvin 1994).

Currently, Nemeth math code is used in Braille texts for the blind. If the individual is a proficient Braille reader, this code can be used for computations. The developer, Dr. Abe Nemeth, who is blind, taught mathematics at the University of Detroit. Dr. Nemeth developed the code which was adopted by the Braille Authority of North America (BANA) in 1961 (Garvin 1994).

Graphing Aids for the Blind

Large scale tactile drawings can be accessible. These drawings are usually 2 to 4 times larger than "normal". This type of graphic is usually prepared by a sighted person. Blind and visually-impaired students do not have easy access to the means of creating their own graphs. Some large-scale, inaccurate graphs can be created by a blind individual, but, first they must know that these systems are available. Graphing aids for the blind or visually-impaired student take on many dimensions; they range from embossed Braille paper to graphing utilities that can access a tactile printer which provides raised-line drawings.

Embossed Braille paper forms with grid sizes ranging from 1/2 to 1-inch grids are mounted by the student onto cork boards; push pins locate the coordinates and are connected with rubber bands (Garvin 1994). Additionally, a teaching aid called Wicky Sticks, made of wax in long strips, can be used with the embossed Braille paper. These strips are very flexible and can be broken into small dots to represent points on a graph. Another method of inaccurate graphing involves the use of the Sewell raised-line drawing kit. This simple tool has contributed to the understanding of graphs by blind/visually-impaired individuals pursuing mathematics. This kit consists of a clipboard with a rubber pad, stylus, and mylar sheets. A mylar sheet is inserted under two thumbscrews, then the stylus is used to create a picture. A raised line is formed because of the stretching capability of the thin mylar.

Graphing aids for the blind student also include a complete drawing kit comprised of a stylus, a compass (produces up to a 5.5 inch diameter circle), a protractor (with 15 degree markings), a 12 inch ruler, a square and 100 sheets of mylar. The protractor and ruler have pegs mounted on their underside. These pegs fit into holes which are located around the perimeter of the 11.5-inch square board with a surface of neoprene rubber. The student mounts the mylar sheets and draws with the stylus or compass, thereby producing a raised-line drawing (Garvin 1994; Trace Center 1994).

Additionally, blind or visually impaired mathematics students can use a special paper which, when heated, provides a tactile image. One system involves printing or copying an image onto the paper, then heating the paper with a Tactile Image Enhancer. The second system uses a special "hot pen" which is sold in Germany. With this pen, the student can draw a raised picture on the tactile paper. Presently, these systems are costly; the tactile paper sells for about $1.00/sheet; the image enhancer retails around $800.00; and the hot pen is available for around $200.00.

Drawings produced by others for the blind can be made using a compass and stylus with tracing wheels. These produce reverse images. Other mathematical tools available for blind/visually impaired students include raised number lines, geometric shapes which introduce a child to different polygons, etc.

Technological Auditory Aids

Talking Calculators were one of the earliest auditory aids. The first breakthrough in talking calculators was made by Telesensory, whose "Speech Plus" was released around 1974. This model had five functions and one memory. Sharp Electronics released a talking clock and a talking calculator in 1979 or 1980; a later model combined these two features (Garvin 1994). Dr. Thomas Blenham, a blind physicist, started Science Products for the Blind which mounted scientific calculators onto voice boxes. The first - an HP calculator model - was followed by Texas Instrument's TI-66. This type is difficult to use proficiently as the keys do not speak - the user must either memorize the key pad or use the Braille key guide. Science Products also adapted Canon's BUSINESS model which was the first talking version with business functions.

A scientific calculator and a financial calculator with speaking keys were released in 1994. The scientific calculator has trigonometric, algebraic, clock, calendar, and other features. The Louis Herbet Center for the Blind has provided a scientific calculator since 1992. This one utilizes a female voice in a French or English version (Trace Center 1994).

Software packages, used in conjunction with an adapted computer, have enhanced accessibility for the visually impaired. Most have scientific functions including trigonometric, logarithms, exponents, and roots. All entries, functions and answers are spoken. These are available through the Internet at various FTP sites.

Another software package converts the computer-like system of Braille-n-Speak 640S and it's companion Type-n-Speak. This shareware alters these notepads into scientific calculators -- no inverse functions. The software is free and available via anonymous ftp from:

handicap.afd.olivetti.com in the /pub/braille directory as CALCBNS.ZIP.

Computers with voice output, referred to as text-to-speech, have been available since the early 1980s. Mathematics is not interpretable by these programs since much of mathematics involves the use of symbols and/or the equations take up more than one line. The symbols used in mathematics are not deciphered in a recognizable form yet. These DOS programs are referred to as text-to-speech and can only work with ASCII characters.

The Nomad Pad, an interactive audio-tactile graphics system developed in Australia, was operational in 1987 and marketed in 1989 for PCs and in 1992 for Apple and MacIntosh computers. This touch pad enables a student to study a series of prepared graphs independently. This is a learning medium which, used in conjunction with stored graphics, allows independent study. It does not allow blind/visually-impaired students to create their own graphics. Someday blind students will be able to create their own graphics, allowing them to share the joy of discovery with their sighted classmates.

Telesensory, Inc. has marketed a product named Oscar which contains a scanner and software. The scanner "reads" in a ready- made graph which is then output to a TSI Braille printer (Graham 1994). The resolution on these graphs is limited, and can "square" round curves.

The Future

Currently under investigation are various shareware graphing utilities which can provide output to a laser or tactile printer. The two requirements of this type of software include its ability to work easily on a 386 or 486 PC with voice output, and that it be "user-friendly" enough for a middle-school student. Much current research in the area of accessible mathematics is geared toward graphing and mathematic or science texts in electronic form. One notable project is a voice synthesizer-based system called AsTeR by its designer, T.V. Raman, who developed the system as a graduate student at Cornell University. Currently this system is implemented on a PC under a Linux operating system, using a Multivoice speech synthesizer. This software will read in the math text, analyze the information, create an abstract model, then provide output using pauses, tones and pitch to indicate the type of mathematical information is on screen. The sound board provides tonal/musical clues, which can indicate section or paragraph beginnings. "Stereo effects are used to make sounds appear in different parts of space. This is useful for reading aloud tables where columns can sound next to each other in space." (Barry, et al)

Additionally, Dr. Gardner has developed DotsPlus which is a "tactile method of printing technical literature for blind readers that incorporates both Braille and graphic symbols in a manner that retains the same structure as a document printed for a sighted person. Some of the more easily recognized symbols such as plus, minus, the division line in fractions, etc. are enlarged and printed as raised images, while Braille is used for alphabetic characters, numbers, punctuation marks and other symbols that are hard to recognize as raised symbols (Barry, Gardner, & Raman)." These systems require more work: AsTeR needs to be more accessible. Plans are underway to move AsTeR from Linux to a common operating system. A better tactile printer needs to be developed for DotsPlus, and last, but not least, books need to be made available in an electronic format which can be easily interpreted by these programs, e.g. SGML or TeX/LaTeX.

References

Barry, William A., John A. Gardner, and T.V. Raman, (March 1994). "Accessibility to Scientific Information by the Blind: Dotsplus and ASTER Could Make It Easy." CSUN Conference on Technology and Persons with Disabilities, Los Angeles.

Garvin, Claude (January & February 1994) Personal Communication. (Note: Mr. Garvin is employed by the Oregon State Commission for the Blind).

Grahm, Kathryn (1994) Personal Communication. (Note: Ms. Grahm is employed by TeleSensory, Inc.).

Nomad Manual, Quantum Technology P/L, Rydalmere, Sydney, Australia.

Trace Center. (1993). CD ROM. Madison, Wisconsin.

Suppliers

Talking calculators (may or may not have clock function):
L S & S Group, Northbrook, IL
American Foundation for the Blind (AFB), New York, NY.

Scientific talking calculators:
L S & S Group
Science Products for the Blind, Southeastern, PA

Talking statistical calculators:
L S & S Group
Science Products for the Blind

Graphing kit (complete or single parts):
Howe Press of the Perkins School for the Blind, Watertown, Maine

Assorted mathematical and graphing aids:
American Printing House for the Blind, Louisville, Kentucky

Wicky Sticks:
Mangolds' Exceptional Teaching Aids, Castro Valley, CA

Thermostift:
Verein Zur Foerderung Der Blindenbildung e.V., Hanover, Germany

Tactile Image Enhancer and paper: Repro-Tronics, Westwood, NJ

Return to itdv03n1 Contents Page

Return to Journal Volumes Page

RESEARCH NOTE: THE BRAILLE 'N SPEAK AS A LABORATORY TOOL FOR BLIND STUDENTS

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December, 1995

Many instruments used today in educational science laboratories provide data in digital format. Frequently these instruments have an RS-232 serial port which allows digitized data to be easily transferred to a computer in ASCII format for automatic data logging. Many of these instruments can be externally controlled by sending ASCII commands entered on a keyboard or computer connected to the instrument's RS-232 port. The Braille 'n Speak, a "personal data assistant" (1) for blind people, manufactured by Blazie Engineering, can be used by blind students as a means of independent access to the instrumental data and as a means of controlling the instrument in such a case. This report details the success we have had in obtaining 2-way RS-232 communication between the Braille 'n Speak and the laboratory instruments listed below.

For readers who are unfamiliar with the Braille 'n Speak, it is a truly portable device which contains a speech synthesizer, a Braille keyboard, serial (RS-232) port for interfacing capabilities, and memory. Text entered on the Braille keyboard can be sent out the RS-232 port in standard ASCII format. ASCII text coming in through the RS-232 port can be immediately spoken by the Braille 'n Speak. The Braille 'n Speak has long been used by blind students and professionals as a note-taking device, and more currently, as a speech synthesizer for a computer.

Although our interfacing experience only extends to the Braille 'n Speak, other Blazie Engineering products, namely the Type 'n Speak and the Braille Lite, which are capable of 2-way RS-232 communication using standard ASCII code, also seem to be suitable for this task. Besides the Blazie Engineering products mentioned here, we are also aware of Braille note-taking devices from other manufacturers which have serial RS-232 ports and which should also be capable of being interfaced to laboratory instruments. The list is too long to include here. (2)

In addition to the instruments listed below, the Braille 'n Speak has also been interfaced to a Fluke digital multimeter equipped with a serial RS-232 port. (3) Certainly that application is also useful to blind science students. One of us (Wohlers) hopes soon to extend the list below to include a digital pH meter. If successful, that information will be the subject of a future report.

We have achieved 2-way RS-232 serial communication using the Braille 'n Speak with the following laboratory instruments:

BALANCES

Ohaus CT200 top-loading balance, centigram accuracy (Gemperline & Sonnesso)

Ohaus TP200 Precision Plus balance, milligram accuracy (Gemperline & Sonnesso)

Fisher Scientific XT-400 DR balance, milligram accuracy (Wohlers) Sartorius Analytical A 200 S balance, tenth of a milligram accuracy (Wohlers)

Mettler PE3600 top-loading balance, milligram accuracy (Wohlers) UV-VISIBLE SPECTROPHOTOMETERS Spectronic 20D Spectrophotometer, manufactured by Spectronic Instruments, Inc. (Gemperline & Sonnesso)

FTIR SPECTROPHOTOMETERS

Perkin Elmer model 1600 Fourier Transform Infrared (FTIR) Spectrophotometer (Gemperline & Sonnesso)

In order to use the Braille 'n Speak with this equipment you must turn on the serial port (chord-34 & F), and use the Braille 'n Speak as a dumb terminal. For specific interfacing information, please contact authors Gemperline, Sonnesso, and Wohlers at the addresses listed below.

This work was supported in part by National Science Foundation Grant #DUE-9254330, David Lunney, Principal Investigator.

FOOTNOTES

1. *Blazie Engineering Catalog of Products for Blind and Visually Impaired People, Fall '94, p.7.*

2. *Dan Mackison, North Carolina Assistive Technology Project, Greenville, NC office, personal communication.*

3. *T. V. Cranmer, "Accessing the Fluke PM2525/623 Multimeter," Smith-Kettlewell Technical File, Vol. 10, No. 4, Fall 1989.*

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Return to itdv03n1 Contents Page

Return to Journal Volumes Page

EASE OF USE AND MAINTENANCE: A NOTE ON SOFTWARE DESIGN

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Increasingly powerful hardware has prompted commercial software developers to concentrate not on highly efficient code but instead on usability. With much modern software sharing the same look and feel, a commercial edge can only be gained by increased usability leading to improved productivity. In the commercial world, usability ratings by NSTL (National Software Testing Labs) and similar institutions can affect sales significantly, in the same way that a poor review might prematurely end a play's run in the theatre.

In the field of voice output communication aids (VOCAs), client usability and high productivity (in terms of speech output rates) have always been priorities. However, much of this usability has typically centred around users themselves and not the rehabilitation worker, or health care professional, who might participate in developing the range of materials and experiences (maintenance) offered by such an aid. In fact, even in Beukelman and Ansel's (1995) enumeration of research priorities in augmentative and alternative communication, no direct mention is made about ease of maintenance of VOCAs by those who have to structure the contents of these devices. As VOCAs take account of new technologies and become increasingly advanced, they may remain highly accessible to users, but increasingly complex for typical maintainers who have to develop material for them. For example, a DECTalk/symbol based aid might require the writing and maintenance of scripts. This process can be complex, tedious, and, in time-pressured service environments, counter-productive.

A simple analogy illustrates the point. At Christmas, a child may receive a toy which needs to be assembled by an adult. The child sees only the completed toy with which they are very happy, but does not appreciate the effort expended by the adult. If the toy were constructed from fewer parts which were less complex it could be constructed more rapidly. This would enable the adult to have a better understanding of the toy's workings in case they needed to fix it, to play with the child for longer, and to reduce potential stress associated with the construction. In a similar way VOCA can be difficult to understand from a maintainer's prospective, which may mean that maintenance times are increased and frustrations raised. Naive maintainers are likely to suffer most in this respect.

Concentration on usability, although highly desirable, can mean that maintainers may easily become disillusioned about a specific VOCA. Negative perceptions regarding VOCA maintenance are usually to the detriment of the user. On the other hand with good design a VOCA can be made to be rewarding and productive for both users and maintainers. If a device enables maintainers to build complex materials easily, and offers instant rewards, ultimately this is likely to be of benefit to the user.

With modern philosophies of software design such as object orientation, the maintenance of VOCA can be made simple and rewarding if the maintainer interface is correctly designed. It is suggested that maintainers' attitudes and abilities to use a given VOCA should be incorporated into the development cycle as is currently the case with users. With the employment of standard user interface questionnaires, such as the QUIS (Shneiderman, 1992), failings can be addressed and strengths consolidated during the development phase. In our own research, by following the principle that users and maintainers share the same good design needs, such concerns have been addressed in parallel. In this instance the needs of users and maintainers are considered of equal importance.

This ethos has produced a software based VOCA known as "Easy Speaker" which, from a user's perspective, seamlessly integrates photorealistic symbols, digitised speech, video clips, animation, MIDI music and the like. By making use of dynamic displays, the user can communicate vocally, in addition to using the device as a learning and recreational environment in its own right. By maintaining a simple user interface, demands on users have not increased to reflect these enhancements. Interaction remains simple but offers a far richer environment.

One might expect that an increased feature set necessarily increases the workload for the rehabilitation worker as it might in many other VOCAs. However, appropriate design means this is not the case. By using an object-orientated design philosophy, maintainers can drag scanned photorealistic images on to any of the dynamic screens the user can see. Speech can then be recorded to accompany these symbols at the touch of a button. By using graphical controls that mirror a Dictaphone, or video cassette recorder, caregivers are already familiar with the notion of pressing the red record button to record speech. Symbols that are incorrectly positioned can be moved at will by dragging and dropping elsewhere. Alternatively they can be dropped into a bin which appears at the bottom of the screen. Whatever the form of media, it can be dropped into place, ready for use.

In short, the object-orientated nature of the design successfully mirrors the rehabilitation worker's understanding of the real world. For example, when sticking pictures in a scrap book, you move them around on the page until you are happy with the layout and then glue them in place. In our software, you drag them around and then save the layout as opposed to the use of glue. By using such synergistic design, the rehabilitation worker can efficiently construct large vocabularies of digitised speech and other media represented by photorealistic symbols. Unlike other VOCAs there is no complex scripting language; for that matter, there is very little else to learn. In this instance the overall objective was to produce a system that could be mastered by those familiar with current graphical user interfaces in a matter of minutes and by computer novices after a few short training sessions. Our first experiences with this latest version of Easy Speaker suggest that some considerable progress has been made in achieving this aim, and so through good design the needs of both users and rehabilitation workers have been addressed. Previous experience with an earlier version of Easy Speaker, which did not have the range of facilities of the latest version, illustrated that some clients, including some with severe learning difficulties, found it had much to offer; Rostron, Plant and Herrman (1994), Rostron, Plant and Ward (1996), did not find it sufficiently user-friendly.

As a complement to object-orientated design, other facilitative features have been incorporated. These include the use of status bar messages that change as the caregiver moves the pointer over screen objects. As a complement to printed manuals, full context sensitive on-line help is provided, which can be searched and printed at will. An Automated Response Tracking System (ARTS) has also been incorporated that tracks utterance construction, timings, cursor efficiency, actual and estimated words per minute scores, etc. Such measures can be used in both assessment and performance monitoring, and more importantly on the basis of these the layout can be modified accordingly.

In sum, the view that both the user and the rehabilitation worker are of equal importance should be taken when developing any communication aid. By following this ethos we have produced a VOCA which is liked by users and maintainers alike. Just as in the commercial software industry, new VOCA may be differentiated on the basis of their usability. It must be remembered that attitudes and decisions made by caregivers and maintainers typically have a greater impact on VOCA users than does the design of the user interface per se. This begs the question of whether the maintenance interface is actually more important than the user interface? If the former is poorly designed this can only ultimately be to the detriment of the user.

The latest version of Easy Speaker is now available, (for PCs only), together with full documentation, via the Internet site - http://150.237.204.194 or
http://www.hull.ac.uk then Psychology

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Return to itdv03n1 Contents Page

Return to Journal Volumes Page

DEPARTMENT: LIBRARIES

NATIONAL LIBRARY SERVICE (NLS) INFORMATION ON THE INTERNET

Judith Dixon, Ph.D.
National Library Service

The Library of Congress provides access to information about its resources and services over the Internet. The National Library Service for the Blind and Physically Handicapped (NLS) is represented with its Union Catalog and with other NLS publications.

The Union Catalog and the catalog of books in process are available through a search system called LOCIS. LOCIS and other publications are accessible through the Library of Congress's gopher, called LC MARVEL; the Library of Congress's World Wide Web site; and through the Library's ftp site. These services are described below.

LC MARVEL

The Library of Congress Machine-Assisted Realization of the Virtual Electronic Library (LC MARVEL) is a Campus-Wide Information System that combines the vast amounts of information available about the Library with easy access to diverse electronic resources on the Internet. Its goal is to serve members of Congress, Library of Congress staff, and constituents throughout the world. Documents are, for the most part, in ASCII text.

LC MARVEL can be accessed in several ways:

1. From another gopher server;

2. By using gopher client software and pointing to marvel.loc.gov, port 70; and

3. By using a World wide Web browser and connecting to gopher://marvel.loc.gov/.

Main Menu

The Main Menu of LC MARVEL consists of the following selections:

1. About LC MARVEL
2. Events, Facilities, Publications, and Services
3. Research and Reference (Public Services)
4. Libraries and Publishers (Technical Services)
5. Copyright
6. Library of Congress Online Systems
7. Employee Information
8. U.S. Congress
9. Government Information
10. Global Electronic Library (by Subject)
11. Internet Resources
12. What's New on LC MARVEL
13. Search LC MARVEL Menus

From the main menu select option #2: Events, Facilities, Publications, and Services. Then select option #6: Services to Blind and Physically Handicapped Individuals, and follow the available options to see NLS publications and databases.

World Wide Web

NLS has established a homepage on the World Wide Web. This hypertext document is available on the Library of Congress web site at:

http://lcweb.loc.gov/nls

It includes an audio sample of a talking book and links to NLS information available on LC MARVEL and to regional and subregional libraries in the NLS network that offer information on the Internet.

This page can also be accessed from the main Library of Congress homepage under "Research and Collections Services."

FTP Site

A limited number of files are also available through the Library's anonymous site. The address of the FTP host is ftp.loc.gov (or 140.147.2.69). The directory /pub/nls includes a SCORPIO search guide and subdirectories containing NLS bimonthly listings and annual catalogs.

E-mail

Internet users may also send messages to NLS. The NLS Internet **address is nls@loc.gov.**

Return to itdv03n1 Contents Page

Return to Journal Volumes Page

DEPARTMENT: ONLINE INFORMATION AND NETWORKING

Steve Noble, Recording for the Blind & Dyslexic
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RFB&D NEWS

Recording for the Blind and Dyslexic's online catalog was moved in December to a new Internet host site, making the old r2d2 address inoperative. The new address is wais.jvnc.net 4445. Be sure to include the port number 4445 in your telnet command. You can also gopher to wais.jvnc.net and go through the Publishers Online menu, or use the EASI gopher via sjuvm.stjohns.edu.

RFB&D may be reached on the Internet by sending e-mail to our information center at INFO@RFBD.ORG

DISCUSSION LISTS

Blind-Jobs-L

Blind-Jobs-L is a new mailing list for anyone interested in the discussion of jobs and employment related issues for persons who are blind.

To subscribe, send email to:

majordomo@winnie.freenet.mb.ca

leave the subject line blank, and send the following message:

SUBSCRIBE BLIND-JOBS-L

ACCESS

The Media Access mailing list is devoted to the discussion of alternate access to all forms of media, and includes such topics as film and video captioning, audio description, and computer based information.

To subscribe, send email to:

listmanager@hookup.net

leave the subject line blank, and send the following message:

SUBSCRIBE ACCESS

WORLD WIDE WEB

NFB

The National Federation for the Blind is now on the Internet. Services available online include access to NFB's monthly publication, _The Braille Monitor_, and two quarterly publications, _Future Reflections_ and _Voice of the Diabetic_. Numerous other NFB publications and a variety of technological information also can be found at the NFB site. The web address is:

http://www.nfb.org

If you do not have Web access, you may also reach the NFB via FTP at the address nfb.org.

Focus on News

There are currently a number of excellent news information resources available on the Web. Many of these make extensive use of graphical information, including photos and maps, but nearly all of them contain a major proportion of simple text. Here are a few sites of interest:

CNN at http://www.cnn.com

This is one of the widest ranging sites, but also has a lot of graphics. Contains world news, U.S. news, business, sports, entertainment, weather, and other headings;

The Electronic Telegraph at http://www.telegraph.co.uk

This London-based news service includes much the same types of stories as CNN, but without the usual U.S. slant on the news. Of particular interests to some may be the European cricket, rugby, and soccer scores. This service requires first-time users to register online;

Reuters News Media at http://www.yahoo.com/headlines/current/news The Reuters service is an excellent Web site for news and makes only minimal use of graphics. Story headings are laid out in such a way that fast retrieval of breaking news stories is fairly simple;

Yahoo News Directory at http://www.yahoo.com/news/

This site is the ultimate news source. It provides literally hundreds of links to international, national and local news sources across the globe. At last glance, this site listed 252 newspapers, 281 newswires, 21 sports publications, 56 K-12 newsletters, and 187 university papers-- just to mention a few subdivisions.

Return to itdv03n1 Contents Page

Return to Journal Volumes Page

N3m2

Information Technolgies and Disabilities

3:2 June 1996

Articles

Return to the EASI Homepage
Return to the ITD Homepage

ITDV03N2.ARTICLE1

ADDING AUDIO DESCRIPTION TO TELEVISION SCIENCE PROGRAMS: WHAT IS THE IMPACT ON VISUALLY IMPAIRED VIEWERS?

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Science programs on television (TV) present much of their information only visually. For people who are visually impaired this reliance on visual cues limits access to the learning and enjoyment such programs offer. Audio description (sometimes called "video description") inserts descriptions of a TV program's key visual elements into natural pauses in the program. It is intended to provide visually impaired people with more access to the programs' content and to make viewing more satisfying. Including description promotes two social policy objectives:

(1) ensuring that people with disabilities have the same access to information and opportunities that people without disabilities do, and

(2) advancing scientific literacy. As subcontract of a National Science Foundation grant to the WGBH Education Foundation, the American Foundation for the Blind undertook this research to examine the effects that adding audio description has on the TV viewing of visually impaired adults.

RESEARCH DESIGN AND SAMPLE

The research was based on two telephone interviews and two personal interviews collected during TV viewing sessions; thus, four sets of data were collected from each participant. The initial interview included questions about vision, TV viewing, interest in science and TV science programs, and personal background. At the viewing session, the participants were shown two TV programs; after each program, each participant individually answered factual questions about the program and questions about his or her reactions to the program. In the follow-up telephone interview, in addition to a small number of factual questions from the two programs, each participant was asked about TV viewing at home and then more specifically about audio description.

The viewing sessions were the experimental portion of this study. In them, each participant saw one TV program presented with description and a different program presented without description. Thus, each person was considered an experimental participant for the program she or he watched with description and a control participant for the program she or he watched without description. All participants saw the same two programs in the same order, and all were asked identical questions, whether they had seen the program with or without description. The two programs, drawn from different science series, differed in style. The first was a more fast-paced show; while it did offer limited opportunities for description to be added, these were generally quite brief. The second program contained longer segments in which information was conveyed by visual images without verbal cues for those who cannot see what is happening.

Participants were recruited in the Boston area through public and private organizations oriented to visually impaired clients, employees, or members. A total of 111 legally blind adults participated in the study. The participants ranged in age from 20 to 89. About two-fifths had been legally blind since birth. Although all the participants were legally blind, they varied in the extent to which they had usable vision at the time of this study: just over one-third reported that they had no usable vision; nearly one-half reported they had a little usable vision, and slightly less than one-fifth report they had considerable usable vision.

RESULTS

(1) TV viewing at home. The overwhelming majority of the study participants felt that, when they watch TV, they miss information that is available to fully sighted persons. Often, when they watch with other people, someone describes what is happening at least some of the time. Virtually all the participants said that such descriptions help them understand and enjoy the programs. However, nearly two-thirds of the participants said that they watch TV alone all or most of the time, so no one is available to provide the descriptions.

(2) Response to viewing session programs. After watching each program, each participant was asked about his or her responses to the program. Overall, the participants reported that they enjoyed each program. They judged both programs to be satisfying and enjoyable, informative, interesting, and clear. For each of the questions, one-quarter to one-half of the participants gave the highest ratings; this similarity of responses makes it difficult to show differences between the participants who saw the program with description and those who saw the program without description. The two groups did not show any significant differences with regard to the first program they saw. For the second program, those who saw the program with description rated the program as significantly more satisfying, more informative, and more clear than did those who saw it without description.

(3) Response to audio description in general. The questions in the viewing session did not direct the participant's attention to whether the program did or did not contain added description. One to two months after the viewing session, each participant was asked about his or her reaction to described TV programs in general. The participants said that audio description generally is interesting, informative, and enjoyable; it is neither confusing nor boring, but some description repeats information some people could have figured out themselves. The overwhelming majority of participants said that, given a choice, they prefer to watch programs with description and would seek out described programs.

(4) Social benefits of audio description in the viewing session. After watching each program, the participants were asked how comfortable they would be talking about that program with sighted friends. Then they were asked how many aspects of the program they would have difficulty discussing. The responses of the groups who saw the first program with and without description did not differ. However, those who saw the second program with description reported they would be more comfortable talking about the program with sighted friends and fewer aspects would be difficult to discuss.

(5) Social benefits of audio description in general. One to two months after the viewing session, the participants were asked whether, in general, having TV programs described makes them more comfortable talking about programs with fully sighted persons. Three-quarters of the participants said description makes them more comfortable.

(6) Audio description as a learning tool. TV science programs provide an opportunity for informal learning. Although each of the programs was designed to provide information in an enjoyable manner, neither the programs nor the viewing sessions were organized to emphasize that the participants should learn the material that was being presented.

To measure whether audio description enhances informal science learning, immediately after seeing each program, the participants were asked factual questions in a multiple choice format. A little over half the questions were based on material drawn from the program as presented without description; the remaining questions were based on material that was presented in the audio description. (For convenience, the former are called "narrated questions" and the latter "described questions.") Then, a month or two later, the participants were asked a smaller number of questions about central points of each program, again including both narrated and described questions.

Whether the participants saw the described or nondescribed version of the program, they answered correctly about the same number of narrated questions. In contrast, those who saw the described version of the program were significantly more likely than those who saw the nondescribed version to answer correctly the described questions. This finding was true both immediately after seeing the programs and a month or two later. Thus, the study participants were likely to note information that was presented in the descriptions and to retain what they had learned over the next months.

CONCLUSION

Audio description of TV programs is a relatively recent innovation in the blindness field. Anecdotal evidence has indicated that description is well received by viewers who are blind or severely visually impaired. This research was designed to obtain a more precise understanding of the aspects of TV viewing that adding description enhances by collecting attitudinal data and measuring participants' responses to two specific programs.

The visually impaired participants in this study reported that they do watch TV but that when they watch TV without description, they feel they are missing information that is available to fully sighted people. For them, adding description makes TV programs more enjoyable and interesting. They said they prefer to watch described rather than nondescribed programs on TV and that they would seek out described programs on science topics.

The participants also reported that having description enables them to use the programs more in social settings. Having programs described makes them more comfortable discussing the programs with sighted friends. It also makes a difference in their ability to talk about the program and to ask others questions about it.

Finally, the participants in this study believed that having audio description makes programs more informative. Furthermore, experimental data from this evaluation show objectively that the participants learned information that was presented in the descriptions and that they retained that information over several weeks between the viewing session and the follow-up telephone interview.

NOTE

The research reported here was supported by a subcontract to the American Foundation for the Blind from WGBH Education Foundation; National Science Foundation Grant #ESI-9253447. A longer report, the questionnaires, and other study documents are available from the American Foundation for the Blind.

Return to itdv03n2 Contents Page

Return to Journal Volumes Page

ITDVO3N2.ARTICLE2

TEACHING LAB COURSES TO STUDENTS WITH DISABILITIES

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As scientific fields make increasing use of technology, new opportunities emerge for people with a variety of abilities. When students with disabilities and science teachers form learning partnerships, the possibilities for academic and career success multiply. Some students with disabilities have conditions that are invisible; some are visible. Their challenges include gaining knowledge and demonstrating knowledge. In most cases, it takes just a little creativity, patience, and common sense to make it possible for everyone to learn and contribute.

Below I have summarized some examples of alternative arrangements that can be made. They come from participants in the DO-IT project at the University of Washington. DO-IT (Disabilities, Opportunities, Internetworking and Technology) is primarily funded by the National Science Foundation. It makes extensive use of computers, adaptive technology and the Internet to increase the successful participation of people with disabilities in academic programs and careers in science, engineering, and mathematics.

GAINING KNOWLEDGE

Many students with disabilities face challenges to gaining knowledge. Examples of specific challenges and accommodations follow.

*For the student who has difficulty reading standard text or graphics due to a visual impairment, materials can be provided in large print or Braille, on tape, or via computer and tactile drawings. Access to adaptive technology that provides enlarged, voice, and/or Braille output can be useful.

*If seeing material on a blackboard or overhead projector due to a visual impairment is a challenge, a student may use binoculars and the instructor can be sure to verbalize the content of all visually displayed materials.

*For the student who cannot read output from standard science equipment because of a visual impairment, try interfacing lab equipment with computer and providing large print and/or speech output. marking scientific equipment with Braille and large print labels can be helpful as well.

*If hearing presentations and instructions is a challenge, a student can use an FM system, interpreter, and/or printed materials. An instructor can help by facing a student who is lip reading and writing important points on an overhead projector or blackboard.

*If a student cannot hear multimedia and videotaped presentations, captioned presentations and/or an interpreter can be provided.

*When understanding concepts due to a specific learning disability is a challenge, visual, aural, and tactile demonstrations incorporated into instruction can be helpful.

*If a student has difficulty reading because of specific learning disability, providing extra time and access to materials via a computer equipped with speech and large print output can sometimes be helpful. Internet access with a system like this can also be an important resource.

*For a student who has difficulty taking notes in class because of a mobility or visual impairment, use of a portable computer system with word processing and adaptive technology can allow independent note-taking.

*A student who cannot operate lab equipment and conduct lab experiments due to a mobility impairment can benefit from an accessible lab facility and adjustable-height tables. A lab partner or scribe can facilitate participation. In addition, computer-controlled lab equipment with alternative input devices (e.g., speech, Morse code, alternative keyboard) and modified scientific equipment can provide access.

*For the student who cannot complete an assignment or lab on time because of a health impairment, flexible scheduling arrangements allow completion of work.

*For the student who has difficulty completing research because of a disability, access to research materials on the Internet can be helpful.

DEMONSTRATING KNOWLEDGE

Some students with disabilities cannot demonstrate mastery of a subject by writing, speaking, or by working through a problem in a lab. Many of the accommodations for gaining knowledge can help the student demonstrate mastery of a subject as well. Examples of other accommodations follow.

*For the student who has difficulty completing and submitting worksheets and tests because of a visual impairment and/or a specific learning disability, instructors can provide worksheets and tests in large print or Braille, on tape, or via computer. Access to adaptive technology that provides enlarged, voice and/or Braille as well as standard print output can maximize student independence.

*If completing a test or assignment on time because of a disability that affects the speed at which it can be completed is a problem, extra time or alternative testing arrangements can provide an appropriate accommodation.

*If a student cannot complete a test or assignment because of an inability to write, in-class access to a computer with alternative input devices (e.g., Morse code, speech, alternative keyboard) can help that student submit work independently.

CONCLUSION

The examples provided demonstrate a wide variety of alternatives for helping a student fully participate in science labs. Since each person's situation is unique, the best solutions for maximizing participation come about when the student and teacher work together to develop creative alternatives that address the specific challenges faced by students with disabilities.

Return to itdv03n2 Contents Page

Return to Journal Volumes Page

ITDV03N2.ARTICLE3

SCIENCE AND MATHEMATICS TO THE SPECIAL EDUCATION POPULATION

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INTRODUCTION

There is a critical need to restructure the methodology of teaching mathematics and science. The traditional way of teaching is through reading from the textbook and doing problems through rote memory of formula and facts. Hands-on experiences, when used, are only to verify "the facts" stated in the textbook. The situation is exacerbated for special education children. A shift to more dynamic and hands-on methods is required. An active, multi-sensory approach to science and mathematics can be effective for children with disabilities, as it is with any other child. The teacher who relies on reading and writing as the sole means of instruction presents all of his or her students with a disadvantage. Children with disabilities may need to carry out their explorations differently.

Educational technology can be a powerful force for change in education. However, technology cannot be considered a panacea for educational reform (Kimmel and Deek, 1995). Technology, when properly used as an integral part of the curriculum and the instructional approach, can be a very effective tool for improving and enhancing instruction and learning experiences in the content areas involving all students in complex, authentic tasks. The use of technology in the classroom can give all students a learning environment that allows discovery and creativity through the use of computer visualizations, such as modeling and simulations, and has the potential to dramatically change the way we view science and mathematics. Opportunities can range from achieving greater independence and maximizing productivity to connecting with the virtual communities across the world and sharing information and ideas (O'Shea, Kimmel, and Novemsky, 1990). Special needs students can be provided with access to technologies that empower and enable them to be successful in an inclusive learning and working environment (Holzberg, 1995; Wiburg, 1995).

Technology can support the kind of student learning advocated by current educational reform. However, enabling students to benefit from such tools goes beyond the availability of technology in school systems. Less than half of K-12 teachers have had adequate training in the use of technology for instruction to their students. The problem is exacerbated for special education teachers.

Teachers must be ready and equipped to prepare and deliver instruction using new approaches which include technology, and hands-on and collaborative teaching.

THE PROFESSIONAL DEVELOPMENT PROGRAM

New Jersey Institute of Technology (NJIT), in cooperation with participating school districts, is developing an infrastructure that will help to facilitate the appropriate integration of instructional strategies and technologies in the science and mathematics curricula of elementary/middle schools involving special education populations. The training program, for teams of special education and regular classroom teachers, is designed as a teacher-centered, diagnostic, prescriptive program and is geared to the teachers' concerns and needs to best facilitate change. A computer-based instructional laboratory was created at NJIT to provide teachers with the necessary environment for exploring and testing new approaches and strategies.

The establishment of a long-term structure for the continued improvement of science and math teaching and learning within the special education population is an important goal of this project. This restructuring must be systemic and comprehensive and include improvement of the physical learning environment, delivery of instruction, and the integration of educational technologies. This project aims to develop a cross-disciplinary elementary and middle school special education science and math curriculum that introduces the basic scientific and critical thinking skills, and uses conceptual themes to develop and reinforce these skills in all students. The curriculum is based on the recommendations of the National Council for Teachers of Mathematics standards (NCTM, 1989), the National Research Council (NRC, 1996), and the American Association for the Advancement of Science (AAAS, 1993).

Training workshops are designed to provide an environment in which teachers feel comfortable in asking and having their specific questions answered so that they will feel at ease with both science and mathematics teaching and learning. A continuing two-way communication is being developed between university faculty and staff, teachers, counselors and parents in support of classroom activities. The training program includes three one-day workshops and a three-week summer component each year for special education teachers teamed with general education teachers. The emphasis of the summer program involves the teachers in a process of teaching science and math that effectively engages the students in learning. The program provides exposure to alternative teaching strategies in the different disciplines of science and mathematics, and introduces approaches to the integration of the subjects. The variety of instructional methods, including the use of technology, demonstrate and model the means by which good math/science teaching can be achieved by addressing the needs of the learners. The teachers are given the opportunity to use alternative classroom techniques in the summer programs provided for students on the NJIT campus.

The science and mathematics lessons were implemented in a practicum situation where teams of teachers were assigned to individual Project student participants. Daily lesson plans and assessment of practicum activities document the practicums. The two-on-one scenario provided maximum benefit to the students and allowed the educators the opportunity to work collaboratively and practice new teaching skills to be used in their classrooms. The teachers were exposed to and experimented with techniques and materials they had not previously considered using in their own classrooms such as manipulatives for introducing math concepts and for enhancing student comprehension. The morning practicums were followed by afternoon sessions that allowed discussion, reflection, and assessment of the morning practicums as well as team planning for the next day's activities. These sessions provided a forum for teachers to share experiences, successes, and problems. This became a most valuable learning experience for project staff as well as for participating teachers.

EDUCATIONAL TECHNOLOGY TRAINING

The technology training component was designed to provide exposure to computers and computer technology. Hands-on training is critical to teachers' willingness to implement new instructional practices into the classroom. "Theory-only training" typically results in few skills and negligible transfer to classroom practice thus limiting successful learning (Showers, 1990). Our training is based on the premise that appropriate use of educational technology requires that teachers have been provided with solid foundations in the general applications of technology in education. This must lead to a level of comfort in using hardware and software systems, that enables the teachers to utilize the technology integrated within the scope of the curriculum and subject matter they are teaching, and to be able to make decisions for varying situations. Ultimately, as technology continues to evolve and other needs arise, teachers will be faced with decision making situations and they must be equipped to make those decisions. This requires additional skills including the ability to evaluate and select hardware and software that are effective and efficient for specific applications.

In our program, we started with a survey of participating teachers to learn about their background, experiences, and current utilization of technology in their classrooms. In the first group, only 3 of 22 teachers had any extensive inservice training, and 14 indicated no training.

Accordingly participants were first introduced to basic information and terminology and an overview of the computer. Internet training was provided so that teachers will be able to communicate electronically, navigate the Internet, and do file transfer and sharing. Initial training sessions introduced participants to the hardware components, and the operating system and its commands. A full day presentation by the Center for Enabling Technology introduced teachers to various hardware and software items that enable students with physical or learning disabilities to access the computer. Keyboard adaptations, screen enlargement, screen reading and other adaptations and solutions were explored. In subsequent sessions, hands-on training allowed the participants to try popular software and hardware such as Intellikeys, Intellitalk, Sammy's Science House and Gizmo's and Gadgets (science software and physics software). Participants were introduced, through hands-on activities, to different applications, such as a database management system, called Tabletop, which has plotting and data visualization capabilities. The applications were related to the teaching of science and mathematics. Teachers were first given an overview of the software and its functionality and then asked to solve problems, as they would ask their students to do. An application of Tabletop to science used the data in the Periodic Table to illustrate trends in physical properties and chemical properties within and across families of elements. An integrated math/science lesson involving the distribution of colors in a package of M&Ms demonstrated the different ways that data can be analyzed, interpreted, and manipulated in Tabletop. In mathematics, the functionalities provided opportunities to build formulae by combining mathematical elements, such as variables, operators, and functions. As a final group exercise, the participants were asked to consider a current project or experiment relevant to a subject matter of their class and adapt it to Tabletop. The goal was to get the teachers to create their own database using data and then report on how it may be possible to use Tabletop to organize, manipulate, and retrieve this information, and to share with their colleagues.

Science and mathematics have a long tradition of being text based subjects, and other than some very basic math are virtually inaccessible to students with certain disabilities. A shift to more hands-on and visual imagery, as provided in this program, recognizes students, especially those with special needs, as learners who tend to enjoy and benefit from this learning approach.

Within the practicum experience described above, the last half hour of the morning is spent on a software demonstration and discussion of utilization and appropriateness for specific disabilities, and an exploration of how software can complement a specific hands-on activity to enhance comprehension and supplement learning. During later practicums, the teachers then have the opportunity to "field test" the software and appropriate strategies and techniques before using them in their own classrooms. Afternoon discussions, reflections, and assessments included the experiences with the software and the technology as well as hands-on science and mathematics activities.

The establishment of the computer-based instructional laboratory gave us the opportunity to attend to the individual needs of the teachers, as well as the group training sessions. During the school year, the laboratory is open late afternoons for teachers to come in for more specific training, as well as hardware and software evaluation, gaining familiarity with assistive technology (alternative keyboards, switches, etc.), and evaluating their use with specific learning and physically disabled students. This is a learning environment not normally available for teachers and provides the teachers with further opportunities to gain better understanding and ability to assess the needs and selection process for a given instructional environment.

The state-of-the-art Multimedia Personal Computer Laboratory includes networked PC's and Apple Powerbooks. The Laboratory was used to introduce teachers to the multi-media and application software available. The Powerbooks are used primarily with the students and in the practicums. NJIT will continue to act as a resource center for those teachers who participated in the first year of the project and the districts interested in establishing their own computer laboratories. A library of software is being researched and developed so that teachers can experiment with applications before they purchase them for their schools. MECC has designated NJIT as one of three New Jersey sites for field- testing and evaluation of their software for participating teachers.

CONCLUSIONS

Participant evaluation of the summer workshop was high. Positive gains in the area of instructional methodology included an appreciation and understanding of the value of a hands-on approach to science and math rather than a textbook approach. The hands-on approach was preferred as the teachers were able to see the value of learning through experimentation. In addition, the teachers found that the students achieved the greatest comprehension with a hands-on approach, and the teachers were better able to maintain attention and engage the students more effectively through a hands-on approach. The teachers were also able to build an awareness of the needs of the special learner. The opportunity to share perspectives, strategies and ideas between regular and special education teachers proved invaluable. There was a great appreciation for collaborative teaching and the adaptability and flexibility required. The teachers left the workshop with an appreciation for teaching science and math in concert rather than as independent subjects.

This project is supported in part by the National Science Foundation, Award # HRD - 9450074.

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Return to itdv03n2 Contents Page

Return to Journal Volumes Page

ACCESSIBLE INTERNET BASED MATHEMATICS AND AERONAUTICS MATERIALS FOR 4TH-7TH GRADE CHILDREN WITH PHYSICAL DISABILITIES.

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INTRODUCTION

InfoUse is running a three year project entitled "An Internet-Based Curriculum on Math and Aeronautics for 4th -7th Grade Children with Physical Disabilities" with funding through a cooperative agreement with the National Aeronautics and Space Administration (NASA). NASA's award, which is administered through the High Performance Computing and Communications (HPCC) Office as part of NASA's Information Infrastructure Technology and Applications (IITA) program and NASA-Ames Research Facility at Moffett Field, was given as one of eight such awards for developing new ways of teaching science, mathematics, engineering, and aeronautics through developing new Internet-based information technologies.

This project will create on-line lessons and activities on math and aeronautics with the aim of improving education and career options for children with physical disabilities. This project proposes to develop a specialized program, drawing from existing curricula, available materials and assistive technology, and using the Internet to support an interactive education experience. The project targets schools nationally with 4th-7th grade students. The on-line lessons and activities will be useful to students in mainstream general education as well as special education settings.

The genesis of this project is based around two issues. The first issue came from an awareness that, around the 4th grade, current mathematics curricula are highly reliant on students' ability to use manipulables such as paper and pencil, calculators, or three-dimensional geometric models. Children with disabilities that affect their ability to manipulate objects (cerebral palsy, muscular dystrophy, specific hand/arm conditions, etc.) and who therefore find it difficult or impossible to use such manipulables are clearly at an academic disadvantage. The second issue came from the realization that physically disabled children may not consider or be prepared for career possibilities in aeronautics or the importance of mathematics in pursuing these careers. The Internet, with its multimedia and communication capabilities, holds great potential for allowing these issues to be addressed.

PROJECT MISSION AND GOALS

The stated mission of this project is "To stimulate and motivate students with physical disabilities in grades 4-7 to pursue aeronautics-related careers via the development and delivery of accessible math education materials on the Internet." From this mission, we developed four goals:

1. Accessibility
Improve access to mathematics and aeronautics curricula materials for 4th-7th graders with physical disabilities.

2. Math Proficiency
Improve mathematics proficiency outcomes among 4th-7th grade students with physical

disabilities.

3. Aeronautics Careers
Inspire and motivate students with physical disabilities to pursue aeronautics-related careers.

4. Innovative Use of Technology
Increase access to, and use of, digital communication and multimedia technology among children with physical disabilities.

PRODUCT

A World Wide Web site that will contain lessons and provide mathematical exercises using examples from aeronautics and that will be maximally accessible by children with physical disabilities. The activities will be based on national mathematics standards and aeronautic content guidelines. The Web site will also contain help information, information for teachers/parents, opportunities for users to find out more about aeronautics from experts/role models, and links to other Web sites. The target age level for year 1 (Phase 1) is 4th grade.

PROJECT RATIONALE

The Internet offers advantages and disadvantages as a medium for providing aeronautics-based math activities. We have re-examined the advantages to provide a rationale for the structure of the activities within this project to guide the design process.

Internet advantages:

*** computer use is motivating, non-threatening and self-paced;**

*** Internet lessons are available to students anywhere there is a computer on-line;**

*** on-line use provides immediate access to an infinite and dynamic amount of information and resources from all over the world;**

*** specificity of information received is unmatched through other resources;**

*** on-line use extends a student's understanding and experience by providing interactive communication and sharing with students all over the world;**

*** possible cost benefits to Internet delivery.**

In order for this project to appeal to classroom teachers and students, the inherent limitations of the Internet were identified and addressed. These limitations include:

*** interactive capability within Hypertext Markup Language (HTML);**

*** activities that could be better addressed (based on best instructional practices) through CD-ROM or other software formats;**

*** realistic amount of time each classroom or group of students will spend on-line based on financial and classroom management restraints.**

*** accessibility issues**

Technology is a tool for educating students. It is a means to an end, not an end in itself. Technology is best used as a tool for providing information to students when it can't be done in a better way. Using the Internet to deliver aeronautics-based math activities will be most effective when the advantages of Internet use are incorporated into the design.

TIMEFRAME

In the first year, the project will establish Internet access at school sites while designing and installing the initial World Wide Web-based instructional lessons. The lessons will be competency-based, with learning goals in math, aeronautics, and in the use of the Internet as a learning resource. The second year will expand the curriculum, delivering additional media and software to the user site by FTP, floppy, or CD-ROM, and then use those materials for interactive, real-time collaborative learning on the Internet. Year 3 will update delivery platforms to accommodate selected technological advances such as fiber-to-the-curb Interactive TV and advances in assistive technology.

We will examine how best to combine the Internet potential for multi-user interaction, the speed of locally-delivered media, and the power of true interactive authoring to maximize the strengths of each of these media and the potential power of these media in combination.

PROJECT RESOURCES

While the project will draw on the proven multimedia, accessibility, and education skills of staff at InfoUse, the project has a variety of resources. The Center for Accessible Technology, an Alliance for Technology Access (ATA) site in Berkeley, California is participating in curriculum research, accessibility issues and activity design. The forty-six Alliance for Technology Access (ATA) sites nationwide, along with the Headquarters in San Rafael, California will provide immediate access to 985 school districts across the nation. California State Polytechnic University, Pomona is providing Internet server access and hosting focus groups. An expert advisory panel of teachers, administrators, and individuals with specific expertise in math, aeronautics, disability, and Internet provides feedback at various stages during the project.

CURRICULUM DESIGN

Research into classical and non-classical approaches to teaching math and interviews with teachers, administrators and experts in math curricula revealed the following list of educational approaches and content needs for 4th grade students to be served in this project in the first year.

Approaches to project curricula include:

*** Outcome-based education**

*** An active role for students in their learning**

*** Use of careers and role models as goals to learning**

*** Cooperative work/Team or Peer Teaching (e.g., semester-long group investigation and group problem solving)**

*** Use real-world experiences to teach math (e.g., exploration, discussion and activities that mirror the mathematical problems encountered by pilots)**

*** Multi-cultural math treatments**

*** Appropriate presentations of persons with disabilities, females and males, and people of various ethnicities and races.**

*** The program should augment existing learning materials, not be a comprehensive mathematics curriculum.**

CONTENT

To ensure that the program follows the approach outlined above, we selected topics for inclusion into the program that are consistent with current educational practices and standards. These topics are presented in ways that are meaningful to a range of learners in today's classrooms. The National Council of Teachers of Mathematics (NCTM) Standards and state mathematics frameworks provided the mathematics content which needed to be covered; national aeronautics curricula were reviewed for age-appropriate content that could be taught with mathematical concepts.

Math content to be covered includes: Estimation; Measurement; Number sense and numeration; Whole number computation; Whole number operations; Geometry; Statistics and probability; Patterns and relationships; and Fractions and decimals.

Aeronautical content to be covered includes: History of Aerospace; Kinds and uses of Aircraft; Parts of An Airplane; Why Airplanes Fly; Weather; Instruments and Navigation; and Airports.

TEACHING THE CONTENT

Using the NCTM standards, the following list of ways to teach the content was assembled.

Data collection: students will be involved in developing and implementing plans for collecting and analyzing data to answer questions, including concepts of mean, median, mode, and range. (The graphics capabilities of computers in general and the Internet in particular are ideal for generating teaching materials in this area.)

Shapes: students will identify shapes, manipulate them in spatial relationships, and develop visualization skills, including understanding of perspective.

Patterns: students will begin to discover patterns in their data, and can then make predictions and form hypotheses for other variables.

Multiplication and Division: students will have opportunities for practicing these math facts in the context of solving questions within activities.

Area and Perimeter: students will grow to understand the relationship between area and perimeter, and experiment with links to multiplication and division, and two-dimensional shapes.

Fractions and Decimals: students will be able to practice working with fractions and decimals through pattern and shape.

Grids and Graphs: students will display their data, hypotheses, and results in a variety of ways using grids and graphs. Patterns and relationships will become obvious through these displays.

Careers: teaching aeronautics for 4th grade children included the coordination of career information with the aeronautical concepts.

ACCESSIBILITY

Web pages can be made accessible in three ways: Web pages can be designed for optimal use, users can set specific preferences within browsers, and browsers themselves can be made more accessible. The project established criteria and is a model for the design of World Wide Web pages with accessibility issues, needs, and equipment in mind. Of particular emphasis are consistent placement of hot links, parallel pages of text-only (no graphics), and non-scrolling pages. Browser preferences allow accessibility through font, color, and page size adjustment. Browser design will not be dealt with directly in this project.

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Return to itdv03n2 Contents Page

Return to Journal Volumes Page

ITDV03N2.ARTICLE5

TEACHING SCIENCE, ENGINEERING, AND MATHEMATICS TO DEAF STUDENTS: THE ROLE OF TECHNOLOGY IN INSTRUCTION AND TEACHER PREPARATION

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It comes as no surprise that when deaf adolescents are asked to rate characteristics of effective teachers, they place a high importance on the visual representation of course content during lectures (Lang, McKee & Conner, 1993). Mediated instruction has been advocated by effective teachers ever since the earliest forms of transparency and slide projections, and motion picture films, have been introduced. As new forms of technology enhanced the general living conditions of deaf people as well, educators have applied them to the classroom.

Such was the case, for example, when the acoustic telephone coupler was designed by three deaf inventors in 1964. Shortly after the modem came out, the large, noisy, 250-pound tele- typewriters were being lugged into classrooms across the country to provide primary and incidental language learning experiences for deaf students.

Not until recently, however, has technology shown great promise to become an integral component of classroom instruction for deaf students. In this paper, I will discuss three avenues of research on technology for science, engineering and mathematics education for deaf students at the National Technical Institute for the Deaf at Rochester Institute of Technology. These arenas of technological research include: 1) direct instruction in the classroom through multimedia approaches; 2) assistive device technologies for enhancing access to classroom lectures in mainstream classes; and 3) use of technology for networking in teacher preparation.

Over the past decade, the use of captioning technology has greatly improved access to information in the science, engineering and mathematics classrooms for deaf students. There are at least two kinds of access through captions which play an important part in learning. First, in the classroom, there is what I call primary access to science films through either open or closed captions. Captioned films are much easier to obtain today and many commercial publishers offer captioned versions of their educational media.

Second, there are many improved opportunities for what I call incidental learning of science, through closed captioned television shows, for example. Programs such as "Bill Nye, the Science Guy" can be copied directly from television and permission is given to teachers to use the tapes in their classes for up to three years. Science-related films are frequently seen on regular broadcast and cable television channels and the opportunity for deaf students to learn science, as well as English language skills, through informal viewing shows great promise. Computer software is available for custom captioning as well.

One of the principal research concerns at this time includes the effect on learning when verbatim or edited captions are used. In one study conducted at NTID by Hertzog, Stinson, and Keiffer (1989), 32 deaf engineering technologies students viewed two captioned versions of a film about cement manufacturing. Both high and low reading groups benefited from instruction when the captions were on an 8th grade level, while only the high reading group benefited from the 11th-grade level captions. This study shows how the development of technology along with a sound educational research program may lead to optimal teaching and learning strategies.

Computer software for direct instruction of deaf students in science is being experimented with across the country. However, without a solid educational research foundation, new CD-ROM and other computer technologies may flounder without direction as was the case with many earlier attempts at computer assisted instruction (CAI). One study now in progress at NTID involves the Content Independent MultiMedia System (CIMMS). As described by Dowaliby (1996), CIMMS provides an interface between a teacher or instructional developer and HyperCard, the authoring system employed, which performs all of the programming, graphics, and compilation. This overcomes problems of cost and lead time which have formerly discouraged teachers from pursuing computer technology for direct instruction or tutoring. CIMMS is currently being evaluated at NTID through experimentation with lessons presented in instructional text, adjunct questions, movies in sign language, and content movies or still pictures displayed simultaneously or in any combination on the computer screen. Not only does this technology present some exciting approaches to visually oriented learners, but it also shows promise to meet the needs of bilingual deaf students (those who use both English and American Sign Language).

Personal captioning workstations are also being explored for their potential to enhance learning in the classroom by deaf students. The highly visual materials stimulate writing, vocabulary enrichment, and independent learning skills. The personal captioning workstation uses two VCRs (one for playback and one for recording), a personal computer, a captioning device that allows text to be superimposed onto video, a printer, a video monitor, and an optional camcorder. Students view videotape material and compose their own text. The method provides teachers with an evaluation scheme to see how well the students are comprehending the topic (Kelly, Loeterman, Morse, Parasnis, and Samar, 1995).

One of the most exciting assistive device technologies being developed for use with deaf students in the classroom today is the Computer-Aided Speech-to-Print Transcription System known as the "C-Print System" (Stinson & Stuckless, 1995). C-Print involves a hearing operator who transcribes spoken lectures on an IBM compatible laptop computer using a commercially available word processing program, WordPerfect, and an abbreviation software program, Productivity Plus. The laptop may be connected to a television monitor to be viewed in real time by students in the class, and the lecture is stored in memory and can be printed as notes for student reference. In studies conducted so far, C-Print has been found successful in courses where numerical information, including formulas, are being discussed. C-Print will be explored in additional science and engineering courses in the near future.

In the area of teacher training for professionals in science, engineering, and mathematics, technology is playing a key role. In a three-year National Science Foundation grant project I am leading with John Albertini at the National Technical Institute for the Deaf, for example, many forms of communication technologies are being used to establish a national network of science teachers who conduct "action research" with us to identify the best practices for use with deaf students. Networking by electronic mail and FAX occurs daily, allowing us to provide teachers across the country with information for their own teaching and teacher preparation in science, engineering and mathematics. Plans are being made for teleconferencing for small, local workshops for teachers. Several regional workshops are offered each year and the entire contents of the two-day workshop are being placed on World Wide Web to allow other teachers access to the information and to join us in our efforts to do research on science teaching strategies.

In addition, we are collecting, evaluating and sharing engineering, mathematics, and science signs through videotapes and a printed manual in a national "Technical Signs Project" (Caccamise & Lang, 1996). Teachers, interpreters, and other professionals use these tapes and manuals to learn the most common signs for technical concepts, which enhances communication in the classroom.

In summary, educators now have available a variety of technologies for use in both direct instruction and in their own preparation as professionals. It is our hope that these many forms of electronic communication will have a significant impact on the quality of science, engineering and mathematics education for deaf students over the years to come.

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Return to itdv03n2 Contents Page

Return to Journal Volumes Page

ASSISTIVE TECHNOLOGY AND LEARNING DISABILITIES

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INTRODUCTION

Schools in the United States, both K-12 and postsecondary institutions, are struggling to meet the needs of the increasing numbers of students with learning disabilities. The 1989 figures from the U.S. Department of Education indicate that almost 2 million K-12 school children or 50% of the children receiving special education services are identified as having learning disabilities. (11th Report to Congress, 1989) These increased numbers of students with disabilities are now also impacting postsecondary educational institutions. Reforms in science and mathematics education have led to the development of national curriculum and assessment standards. The American with Disabilities Act (ADA) and the Individuals with Disabilities Act (IDEA) have mandated academic access in all areas of education for students with learning disabilities (Stinson, 1993).

Books on learning disabilities such as those by Vogel (Vogel, 1993) and Wong (Wong, 1991) and literature searches on accommodations for students taking mathematics and science give little insight in how to accommodate the learning needs of these students. Assistive technologies are an excellent way to improve access, but some of these don't work as well for science and mathematics because formulas and numbers complicate the translation process.

The focus of this paper must be restricted and will concentrate on mathematics education. This is the core of the information access problem, so if mathematics can be made accessible, all scientific information should be accessible. Not all learning disabilities will be treated fully in this short paper. In particular, students with Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD) are not discussed because different techniques from those that are the focus of this paper are necessary to meet their needs.

It is difficult to classify math disabilities. Tentative groups are (1) the visual-spatial group who have an adequate "sense of number" and know basic facts but have errors in writing of numbers, regrouping, and spatial activities (2) poor logico-mathematical group who have deficits in nonverbal concepts, meaning, or inner language. This leads to not knowing when to calculate and which operations to use. (3) language comprehension problems group. This leads to difficulty with math concepts because of confusion caused by symbols and mathematical terminology. (4) the group who has frequent, inconsistent fact errors and some inconsistent procedural errors. They have some difficulty with the multiplication tables. Most are considered dyslexic with auditory perceptual and memory deficits. (Johnson & Blalock, 1987). Unfortunately because of the many difficulties that students encounter when trying to learn mathematics, math course requirements are often waived at the postsecondary level. The student's failure to succeed during high school is often used as evidence of the disability.

ACCOMMODATIONS

It is unfair to waive the mathematics requirements. Instead accommodations should be made to assist the students to succeed in these courses. More research needs to be done to evaluate which accommodations are effective, but it should also be remembered that students with learning disabilities benefit from good teaching techniques. New concepts should be presented both visually and auditorily, and students should be given hands-on experience. The use of manipulatives helps the tactile learners and helps to create understanding of mathematical concepts instead of rote learning. Actually these techniques help all students and are being endorsed by the National Council of Teachers of Mathematics (NCTM).

To assist students with learning disabilities to achieve understanding and fluency of math facts, Cecil Mercer of the University of Florida has designed math workbooks to teach math concepts by using a concrete-representational-abstract (CRA) teaching sequence. Implicit in this method of instruction is an emphasis on teaching students to understand the concepts of mathematics prior to memorizing facts, algorithms, and operations. Instruction begins at the concrete level with students using three-dimensional objects to solve computational problems. At the representational level, drawings are used to solve the problems. Finally at the abstract level, the student looks at the computation problem and tries to solve it without using objects or drawings. The results from field testing the Strategic Math Series indicate that students with learning disabilities were able to (a)acquire computational skills across facts, (b) solve word problems with and without extraneous information,(c) create word problems involving facts, (d) apply a mnemonic strategy to difficult problems, (e)increase rate of computation, and (f) generalize math skills across examiners, settings, and tasks.

Students with learning disabilities need to learn the math basics and problems solving techniques. Smith and Rivera stress that students with learning disabilities need to be allowed adequate time to master math skills and that instruction should match the skill level. Students tend to have difficulty with math because of their slower response rate and because of inefficient selection and use solution strategies (Wong, 1991). If they are unable to master these concepts in the early elementary grades, then the problem intensifies and in addition a "math phobia" is developed.

ASSISTIVE TECHNOLOGIES

There are several reasons why the use of assistive technologies is an attractive accommodation. The persistence of learning disabilities is becoming an accepted fact (Johnson & Blalock, 1987). Many of these students have received remedial assistance throughout their education. To be able to function as independent individuals and to take full advantage of their potential and capabilities, they need a way to compensate for their weaknesses. Assistive technologies are often the ideal solution.

In all disciplines typical accommodations for students with learning disabilities include such things as taped books, readers, additional time, and scribes. Raskind and Scott in their chapter, "Technology for Postsecondary Students with Learning Disabilities," support the use of assistive technologies. Although many different types of assistive technologies are listed, the only one for math education is the talking calculator (Vogel, 1993). The entire issue of the Learning Disability Quarterly of Spring 1995 is dedicated to "Technology for Persons with Learning Disabilities" but contains nothing at all specifically relevant to math or science.

Though there are positive reports about the successful use of assistive technologies for accommodations in other subject matter, little research has been compiled for math and science education. Some of the assistive technologies which students with visual disabilities use to provide access to textbooks could also be used in mathematics and science. The problem, of course, is that most optical character recognition (OCR) programs can only recognize text characters. Graphs and symbols can't not be read by recognition systems and therefore cannot be listened to using synthesized speech. Though students could use taped versions from Recording from the Blind and Dyslexic or use human readers, reading mathematics textbooks takes special skill that not all practiced readers have.

One of the major problems that dyslexic students have is the reversal of numbers and the inability to copy numbers correctly. Voice recognition systems are used to help students who have similar problems in other subject areas, but it is difficult to "dictate" a formula to a computer. Solving problems by dictating to a scribe is a time consuming and frustrating process.

Students with learning disabilities usually enjoy using computers. The computer allows students to drill and practice for an indefinite amount of time in an unthreatening environment. Unfortunately, it is difficult to find programs with an instructional component. The drill and practice programs can be beneficial if the student is guided through the correct problem solving steps and receives explanations for incorrect answers. Programs which provide auditory cues or the use of sound and visual instructions simultaneously would be an excellent choice. Programs should be easy to use with consistent on screen directions.

FUTURE TECHNOLOGIES

As technologies improve, it is possible to include accessibility in their design. Some publishers are becoming sensitive to the problems that students with learning disabilities and other disabilities have in accessing textbooks. Some textbooks are now available on CD-Rom. If these books also provide audio access, it would be an excellent accommodation. Some postsecondary mathematical textbook publishers are now providing video taped lessons to accompany their textbooks. These also could be an excellent accommodation. The University of Surrey in England is developing a physics course on the computer. This course uses computer simulations of experiments, allows branching to other resources if the student needs additional information or practice, and has an on-line glossary of terms. Courses such as these have great potential for providing access for students with disabilities.

Dr. William Mead at Adaptive Network Solutions, Inc. is leading an exciting new project to develop three prototypical applications of Artificial Neural Networks (NN) to teach basic arithmetic facts to students with learning disabilities. The three applications are symbiotic: a student simulator, a student assessor, and a CAI training (tutor) module. Dr. Mead is applying the principles he has used in neural networking to develop software which will respond "intelligently" and adjust to the student's behavior or responses. An advisory panel of experts helped establish some guidelines for the math tutor. The advisory panel is currently getting the "research-prototype." For more information about this project look at the web site: http://www.ansr.com/ansr

The Oregon State University Science Access project led by Dr. John Gardner is further developing T.V. Raman's AsTeR, an audio formatting program, and developing an auditory graphing calculator. These applications are primarily designed for use by students with visual impairments. For more information on this project look at the web site: http://dots.physics.orst.edu Students whose learning disabilities effect visual perception would also find some of these assistive technologies useful. The author has recently begun a National Science Foundation sponsored project to use simultaneous visual and audio formatted information on computers to teach math concepts to students with learning disabilities at Linn Benton Community College.

FUTURE DEMANDS

In the 1980's a dramatic increase in the number of students with learning disabilities attending colleges and universities has been witnessed. According to the Higher Education and Adult Training for People with Handicaps (HEATH) Resource Center of the American Council on Education (ACE), the proportion of first-time, full-time freshmen with disabilities attending college increased threefold between 1978 and 1985 (Vogel,1993). At the same time society demands that graduates have an increased knowledge of math and science to compete in the job market. If students with disabilities are to have full access to the job market of the future, they need to be provided accommodations so that they can learn mathematics and science.

OTHER RESOURCES

Heath Resource Center
One Dupont Circle, Suite 800
Washington, DC 20036
(800)544-3284
(202)544-3284

National Adult Literacy and Learning Disabilities Center
1875 Connecticut Avenue, NW

Washington, DC 20009
(202)884-8185

WORLD WIDE WEB URL'S

EASI http://www.rit.edu./~easi/easisem.html

LINCS National Resource Directory
http://www.portal.com/~cbntmkr/php.html

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Return to itdv03n2 Contents Page

Return to Journal Volumes Page

n 3 n 4

Information Technolgies and Disabilities

3:4 December, 1996

Articles

(ITDV03N4.CONTENTS)

Return to the EASI Homepage
Return to the ITD Homepage

ITDV03N4 VISLAB

TEACHING SCIENCE TO THE VISUALLY IMPAIRED: PURDUE UNIVERSITY'S VISIONS LAB

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The areas of science and mathematics have traditionally been inaccessible to students with visual impairments. Complex and high-tech fields such as Chemistry, Physics, Engineering, Biology, and Mathematics are rife with visually-presented concepts and information. Historically, this complex visual information has not been made available for widespread use in a format easily accessible to blind and visually impaired students. This lack of information, in turn, leads to decreased interest in scientific fields by the blind, and thus few visually impaired scientists exist to provide standards for imparting scientific knowledge to the blind and to serve as mentors and role models for those visually impaired students who wish to pursue careers in the sciences.

The Purdue University VISIONS Lab, which stands for Visually Impaired Students Initiative ON Science, is a research laboratory dedicated to providing access to the numerous science courses at Purdue. Since its inception in the summer of 1995, this university-funded lab has served as a production facility for providing visually impaired students with educational materials and as a research lab for developing new adaptive technologies. Interestingly, the VISIONS Lab was part of a university-wide response to the problems that visually impaired students face when attending a major university, and included the efforts of individuals from the Office of the President to the individual Teaching Assistants themselves, and everyone in between. As of Spring 1996, the VISIONS Lab has worked with two blind pre-medicine majors and one low-vision graduate student in Chemistry. The VISIONS Lab has been involved with course work from many different departments, including but not limited to Mathematics, Chemistry, Physics, Engineering, Computer Science, Psychology, Biology, Agronomy, and Spanish. As can be seen, the VISIONS Lab has rapidly expanded beyond its initial design to become a gestalt facility, encompassing and supporting the daily needs of the students as well as predicting and planning for future needs.

The approach of the VISIONS Lab to solving specific academic problems encountered by visually impaired students can be divided into two distinct parts: educational needs and technological needs. It is often the case that the latter is most easily provided; however, it is of paramount importance that the educational requirements of learning not be lost in the forest of high-tech, glamorous equipment. To this end, the VISIONS Lab administrators participate in planning the student's course needs on a semester-by-semester basis with the help of case conferences with the student, his or her instructors, and several university student service organizations such as the Dean of Students Office. After the needs have been assessed, the scientists involved in the daily operation of the lab take charge and develop the necessary technology to realize these educational necessities. The VISIONS Lab currently employs several graduate and undergraduate students, under the administration of the director, who develop and produce the educational materials needed by the students on a daily basis.

In order to fully understand the power and usefulness of this approach, the two halves of the VISIONS Lab problem-solving strategy will be examined for two courses from two disparate disciplines. The courses to be discussed in detail are Organic Chemistry and the Calculus. These classes serve as excellent examples of the technological and educational advances developed by the VISIONS Lab and available as educational standards on the World Wide Web. In every case, the adaptive technologies used for a particular class depend primarily on the abilities and strengths of the students. For example, a student skilled in Braille will receive most of the course information in tactile format, whereas a student geared towards auditory learning will be the recipient of taped lectures, computer-synthesized screen readers, and other vocal learning methods.

The VISIONS Lab originally was conceived as a means to solve a nagging problem in mathematics, specifically dealing with a particular calculus course. Calculus is a special challenge for the blind, as it is very difficult (and sometimes not possible) to interpret all of the mathematical information orally. What was needed at Purdue was a way for the blind students and faculty to quickly and easily interact with each other and communicate complex mathematical ideas. Since the two blind students at Purdue were different types of learners, one auditory and the other tactile-oriented, a general strategy to service both was desperately needed. The solution to this problem, which was produced by the VISIONS Lab during its initial development stages, was to develop a software program that would translate mathematical and scientific equations into a format appropriate to blind students. The initial approach was to convert the equations into the standard Nemeth Braille code for mathematics; later, modifications were made to allow speech output of the equations (this is still in development). The program is available on the VISIONS Lab homepage at http://www.chem.purdue.edu/facilities/sightlab.index.html and is freeware, together with a manual explaining its use.

Also available is a tutorial manual to the Nemeth code, that follows most example equations in the Nemeth Braille Code for Science and Mathematics, 1972 rev., and translates it into Braille using the program. The program was created as a giant macro for WordPerfect for Windows version 6.0 or 6.1 and produces all output in proper Nemeth Braille code. This allows the various secretaries at Purdue who type materials for the Calculus courses to submit the tests in electronic format to the VISIONS Lab. The secretaries must follow a few simple typing conventions when creating the documents, but these conventions in no way prevent the final document from being used by BOTH sighted and blind students. Also, the typing conventions are clearly detailed with examples in the manual and are usable by someone with no knowledge of Braille. The VISIONS Lab, upon receipt of the electronic copy of the document, converts the equations into Braille using the macro. The literary portion of the document is then translated using a commercially available Braille translator, the Duxbury (TM) Braille Translator for Windows. Many other translators would be suitable as well, however, such as MegaDots(TM) from Raised Dot Computing. The final Braille document is embossed on a Braille printer such as the VersaPoint Braille embosser. This entire process, from receipt of the electronic document to printing of the Braille copy takes about 5 minutes per page translated on average. Of course, documents that are not in electronic format or that include special items may take longer. This process is certainly easier than translating the entire document by hand, which may take days or weeks.

After the development of the Braille translation software, the next natural step was to allow for speech output of equations as well. This project, currently under development, will allow students to translate the equations themselves and have the information read to them via a standard software package (TextAssist (TM) for the SoundBlaster (TM) family of sound cards). Concomitant with this project is another in sound imaging. This project attempts to vocally image two- or three-dimensional objects (such as matrices in math or molecules in Chemistry) in three dimensions around the listener's head. This is currently being done with the SoundBlaster (TM) card and the Qsound (TM) software technology, as well as a pair of Altec Lansing (TM) SurroundSound (TM) speakers.

Of course, some aspects of calculus require more advanced treatment. For example, much of advanced calculus deals with the interpretation of two- and three-dimensional graphs, and how aspects of them relate to mathematical equations. This information simply cannot be communicated orally, and yet it is vital that the student understand graphical relationships, since many key ideas in science and math are too complex to be interpreted symbolically. Indeed, the use of models and visualization to simplify complex ideas is a critical skill for future scientists; blind students, like others students, must be able to assimilate vast amounts of data at a glance by the use of graphs and diagrams. In order to deal with this problem, the use of a Tactile Image Enhancer (TM) from Repro-Troniks (TM) was used. Various standard computer graphing packages such as MathCad, Maple, and Mathematica were modified to produce graphs with Braille labels created by the Duxbury Braille Font for Windows (TM). After printing these images in ink, the images were transferred via Xerox to Tactile Image Enhancement paper and converted into a raised Tactile Image via the Tactile Image Enhancer. When appropriate, these graphs and diagrams were embedded in the Braille text of the document by cutting and pasting. For images that are not reproducible by the computer or available in electronic format, scanners were used with a graphics program like CorelDraw (TM) to produce ink output for subsequent image enhancement. This general technique, like the equation translation, has two advantages: the ability to accept electronic forms of diagrams for enhancement, and the overall speed of the process. For diagrams received in electronic format, the entire process - from modifying to pasting into the Braille document - can take less than 15 minutes.

The second subject dealt with by the VISIONS Lab, and perhaps the most challenging, is Organic Chemistry. This field involves several problems that are especially difficult for blind students. First, Organic Chemistry involves a tremendous volume of material, which is barely tolerable by many sighted students and can be too much for some blind students to keep up. This is mainly because of the lengthy process of listening to taped or read materials. Second, most of the material in Organic Chemistry is two- or three-dimensional in nature, and it is critical to have an understanding of spatial relationships of molecules to be an organic chemist. Finally, the laboratory part of the class must be modified to allow blind students to use the laboratory equipment, perform experiments, and take data.

For the Organic Chemistry lecture, the main problem was in translating the material into Braille or tactile images for the blind students. The main process once again involved the translation macro, which can also translate all chemical reactions not involving complicated two- or three-dimensional molecules. For those molecules which are not expressible in linear format, tactile images were once again embedded in the appropriate part of the text. For producing Braille tactile diagrams of chemical structures, several standard chemical drawing programs were used, including HyperChem, ChemDraw Pro, Chem 3D, and Chem Windows. These modifications have been standardized and are available on the World Wide Web. Also, some modifications and/or additions to the existing Nemeth code had to be developed to allow for complex chemical reactions and structures, as this was not a part of the existing code. Whenever possible, the spirit of the Nemeth code was kept in mind when developing new conventions. Thus, many of the conventions are very small adjustments to existing rules and symbols to allow for inclusion of information from the world of Chemistry. These new Braille conventions are also available via the VISIONS Lab homepage on the World Wide Web. One problem with converting chemical diagrams is that often the diagrams are too complex or too crowded for successful tactile interpretation. Because it is difficult to decide what information (if any) can be excluded from a complex chemical diagram without loss of meaning, careful consideration was given to educational adaptations. With the help of Chemistry faculty and teaching assistants, the diagrams are simplified on a case-by-case basis, with the main goal of remaining as true as possible to the original diagram. In general, many diagrams can have their original meaning preserved by simply enlarging the details to allow proper tactile resolution of things such as location of atoms, movement of electrons, etc.

A final problem for the blind Chemistry students was in the evaluation of their learning. Often when taking tests or quizzes, the organic student must demonstrate knowledge by drawing detailed diagrams of reaction mechanisms or chemical structures. Three different approaches were used to combat this problem. First, a Velcro box was constructed with Velcro pieces that attach to the surface and stick. The pieced are differently shaped and labeled in Braille as to the identity of the piece. The geometry of the particular piece indicates its identity as well. For example, carbon atoms are squares labeled with a "C", and in chemical reactions, Carbon bonds with four other atoms (indicated by the four sides of the square). Electrons are represented by small circles. This allows the student to interact with a tutor, teaching assistant, or proctor and demonstrate a reaction to someone who does not know Braille but does know Chemistry. A second approach was the use of raised line drawing kits, such as the Swail dot inverter or the Sewell raised line drawing kit, both available from the American Printing House for the Blind (TM). Here, both the student and proctor can draw "stick" diagrams (which are commonplace means of expressing reactions in Organic Chemistry) and interact in real time just like a sighted student with an ink pen. A final approach was the creation of software, still in development, that will take Braille typed on carbonless copy paper (which makes an ink image of the Braille dots), scan this Braille into electronic format with a scanner, and re-convert this scanned Braille into text. This would allow blind students to hand in assignments in Braille for the professor (who knows nothing about Braille) to later grade and return. The eventual goal for this would be to have a computer act as the intermediate between professor and student; that is, the computer would translate from print-to-Braille or vice versa and serve as the interpreter for the blind student and the professor.

The Chemistry laboratory also presented several formidable challenges. The first concern of many members of the Chemistry faculty was the safety of blind students and their assistants in the laboratory. Thus, any adaptations made must account for safety and proactively prevent any possible dangerous situations from arising. To this end, it was decided that a sighted laboratory assistant, together with the technological adaptations, would be best for all involved. This situation has been proven beneficial for the blind student as well as the other students and teachers, because the blind student has the opportunity to fully explore the laboratory environment with immediate feedback from the assistant, and can learn interactively along with the other students. As far as the technological aspects of the laboratory equipment, some modifications were made to the actual equipment, allowing for knobs and buttons to be Brailled and so forth, and all of the laboratory materials were made available in Braille. Most of the readings and measurements were taken with the use of the lab assistant, who acted as the blind students "eyes" and "arms" for some of the work such as taking a reading from a dial, mixing chemicals, heating solutions, etc. Some work is currently being done in the VISIONS Lab to convey some laboratory instruments such as spectrophotometers to voice-output systems. However, the more promising area of research in the VISIONS Lab has been in the area of virtual instrumentation.

The VISIONS Lab is currently exploring, with the use of both in-house and commercial programs such as LabView, the creation of virtual experiments on the computer that would have voice-input and voice-output control interfaces. Purdue currently uses virtual instrumentation for a number of its laboratory courses, so the task is to modify the existing software.

As can be seen, the VISIONS Lab is both adapting existing technology and creating new technology to solve specific problems encountered by blind science students. We have made these advances available on the World Wide Web in the hopes that others working on similar problems will join with us in an attempt to solve some very challenging problems. It is our sincere hope that the advances developed in the VISIONS Lab will provide the impetus for blind students to begin to explore the realms of science that have been so difficult to learn for so long.

Purdue's long-range plan for the VISIONS lab is one of optimism and hope that many blind students both at Purdue and around the world will take advantage of some of the standards developed here. Together with adaptive technologists around the globe, the VISIONS Lab hopes to make the future of science education for the visually impaired a brighter one.

Return to itdv03n4 Contents Page

Return to Journal Volumes Page

TACTILE GRAPHICS: AN OVERVIEW AND RESOURCE GUIDE

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INTRODUCTION

This article is intended primarily for parents, teachers, and friends of blind people. It introduces the reader to some of the possibilities and to some limitations of using tactile graphics for conveying information to blind people. A number of methods for producing tactile graphics are described. A resource list of useful tools, supplies, and technological methods and devices, and the names and addresses of firms and organizations selling these products is included. A major focus of this article is tactile graphics in science, engineering, and math.

Tactile graphic images are used by blind people to obtain information that sighted people get from looking at pictures. Students learning geography for example would be lost without maps of regions being studied. A blind student without equivalent tactile maps is at an enormous disadvantage relative to sighted peers.

The unfortunate truth is that blind students seldom have tactile maps that are equivalent to visual maps. Visual maps use color and many kinds of texture to indicate such things as elevation, population density, agricultural productivity, and thousands of other variables that the authors use maps to illustrate. The information conveyed by color and texture are difficult to translate into equivalent haptic information. Even the most skilled professional does not know how to make tactile representations of many such maps that are as informative to blind readers as the visual maps are to sighted readers.

There are several problems. One is that haptic perception is much less detailed than visual perception. Another is that most blind people have little experience in reading tactile pictures. Consequently it is difficult to make tactile pictures that are very detailed without simultaneously making them confusing to blind readers. Research on haptic perception, development of inexpensive methods for making tactile graphic materials, and early training of blind children in techniques for reading tactile graphics are needed before the full potential of tactile graphic materials is likely to be realized.

This article provides an overview of the state-of-the art in preparation and use of tactile graphics as well as a brief description of research on these topics that is underway in the author's research group. Reference is made to a few other research efforts as well.

PREPARATION OF TACTILE GRAPHIC MATERIALS

Variable height tactile pictures

Professionals working in organizations serving blind people routinely make topographic maps, images of animals, and other quasi-three-dimensional pictures for their clients. Most are made by thermoforming a plastic sheet over a hand-made mold. The mold can be anything that is porous and can withstand the temperature of the thermoforming process. Many molds are made by cutting and pasting paper, cardboard, string, metal foil, etc onto a heavy paper base. Heavy acrylic paint (e.g., Liquitex brand) can be squirted through a syringe to make into intricate patterns of raised lines. The paint dries in about an hour.

Some of the things used to make the molds are common materials in the home. Most are common supplies available in arts and crafts shops. The syringe used by many professionals is a "onojector" available from drugstores, pet stores, or veterinarians.

Braille wording can be added to these tactile pictures using a braille slate and stylus---available from almost all firms and organizations selling general supplies for blind people.

Another technique for making molds is by deforming soft aluminum sheets with various tools. The American Printing House for the Blind has a kit that includes a number of these aluminum sheets and a selection of useful tools and dies for making images on the sheets. The kit includes a punch and die set for putting braille wording on the mold.

The American Printing House also sells a Starter Graphics kit intended primarily for non-professional production of single copy tactile graphic pictures. This starter kit includes fabric puff paint and a squeeze bottle applicator, a number of different fabrics with different textures, several sheets of glue-on tactile labels, a braille slate and stylus, and a guide to braille. One can also use the starter kit to make molds from which thermoform copies can be made, but users caution that the puff paint mold should be powdered with talcum to prevent the puff paint from sticking to the plastic thermoform sheets if used for this purpose.

Many volunteer and professional transcribers working for public and private organizations providing materials for the blind use these methods routinely to make excellent quality maps, relief drawings, etc. Prof. Judith Tamburlin and Prof. Charles Severin of the State University of New York at Buffalo [1] have established a research program to develop high-relief educational materials used in the life sciences. Their largest project to date is a three volume atlas of human anatomy with over 100 illustrations. It is used in the university and by high school students. They distributed three copies of the atlas to each state resource center or agency designated for the dissemination of educational materials to visually impaired students and their teachers.

At the present time, virtually every variable height tactile picture or the mold from which it is made is constructed by human hands. High-tech production methods are topics of research, but none are presently being employed for any large scale production. There are at least three research projects underway in the US employing computer-controlled milling machines to make molds [2-4] and one using a new stereolithographic instrument [4] for making molds. These research projects show promise for simplifying the process and reducing the human labor required to make variable-height tactile pictures, but the cost of the machines is large enough that they are unlikely to replace the human cut-and-paste process any time in the very near future.

Thermoforming requires a Thermoform Duplicator---a heated press that takes the mold and a piece of Braillon sheet. When the press is closed a partial vacuum pulls the heated Braillon sheet around the mold making a faithful copy of the original. Several standard sizes can be made using supplies and equipment available from American thermoform. Several different weight Braillon is available. The lighter weight is satisfactory for regular size braille pages, but heavier weights are generally recommended for large sizes.

UNIFORM HEIGHT (2D) PICTURES

Variable height tactile pictures are very useful for conveying three-dimensional shape information such as topography and the shapes of various objects. Uniform height tactile pictures are the tactile equivalent of visual line drawings and convey only two dimensional information. For simplicity these will be called 2D tactile pictures from now on.

Manual methods of making 2D tactile pictures

Any of the methods used for variable-height tactile pictures can also be used to make 2D tactile pictures, but there are several methods useful for 2D pictures that are faster and easier than the laborious methods described above.

A popular and inexpensive raised line drawing pad, sometimes called a Sewell pad, provides a "quick and dirty" method of making 2D tactile pictures. One places thin sheets of a special mylar polyester film on the rubberized pad and sketches pictures using some kind of stylus with a rounded tip. Many sighted people find it convenient to use a ball-point pen as stylus, because the pen leaves a more visible image. The sketched lines pop up, and a permanent image is obtained. The height of the image is marginal, but this pad can be a very useful means of instant graphic communication with blind people. A kit consisting of the rubberized pad, a stylus, and a number of mylar sheets is available from most organizations selling general supplies for blind people and costs typically $25 to $30. 8.5 x 11 inch mylar sheets cost $8 to $10 for a package of 100.

Instant tactile images may also be created with the use of a special paper that swells when heated. One can draw directly on swell paper using the Thermo Pen (from Repro-Tronics and its dealers). One must draw slowly and evenly with the Thermo Pen to obtain good quality tactile images, but with practice and some care, one can create good quality images. The Thermo Pen and swell paper is a somewhat lower and more expensive alternative to the raised line drawing pad for instant graphic communication, but the resulting images can be much more readable than the mylar raised line drawings made using the drawing pad. Swell paper is manufactured by Matsumoto Kosan (whose US representative is JP Trading) and Repro-Tronics.

Another way of using swell paper is simply to draw an image using a black felt-tip pen, grease pencil, etc. onto the swell paper surface. The paper is then fed into a machine that passes it under a heat lamp. When the machine is properly adjusted, the black areas of the paper swell but the white areas do not. With some practice, one can make excellent tactile images.

A picture may also be copied onto swell paper using a photocopier and then passed through the swell paper machine. A fast photocopier usually does a better job than a slow one. Slow photocopiers sometimes heat the swell paper enough to cause the white areas to swell slightly and become somewhat textured.

The least expensive swell paper machine available in the US is the Thermal Image Enhancer manufactured by Repro-Tronics. The Stereocopier machine, available from JP Trading, combines the copying and swelling machines into one. With this machine, a picture can be copied directly to a tactile representation.

A common method employed by many professionals to emboss excellent quality images into braille paper is by using A small hand-held tracing wheel. The tool is used to press a line or other image into paper mounted on a firm rubber mat. Since the picture is drawn onto the paper from the back, it must be drawn in mirror image. Howe Press sells these tracing wheels and a variety of other tools for embossing, including a number of tools intended for geometry and math. A Grifhold pounce wheel, available from art supply shops, as well as marking wheels available in fabric shops are also useful for embossing lines.

2D images may be drawn on paper with the acrylic paint or fabric puff paint mentioned above. In addition, a standard hot glue gun can be used for making reasonably good tactile images and has the advantage that it dries much more quickly than the paint.

Bulk production of 2D pictures

A variety of methods are used for producing tactile pictures when large volumes are needed. The thermoforming method described above is one such method. Large printing houses for the blind have presses that squeeze braille paper between heavy metal embossing plates. The male/female embossing plate pairs are made by a human-controlled machine and require a skilled operator to achieve reasonable quality. The total cost of making a pair of embossing plates is many hundreds of dollars. R The Braille Institute has developed a printing press method that utilizes a single embossing plate. Paper is pressed between this embossing plate and a rubber material. The images are not as crisp as those produced by good quality embossing plate pairs but are good enough for most purposes. The single embossing plates can be made from standard photoresistive plates and can be produced for $20 to $30 typically. R Hy-tech Forming Systems has developed a pressure bladder that can be used with single embossing plates to produce excellent quality graphic materials. The company has expressed interest in developing presses for the tactile graphics market. R Most printing houses for the blind are willing to accept outside requests for bulk print jobs, although some may not have the capacity for producing non-standard tactile graphics. A Canadian service company, Braille Jymico, offers to make tactile printouts in large or small quantities using a unique polymer deposition printing method. R A recently-founded company, Tactile Vision [5] Inc, Oakville, Ontario CANADA has developed a new method for inexpensive bulk printing of high-resolution tactile graphics using a deposited polymer. This company can make excellent tactile copies from black and white drawings having lines and dots of order 0.05 inches wide. This is a very promising technology that could become the standard bulk process of the future. R **Computers and tactile graphics**

Computers are rapidly becoming indispensable tools for blind people. Screen-reader software programs combined with either refreshable computer braille displays or voice synthesizers provide unparalleled access to electronic literature. R Computers are also excellent tools for producing high-quality inexpensive 2D tactile pictures. Many images needed by blind students or professionals are increasingly available as computer files. Software for creating and editing graphics files is relatively inexpensive and user-friendly. A number of computer programs, discussed in the next section, are becoming available specifically for creating tactile images. If there were such a thing as a personal tactile-image printer, the creation of 2D tactile pictures would become essentially a trivial exercise in manipulating and printing graphic computer files. R Computers can also assist enormously in conveying information to blind users about 2D pictures. This topic is discussed extensively in a later section. R **Computer hardware for making 2D tactile pictures**

For a period of time in the early 1990's, the HowTek Pixelmaster wax jet color printer was available with a modification that permitted a thick layer of the printer's polymer ink to be deposited. The printed images had a height of almost 0.010 inches. Although this height is much lower than the standard braille dot height of 0.025 inches, it was thick enough to be a useful tool for making 2D tactile pictures. Unfortunately the product failed on the commercial market, and at the present time, there is no commercially-available computer printer capable of making a tactile printout of a quality useful to blind people.

Until a usable and affordable tactile computer printer becomes commercially available, the only practical small-scale method by which a computer image may be transformed into a high-resolution 2D tactile picture is by using swell paper. Most computer printers heat the paper too much to allow direct printing on swell paper, so the computer image is normally printed onto regular paper, and the image is transformed into a tactile picture by methods described in the previous section.

Most braille printers may be switched into a mode for printing graphic images in the form of braille dots. Many of them have high resolution modes that print dots on a grid with dot-to-dot spacing of order 0.08 inches or less. Images printed with small dot spacing feel markedly smoother than those with the standard braille dot spacing of 0.1 inch.

Braille graphic images even with small dot-spacing are not as universally useful as high-resolution images made by other methods. Even so, braille graphic resolution can be very effective for many purposes. A few computer programs intended for production of braille graphics, many of which are usable by blind people, are described in the following section.

Computer software for making 2D tactile pictures

Several manufacturers of braille printers sell computer programs that permit a user to print out graphic images. These proprietary programs are not discussed here. The owner or potential purchaser of a braille printer should contact the dealer or manufacturer for information about such programs. KanSys supplies an inexpensive program, LowRez, that can print graphics files from a PC computer to many braille printers.

There are a few programs available that allow a user to print graphs of functions on braille printers. These programs may be used by blind people and are likely to be useful in advanced math and science. One such program is Graph-it sold by Blazie Engineering. This program runs on their popular Braille Lite note-taker and prints to most popular braille printers. They also sell a PC version.

Sighted computer users can design graphics on almost any computer graphics program and can add Braille through the use of Braille Font packages available from Duxbury, Inc. Prof. Marie Knowlton [6], University of Minnesota, has modified a version of the MacPaint program for the Macintosh to include braille fonts and useful tools for making graphics for blind people. Images made with any of these programs may be transferred to swell paper from which tactile pictures are obtained, as described above.

A recently-introduced program called AudioCAD allows both sighted and blind computer users to design images and print them on swell paper or on braille printers. AudioCAD includes several additional features that are described below in a section on including hidden information in computer files.

USING TACTILE GRAPHICS

Recognition problems with tactile graphics

Few sighted people fully understand the great difference between 2D tactile and 2D visual perception. It is far more difficult for a blind person's fingers and hands to provide him/her with the kind of overview of a tactile picture that sighted people perceive instantly with their eyes. The human eye and its associated parts of the brain can take in and process much more information in a moment than can be perceived by tactilely in hours.

Most people who are born blind or who lose their sight at an early age have great difficulty understanding information presented in 2D tactile pictures. Sighted children have to learn about parallax, representation of 3D objects by 2D projections, and use of spatial position in such things as maps and graphs. Blind children seldom have access to comparable tactile pictures and do not develop these concepts. As a consequence, blind students often have great difficulty with topics such as geometry and function graphs that are typically taught using 2D pictures.

The best advice known to this author on how to use and not use tactile graphics was given by Ms. Cathy Mack, a former special education teacher and expert on technologies for blind children. An excerpt from her contribution to a symposium on tactile graphics [7] follows:

"When you introduce a tactile diagram, whether it's to a kindergartner or to an adult, it's important that it be presented in an informational way, not as a guessing game. Many times I've seen a person hand a tactile diagram to someone and say `can you tell what this is?' You have to keep in mind that a diagram done by a Braille printer, 11 by 11 inch size, whether a diagram of a cat, or a diagram of the Empire State building is going to occupy roughly the same amount of space on that paper. So, the person approaching that picture tactilely doesn't have a clue about the frame of reference. So it's rarely productive to say `can you tell what this is?' It makes so much more sense to say, `This is a diagram of a church. You'll see the pointed steeple at the top' or one little bit of information to give the person a starting point to get some meaning from that picture."

Using a Computer to Supply Hidden Information

The concept of using computers to facilitate access to 2D information by blind people was pioneered by Dr. Donald Parkes, University of Newcastle, Australia, with the Nomad tablet. The Nomad is a touch-sensitive digitizing pad with a built-in voice synthesizer. It is attached to a computer through a standard serial port connection. A tactile picture is mounted on the Nomad pad, and information about various portions of the picture is contained in an electronic file in the computer. A user presses on some part of the picture, and information about that region is sent from the computer to be spoken by the speech synthesizer on the Nomad.

The Nomad is currently being sold in the US by the American Printing House for the Blind. They also sell Nomad pictures with the accompanying computer files that they have made to illustrate several subjects studied by blind children. Users can prepare their own pictures by any method and program in the information using software tools supplied with the Nomad. Anybody, sighted or blind, who can use a computer can prepare these computer maps.

Dr. Parkes has recently introduced two new computer programs that greatly extend the usefulness of the digitizing pad. AudioCAD is a computer graphics design program usable by both blind and sighted users. Blind users can design some things using voice and other audio information, but AudioCAD is most useful when used with the Nomad or other digitizing pads. The initial version of AudioCAD supports the Nomad and the Edmark TouchWindow. The TouchWindow is available from commercial computer hardware vendors and dealers who sell AudioCAD.

The second new program from Dr. Parkes is AudioPIX. This program allows blind or sighted users to construct computer files identifying various objects on tactile pictures mounted on either the Nomad or other supported digitizing pads. AudioCAD and AudioPIX are sold by Repro-Tronics and its dealers.

THE SCIENCE ACCESS PROJECT RESEARCH PROGRAM

The Science Access Project [8] was formed in 1995 under sponsorship of the National Science Foundation. Its goal is to enhance the ability of people with print disabilities to read, write, and manipulate information. In particular this project concentrates on information that has traditionally been difficult for people with severe print disabilities. This includes math equations, information normally presented in tables and graphs, and information presented in diagrams and figures that is often nearly impossible to describe in words.

The Science Access Project is developing several methods and computer programs. Those most directly concerned with tactile graphics are discussed briefly in this section.

Dotsplus

Dotsplus [9] is a method of presenting tactile information for blind readers with the same spatial formatting used for printed materials. It was developed largely for presentation of mathematical equations and scientific symbols used in text. It represents letters, numbers, and a few other symbols by braille dot patterns, but many symbols are represented by enlarged raised images of the ink-print symbol.

Dotsplus output is produced by making tactile copies of graphic computer files produced by a number of standard graphics programs, word processors, and page setting compilers. Authoring tools for producing Dotsplus are being developed and will be released by the Science Access Project when completed.

Any computer file that permits a global font change can be reproduced in Dotsplus with minimal editing. The Science Access Project and other organizations such as ICADD [10] (International Committee on Accessible Document Design) are promoting adoption of publishing standards to ensure that literature in the future will be available in electronic formats from which Dotsplus as well as other accessible document formats can be generated easily.

Dotsplus materials can be produced in bulk quantities by bulk graphic production methods described above. Swell paper is presently the only straightforward means of making single copy Dotsplus printouts.

Improving Computer Usability for Science, Engineering, and Math

The Science Access Project promotes computer programs that are accessible by multiple modalities. To date one product has been completed. This is an addition to the SCREEN [11] utility program that provides braille access to Unix applications that can be run in text mode.

The next product will be the TRIANGLE [8,12] program. TRIANGLE runs under the DOS operating system and is as trimodal (accessible visually, orally, or through braille) as possible with present technology. It is intended to be a tool for reading, writing, and manipulating information, including mathematical equations, complicated tables, and various kinds of graphs, diagrams, and tables.

A graphing calculator is part of TRIANGLE and its output can be "viewed" on the computer screen. It can also be heard as a tone graph, or felt by a moving braille icon as the x coordinate is varied. The graph may also be printed on a braille printer.

Flow diagrams, computer tree diagrams, and a number of other types of information typically presented graphically for sighted readers have been translated into "braille diagrams" that blind students have found fairly understandable. Some of the simpler diagrams of this kind can often be read using a refreshable braille display even though these displays show only one line at a time. TRIANGLE provides a braille reader for such braille diagrams.

Many such diagrams and most other graphical information is more easily understood if available as a tactile picture that can be viewed on a digitizing pad so that the computer can supply additional information. TRIANGLE includes this capability.

A number of translator programs will be made available in order to make TRIANGLE as useful as possible. At a minimum these will include programs to translate LaTeX, MS Word, and WordPerfect files into the GS [13] notation used by TRIANGLE, translation of standard spreadsheet files to the GS table form, and translations of the computer map files generated for figures by the Nomad and AudioPIX software.

Firms, Organizations, and Products

This section provides names, addresses, and contact information for a number of major US firms, organizations, and a few dealers for non-US firms manufacturing or selling products related to tactile graphics. The list is certainly not complete, and the author will be happy to include others in later versions of this paper if so requested. The product list is representative, not exhaustive. Contact the firm for dealer lists.

The state Commissions for the Blind also provide a good resource. Many sell products for the blind and maintain lists of local firms serving the blind. They can also provide local contact information for blind advocacy organizations. The Commission for the Blind usually has offices in the state capital and/or the major cities of the state.

American Foundation for the Blind
Product Center
3342 Melrose Ave.
Roanoke, VA 24017
tel: 800 829 0500
FAX: 703 345 6546

AFB sells a variety of items for the blind including the raised line drawing pad kit.

American Printing House for the Blind
PO Box 6085
Louisville, KY 40206
tel: 800 223 1839

Kit for making molds for tactile graphics: $228.75.
11 x 11 inch aluminum sheets for molds: 30 sheets for $17.65.
Aluminum rolls 150 feet by 11 inches: $57.15.
Starter Graphics kit: $24.95.

Nomad Tablet with standard speech synthesizer:
$1142.95 for educational institutions, $1505.95 for other customers.
Nomad Tablet with Keynote Gold Synthesizer:
$1644.95 for educational institutions, $2205.95 for other customers.

American Thermoform Corporation
2311 Travers Ave.
Commerce, CA 90040 tel: 213 723 9021

Regular duplicator, 8.5 x 11 or 11 x 11 inches: $2250. Large frame duplicator, 13 and 7/8 x 18 and 5/8 inches: $2800. Regular weight Braillon 11 x 11 inch size: 500 sheets for $45. Heavy weight Braillon 13 and 7/8 x 18 and 5/8 inch size: 100 sheets for $45. These are the extremes. Other Braillon sizes and weights and various special supplies used for labels, etc. are also stocked.

Blazie Engineering
109 East Jarrettsville Road
Forest Hill, MD 21050
tel: 410 893 9333
BBS: 410 893 8944

This firm manufactures and sells many products related to braille and tactile graphics including the Graph-it program (cost $49) that runs on their Braille Lite note taker. A PC version is also available.

Braille Institute
741 N Vermont
Los Angeles, CA 90029
tel: 213 663 1111

The Braille Institute runs a printing operation that can produce bulk tactile graphics relatively inexpensively.

Braille Jymico
110, 51st street East
Charlesbourg, Quebec
Canada G1H 2J9
tel: 418 624 2105

This firm offers design and production services for high resolution tactile graphic materials.

Duxbury, Inc.
435 King St.
P.O. Box 1504
Littleton, MA 01460
tel: 508 486 9766

PC Braille fonts, both TTF and ATM, for Windows $99 Macintosh braille fonts $99.

Hy-tech Forming Systems, Inc.
2329 West Mescal #303
Pheonix, AZ 85029
tel: 602 944 1526r FAX: 602 371 8503

Mr. Greg Nelson, Vice President for Marketing, may be contacted for information on possible uses

of the company's forming systems for producing tactile graphics.

Howe Press
Perkins School for the Blind
175 N. Beacon Street
Watertown, MA 02172
tel: 617 924 3490

Small tracing wheel $15.75.
Drawing compass with wheel on end $28.75.
Freehand drawing stylus (bigger than a braille dot) $18.75.
Raised line drawing pad kit including compass, protractor, square, 12 in ruler, drawing tool, and 100 sheets of mylar $118.

HowTek, Inc.
Hudson, NH
tel: 603 882 5200

This company sold the Pixelmaster wax-jet color printer in the early 1990's. A modified version, called the Braillemaster, was capable of producing images with a thickness of approximately 0.01 inches. The product is no longer available, but the company supports it with supplies until they are exhausted.

JP Trading, Inc.
US representative for Matsumoto Kosan Corp
300 Industrial Way
Brisbane, CA 94005
tel: 415 468 0775

A4 (8.25 x 11.5 inches) swell paper: 200 sheets for $220. B4 (10 x 11.5 inches) swell paper: 200 sheets for $280. Stereocopier: $6700.

Kansys, Inc.
P.O. Box 1070
Lawrence, KS 66044-8070
tel: 913 843 0351

This company sells a variety of modest cost software products. Several freeware or shareware programs and a free demonstration copy of their LowRez program for printing graphics on braille printers are available over the internet. People with ftp access to the internet can follow the KanSys prescription explained in a recent press release:

Our freeware and demos will be available from now on from the FTP site maintained by Phil Scovill on ftp.crl.com.

Type ftp ftp.crl.com and at the first prompt, type the word anonymous and press enter. At the second prompt, type in your complete email address and press enter. You will then be in the crl system. Change directories by typing cd /ftp/users/ph/phil/kansys and press enter. The Kansys welcome screen will pop up and list all available files for download.

LS&S Group, Inc.
P.O. Box 673
Northbrook, IL 60065
tel: 800 468 4789
TTY: 800 317 8544
FAX: 847 498 1482

e-mail: LSSGRP@aol.com
This firm carries a general line of supplies for the blind including the raised line drawing pad kit and a few other items related to tactile graphics.

Repro-Tronics, Inc.
75 Carter Ave.
Westwood, NJ 07675
tel: 800 948 8453, 201 722 1880r FAX: 201 722 1881

Tactile Image Enhancer, used for processing swell paper: $895.
Thermo Pen, for writing directly on swell paper: $195.
8.5 x 11 inch "Flexi-paper" swell paper: 100 sheets for $98.
A4 "Flexi-Paper" swell paper: 100 sheets for $100.
Other sizes available on request.
Bumpy Pictures (AudioCAD and AudioPIX) software $425.
Bumpy Pictures with Edmark TouchWindow $625.

Telesensory Products, Inc.
455 N. Bernardo Ave.
Mountain View, CA 94043
tel: 800 227 8418
FAX: 415 691 0637

Computer programs for printing computer graphics files on the TSI Versaprint printers available free by modem from the TSI BBS using a standard computer communication program. BBS phone numbers are 415 335 1819 and 415 335 1820.

ACKNOWLEDGMENTS

The author is grateful to Ms. Jane Corcoran for explaining details of hand-preparation of variable-height tactile graphic materials. This paper was prepared with partial support by the National Science Foundation.

REFERENCES

[1] Prof. Judith Tamburlin and Prof. Charles Severin, Departments of Clinical Laboratory Science & Anatomy and Cell Biology, State University of New York at Buffalo, 310A Sherman Hall, Buffalo, New York, 14214. 716-898-5196, 829-2912.

[2] Contact Dr. John D. Brule, jdbrule@cat.syr.edu, Professor Emeritus of Electrical and Computer Engineering, 121 Link Hall, Syracuse University, Syracuse, NY 13244, for information about his use of computerized milling machines for producing molds.

[3] Contact Prof. Karen Luxton-Gourgey, Baruch College, Computer Center for the Visually Impaired. Office: 212 447 3070, for information about her use of computerized milling machines for producing molds.

[4] Contact Prof. Guangming Zhang, Department of Mechanical Engineering, University of Maryland, College Park, MD. tel: 301 405-3565, FAX: 301 314-9920, e-mail: zhang@isr.umd.edu, for information about his use of computerized milling machines and stereolithography to make molds.

[5] Tactile Vision, Inc, 2375 Saugeen Rd, Oakville, Ontario

CANADA L6H5X9, tel: 905 257 1582, e-mail: eanczur@pathcom.com.

[6] Contact Dr. Marie Knowlton, Department of Educational Psychology, University of Minnesota, 214 Burton Hall, 178 Pillsbury Drive, S.E.Minneapolis, MN 55455 (612) 626-1859. e-mail address: knowl001@maroon.tc.umn.edu. For a handling charge of $3.50 she will send a version of the MacIntosh MacPaint program that includes braille letters. This program can produce graphics to be reproduced on swell paper.

[7] Excerpt from an oral presentation at the Symposium on High-Resolution Tactile Graphics, held as part of the CSUN International Conference on Technology and Persons with Disabilities, March 15, 1994. Proceedings of this symposium are available by ftp from TRACE.WISC.EDU as paper 10%5fmagar.txt in the /pub/txt/tactile directory. These papers are also available on the world wide web at http://www.trace.wisc.edu.

[8] For up-to-date information about the Science Access Project, see the world wide web site URL http://dots.physics.orst.edu.

[9] "Dotsplus - better than braille?", John A. Gardner, published in Proceedings of the 1993 International Conference on Technology and Persons with Disabilities, Los Angeles, CA, March, 1993. Also see discussion on WWW at http://dots.physics.orst.edu

[10] For information on the International Committee on Accessible Document Design, contact Michael G. Paciello, 131 D.W. Highway #618, Nashua, NH. 03060, Phone: (603) 598-9544, Email: mpaciello@webable.com.

[11] For up-to-date information about the Science Access Project's add-on to SCREEN, see the world wide web site URL http://dots.physics.orst.edu.

[12] "Scientific Reading and Writing by Blind People - Technologies of the Future", Hadi Bargi-Rangin, William A. Barry, John A. Gardner, Randy Lundquist, Mark Preddy, and Norberto Salinas, published in Proceedings of the 1996 International Conference on Technology and Persons with Disabilities, sponsored by California State University Northridge, March 19, 1996, Los Angeles. Can be found on WWW at http://dots.physics.orst.edu or http://www.isc.rit.edu/~easi/easisem/gardnerj.html.

[13] The GS notation is a compact linear representation for math equivalent to that used in the TeX languages. This notation has a one to one correlation with the GS dual 6/8-dot braille code developed by the author and Norberto Salinas, Prof. of Mathematics, University of Kansas. For a discussion of GS and its relationship to the uniform braille code development by the International Committee on English Braille, see the WWW site http://dots.physics.orst.edu.

Return to itdv03n4 Contents Page

Return to Journal Volumes Page

(ITDV03N4 ROBBINS)

COMPUTER TECHNOLOGY EDUCATION AND THE DEAF STUDENT: OBSERVATIONS OF SERIOUS NUANCES OF COMMUNICATION

Curtis Robbins, Ph.D. crobbins@erols.com

INTRODUCTION

The purpose of this paper is to raise a very peculiar topic of concern. As a deaf student taking computer courses to earn certificates as a multimedia specialist and a network administrator at two different colleges in the state of Maryland, I have experienced recurrent problems in different computer classes. I have found that no studies or projects have ever been conducted to find ways of serving deaf students like myself who are taking computer courses in regular colleges and universities.

A review of the education literature revealed only one study relevant to the issue I'm discussing here. This 1987 report, which focused on high school math teacher training (American Association of State Colleges and Universities, 1987), does not address the issue of how computer courses can be taught to deaf students in college or university settings.

For over thirteen years I have taught computer courses at Gallaudet University, an institution of higher education serving a very specific group -- deaf students. Additionally, I have taught non-technical courses and counseled at the National Technical Institute for the Deaf for two years.

These institutions of higher education were established to serve a target population of deaf students with all the technology and communication skills among the staff and faculty being geared to that purpose. Furthermore, these schools have budgets to serve these students, who get considerable technical support from staff and faculty who have sign language skills. This paper is not about specialized schools, but rather the many more "regular" schools whose programs and resources might be made more accessible to deaf learners.

This paper is about my observations as a deaf computer student who attended hearing institutions of higher education at which the budgets for services to disabled students are very limited (and in the case of the deaf student this means funding sign language interpreters). Significantly, most of the staff and faculty at these institutions have little or no understanding of the needs of deaf students.

As a former educational technology professor I sought to improve my employability by adapting my skills and knowledge of computing to the current job market. I've taken courses and seminars at several institutions of higher education. As a deaf individual, I consider myself an excellent lipreader with very understandable speech, but in any classroom setting I strongly prefer having an interpreter present in order to be able to participate in class discussions. On the other hand, on a one-on-one basis, I am able to carry a relatively decent conversation without hesitating to ask the other party to repeat if I don't understand -- reminding other speakers to speak slowly and keep things away from lips.

THE CLASSROOM

At all computer courses I've taken, practically every classroom contained a cluster of networked computers lined up on rows of tables facing the front of the room. All were unintentionally set up with poor visibility (after all, these schools were not designed for deaf students). I've had difficulty trying to follow instructors' demonstrative, illustrative, or graphic gesturing, whether by hand, on hand, or on the blackboard, an overhead projector, or a large monitor -- they were, above all, visual obstacle courses for me in following the instructor. And of course, as crowded as most computer labs/classrooms are, lipreading or watching interpreters under such conditions was just as preposterous.

These classrooms typically contain workstations with bulky monitors and high miditower computers, with little or no room to set the notebooks down. Catching even a glimpse of the instructor is a strain.

And the interpreters! They come with all levels of sign language skills and from almost every walk of life, but with little, or some, or no prior knowledge or skills in computer technology. We, the interpreters and I, would come to class early in order to discuss my needs with the instructor. This often included checking for buzzwords that would be used in the lectures and developing some "homemade" signs to help minimize fingerspelling. We also discussed how the interpreters should assist me in case the instructor had to make a point or two while I was working on a class exercise. Finally, we identified computer jargon and developed the special signs to replace fingerspelling. As strange as it may seem, many of these interpreters have interpreted in computer classes for other deaf students but few of them were able to make headway in those classes- -- and still further, they could not figure why some convenient signs differ in meaning from student to student -- though other signs were similar or the same.

More often than not, the instructors were unprepared, disorganized, and haphazard. In many cases, textbooks were inappropriate because of the lack of lab assignments. In most cases, there were no textbooks or handouts. In every case, the instructor created exercises at the spur of the moment. And in every situation, I felt like I was in a computer triathlon, constantly figuring out what's going on, constantly trying to remember the details of the lecture, and persistently hoping to finish every exercise. If that sounds bad, my fellow classmates told me during class breaks that most had hardly any time to write notes. Fairly often I approached the instructors, before, during and after class, asking for written instructions on exercises so I could keep up with the class. For the most part, they did let me have them -- and graciously so! Still such previous inquiries were -- frequently -- moot because the instructors came up with other exotic ideas for the exercises.

The significant point here is that in all my classes and seminars, most if not all of the hearing students continued to tinker at the keyboard while the instructor kept lecturing or explaining the concepts. All the while, I was sitting still, watching the interpreter until the instructor finished lecturing. Thus, I would fall behind and frantically try to catch up before the next exercise. Sometimes, I've beaten the odds and completed the exercises, but other times I've been unable to. Tough luck, I dare say.

And while I was doing those exercises, the interpreters frequently stopped me in order to convey to me the points that the instructor was making. This was part of the agreement the interpreters and I made before classes started. It was the only way to keep up with the rest of the class during these activities. There was no way for me to keep an eye on the instructor or interpreter while attempting to complete the various exercises and focusing on the monitor. Insofar as I succeeded, the exercises were done spasmodically. I succeeded? You might ask indeed. Yes, because I was able to absorb the information and make every attempt to complete the various exercises either at home on my own computer or at the computer lab, at least an hour before classes started. Sometimes the instructor would be there at about the same time and spend some time with me to finish up the exercises by giving me the details that I either forgot due to my haste, or the interpreters, through no fault of their own, missed out. Most of the time, I was on my own.

I almost always managed to grasp everything that the different computer courses were designed to teach. I met just about every goal and objective of these courses except a few that I could never complete due to the time frame. Not every project was done with diligence and clearheadedness on my part; the satisfaction of completing the activities was all that mattered. It was a struggle -- a tortuous and frustrating experience, to say the least. For the interpreters, it was the anxiety of knowing whether or not they had done the job. It goes without saying that they have, but the concern is whether they have the right technique. Theirs always has been a frustrating and laborious task. We were constantly perplexed as to how the situation could be remedied.

Also, before a class started, I would ask a willing classmate to take copious notes on the lectures, and give him/her carbon paper with a writing pad. Hopefully, s/he would give me enough information to get by. If not, then I'd spend more time looking over the texts to find the missing information. Often, instructors tended to give lectures without any notes. Sometimes what was said was not found in any book. Often, I found that other students did not wish to share their notes with me, for whatever reasons. What I got from the notetaker was all I would get.

THE COMPUTER LAB

In most cases, computer courses require lab time. The lab is a place where theories and concepts are put to work through practice assignments. None of the computer lectures gives textual recipes for easy solutions. It's all entirely left to the student to explore. Critical thinking, critical analysis, algorithmic and logical reasoning, and self-actualization are expected of him by putting to test the newly acquired and untested knowledge through experimentation in the lab -- without the presence of an interpreter, a notetaker, or the professor. Students tend to discuss and exchange probabilities or possibilities while working on the lab exercises. In every lab, I noticed that many students were anxious to complete the lab assignments as quickly as possible. Sometimes, they would come in the lab on a "buddy system;" then it would become very difficult for me to join with them. The conversations they carried on between keystrokes were usually very rapid, thus, making it very difficult for me to follow. Whenever I asked a question or made a comment, it was usually difficult to comprehend what they were saying no matter how many times they repeated it. As much as they were trying to be helpful, my efforts to understand them were generally fruitless. Sometimes, they were aware of my communication situation, but they really did not want to be bothered -- quite obviously. Again, I had to be on my own.

This reminds me of an experience I had while working as a computer programmer in a Federal agency many years ago. I was doing a subprogram in COBOL and JCL on an IBM 3033 system. This program calls for a specific database file that would print out certain information in a very peculiar way. It turned out that the program did not produce the desired information. After carefully reviewing my work for a few days, I found that all the pertinent information required for the final output was correct. There was nothing wrong with the program itself. File tape numbers were correct. Input and output file names were correct. A file dump was done on an input file, and there wasn't anything wrong with it. The computer analyst I was working with took the program and studied it herself. After several days, she returned it, baffled. Other analysts overheard our conversations and came to assist, but I'm guessing that she called them over. Once they started conversing, I was left out because I couldn't follow. Lipreading at this point became a worthless task because too many people were talking at once, and often they talked with the printouts practically covering their faces, or their heads were looking down on the paper. After a number of weeks went by, my immediate analyst returned saying everything was fine and that I didn't need to worry about it anymore. No statement of the solution was given. Nor were there any reasons for the problems given. I asked for an explanation but she dismissed me, saying she was busy and would get back to me another time (and never did). Perhaps, for her it might be too much of a problem to explain it all to me. However, the interesting part was that my colleagues in the unit knew what the problem was. They hesitantly told me what it was. Why wasn't I told directly? After all, wasn't it my work?

>From that day on, I vowed never to be a computer programmer again. It happened too often with other analysts in the other jobs I've had. And so, whether at school or at work, this communication problem was undoubtedly prevalent -- a hopeless paradox, or so it seemed.

THE INSTRUCTOR

As a child, I was taught to always ask the teacher to let me copy his/her class notes or get extra help in order to understand what s/he taught. Such a good habit didn't always work after leaving high school because not every instructor came in with prepared lecture notes or took the time to serve the students. There is an old adage: A terrific artist does not always make the best teacher -- and vice versa.

Most computer professors -- in my professional and professorial judgment -- have very little understanding of the intrinsic concerns of their students. Theirs is a propensity to lecture, answer questions about the course or class, and depart -- leaving students in the limbo of a plethora of confusing statements of theories and concepts, lost logical frameworks, or simply with an odd mnemonic string left hanging over the cranial edge. Students often can't get a word in edgewise with the instructor. The double stigma prevails for me, though. Not that I'm one of the students who got the same treatment as the others in class, but that the anxiety for clarity is in want of simple answers. What if what I grasp is misconstrued or misconceived? How am I to know? Is it the fault of the interpreter for missing a point or two during transition from spoken word to sign language? Is it the fault of the notetaker for nodding while meticulously detailing every theory and concept in writing espoused by the speaker? They are not human tape recorders. Or maybe it was me falling asleep or getting lost in the middle of words or thoughts -- mine or the speakers? Mine eyes have only seen some glory every now and then! But the benefit of the doubt lingers -- and the professor is nowhere to be found.

I've met instructors who tend to think that because of the presence of the interpreter, I'm not able to carry out a conversation with him/her. Nor do some of them want to take the time to clarify to me some misconceptions again and again. Then again, like with the computer analyst, to them it might be too much of a bother to explain things to me without the interpreter present -- no matter how many times I've told them I could lipread if they would just spend a few moments of their time.

Yet, I've had a few good instructors who have provided excellent handouts that were helpful in following their lectures. They were also available to answer questions or discuss concerns. They, too, made efforts to communicate with me. But, they were only a few.

(

UN)SOLVABLE QUESTIONS

If a deaf student does not have previous computer knowledge or skills, would s/he have succeeded in those classes? Would s/he have the stamina to follow through the lectures and computer activities with computer lingo flowing through the lectures? Suppose the student did, would s/he know how to approach the interpreter to deal with the class activities, or the appropriate computer signs, which can be very nerve-wracking and extremely frustrating for the want of support -- moral or otherwise? Could the interpreters be the resources for helping the student succeed in computer classes or seminars without overstepping their roles? So, what is the interpreter to do?

Suppose this deaf student can't lipread. Should s/he take the initiative and ask his/her classmates for assistance - especially in the lab? Could s/he find a friend in that class and go in a "buddy system" and do the lab exercises together? I empathize with academic advisors and counselors in many Offices of Disabled Student Services who can't find or don't have resources to deal with such problems. And I, too, empathize, if not sympathize, with those deaf students who have had to struggle as hard as they can to succeed in computer classes. They're still out there trying, without the help they're entitled to get.

When there are trying times, there must be solutions somewhere.

REFERENCE

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Return to itdv03n4 Contents Page

Return to Journal Volumes Page

JOB ACCOMMODATIONS

EDITED BY JOSEPH J. LAZZARO LAZZARO@WORLD.STD.COM

Access to Windows and Windows 95 continues to be at the forefront of vocational rehabilitation for the blind and visually impaired. The disability community has long been aware of the problems that the graphical user interface has presented for computer users with limited vision. In order to solve the accessibility problem, MicroSoft has created Active Accessibility, a series of hooks that will enable adaptive hardware and software to more easily communicate with the Windows 95 operating system. Active Accessibility holds the promise of increased reliability, stability, and increased efficiency in general. It should be noted that several screen reader developers have indicated publicly and privately that they will be supporting Active Accessibility in their screen reader software programs. MicroSoft has also incorporated many of the features from their older Windows Access Pack, and have made them part of the default Windows 95 installation. It should be noted with pride that many of the utilities now available in Windows 3.1, 95, Macintosh, and Unix began life at the Trace Research & Development Center in Madison Wisconsin. Funded by NIDRR, the Trace Center is responsible for increasing access across the board, although it is not widely known. With all this in mind, we bring you two articles that were previously published in Byte Magazine. The first article describes the basic accessibility features that are currently built into Windows 95. The second article appeared in the December 1996 issue, and describes two accessible web browsers -- MicroSoft Internet Explorer, and Productivity Works PWWebSpeak. Internet Explorer is the first MicroSoft product to have Active Accessibility hooks built-in, and works with Windows 95 based screen readers. PWWebSpeak is a talking internet browser that provides both speech and enlarged video output.

Joseph J. Lazzaro

If you run an office staffed with more than 15 employees, you must comply with the Americans with Disabilities Act. This may require that you provide adaptive hardware and software on office workers' computers. Such equipment enables workers with disabilities to accomplish many tasks independently. For example, if you are blind, it can transform on-screen text to synthesized speech or braille. If you can't hear, adaptive hardware transforms a computer's audible cues into a visual format. So far, adaptive technology has consisted of third-party add-ons to OSes, with the exception of the Mac. This has resulted in adaptive equipment that only sometimes works. Fortunately, because of lobbying by the disabled community, OS vendors have begun to embed adaptive-access features directly into their OSes. This makes such features widely available right out of the box, more reliable, and a lot less expensive. Microsoft began to build a suite of disability-access features starting with Windows 3.x. Win 95 offers access to a built-in set of utilities that accommodate users with hearing, motor, and some visual disabilities. Furthermore, the Win 95 Help system includes information on these built-in accessibility features. The control and configuration of most of these features are centralized in an Accessibility Options Control Panel, as shown in the screen. This Control Panel lets you activate or deactivate specific access features and customize timings and feedback for certain utilities. It also lets you set hot keys so that you can activate these features quickly.

Keyboard and Mouse

Using a keyboard requires a significant amount of hand dexterity, particularly when using the modifier keys, such as Shift, Control, and Alt. For persons unable to use a standard keyboard or mouse easily -- if at all -- several Win 95 utilities can help by altering the keyboard's behavior. You can configure these utilities in a pane on the Accessibility Options Control Panel. The StickyKeys utility, for instance, helps you type capital letters or manage complex key sequences, like Control-Alt-Delete, that require the use of both hands. StickyKeys lets you press one key at a time in a sequence instead of pressing multiple keys simultaneously. Another powerful utility, FilterKeys, helps users who accidentally strike keys by filtering out those keystrokes that do not fall under a user-definable time duration. In other words, for a key press to become a valid keystroke, it must be held down long enough to register. Any keystrokes that don't last for the specified duration are discarded. ToggleKeys is a utility that provides audio feedback for certain keystrokes. This is a useful tool for computer users who are unable to determine the status of the keyboard's modifier keys by using any other method. The ToggleKeys utility provides both high- and low-pitched beeps that indicate the current status of the Caps Lock, Num Lock, and Scroll Lock keys. Driving a mouse demands strong hand/eye coordination and good hand/arm agility. It's a prerequisite for using the GUIs on many of today's desktop computers. MouseKeys assists users who have difficulty pointing the rodent. The program lets you use the arrow keys on the keyboard's numeric keypad to move the mouse pointer around the screen and emulate mouse actions, such as clicking, double-clicking, dragging, and dropping. Holding down the Control key accelerates pointer movement, while holding down the Shift key propels the pointer a pixel at a time, offering fine-grained control.

Video and Sound

For persons who have difficulty seeing images on a standard computer screen, Win 95 offers several features that make the monitor easier to see. Some of these features are simply a matter of adjusting certain Control Panel settings. For example, if you are visually impaired, you can use the Display Panel to scale the size of various user-interface elements, such as window titles, scroll bars, borders, menu text, and icons. The Mouse Control Panel allows you to adjust the mouse pointer's characteristics. You can select from among several sizes (small, medium, and large), which is valuable for users with limited vision or learning disabilities. You can also adjust the pointer's color and apply animation effects to increase its recognition factor and visibility. For users with limited vision, color plays an important role in their ability to read comfortably -- or at all. Again, Win 95's built-in customization features enable you to modify the color scheme of the environment. You can select a high-contrast mode or choose from several ready-made appearance schemes that make it easier for users with limited vision to focus on the screen. The Accessibility Options Control Panel allows you to set a global flag that instructs your applications to employ the high-contrast color scheme, as shown in the screen. It also enables you to avoid schemes that are difficult to see, such as text that's displayed over pictures. For users who are deaf or hearing-impaired, Microsoft has implemented several useful features into Win 95 that increase access to the computer and its data. This is of vital importance as many applications begin to use text-to-speech or audio playback. Win 95's SoundSentry lets you have sounds presented in an alternative format, such as visually or through text captions. ShowSounds lets you set a global flag that displays sounds in a visual format. This can be accomplished by several methods, depending on your preference. For instance, you can have the active window flash every time a sound is generated or display text captions that represent the sounds.

Third-Party Speech-Access Products

Despite all these improvements, Win 95 still lacks critical support for users who are totally blind and must rely on speech-synthesis systems to read the information on a computer screen. Microsoft plans to implement an off-screen model that captures on-screen information so that special-purpose software can perform a text-to-speech conversion on it or drive a braille-output device. Unfortunately, the hooks to this mechanism might still be unavailable when this article sees print. This sorry state of affairs presents an opportunity for third-party access technology, chief among them speech- and braille-output packages designed to read the screen.

(Readers Note: Since the publication of this article, Active Accessibility has shipped to independent software developers, and several developers have publicly and privately stated support for Active Accessibility. the proof of the pudding now lays in the hands of the independent software developers and Microsoft as Active Accessibility continues to evolve.)

The Automatic Screen Access program for Windows (ASAW), from MicroTalk, is one of the latest Win 95 screen readers to enter the market. ASAW works with Win 3.x and Win 95 applications. Biolink's ProTalk32 is a screen reader for Win 95. A Win 3.x and NT version is also available. Winvision, from Artic Technologies, runs on both Win 3.x and 95 and supports several commercially available speech synthesizers. Winvision also drives braille displays, providing a tactile representation of Windows screens. Syntha-Voice's Window Bridge, which runs under Win 3.x, Win 95, and DOS, was the first

Windows-based screen reader to enter the adaptive market. Computers play a major role in our society; they're used at home, at school, and on the job. It only makes sense for OSes to provide adaptive-access features. This makes the computer accessible to everyone, no matter what their abilities, so they can make a contribution in the workplace. Microsoft has done a commendable job so far with much-needed improvements to Win 95. But the company still has a lot of work to do if Windows is going to provide OS-level support for blind computer users.

Where to Find:

Arctic Technologies Troy, MI Phone: (810) 588-7370 Fax: (810) 588-2650

Biolink North Vancouver, British Columbia, Canada Phone: (604) 984-4099 Fax: (604) 985-8493 Internet: http://biz.bct6l.net/biolink

MicroTalk Texarkana, TX Phone: (903) 792-2570 Fax: (903) 792-5140 Internet: http://www.screenaccess.com

Syntha-Voice Stoney Creek, Ontario, Canada Phone: (905) 662-0565 Internet: http://www.synthavoice.on.ca/~davidk

BROWSE THE WEB WITH YOUR EYES CLOSED

Surfing the Internet's World Wide Web can be extra challenging if you can't see the screen. For thousands of blind or visually impaired computer users, the Web is accessed using speech, braille, or screen-enlargement hardware/software. If you have a PC and a visual disability, it is possible for you to access the Web, but most Web sites won't work well with your adaptive equipment.

Webmasters who don't add descriptive tags to elements in their pages make it more difficult for adaptive programs to describe to a blind user what's on the screen. But the good news is that awareness about adaptive technology is increasing in the computer industry. Microsoft is leading an ambitious effort to make adaptive technology more mainstream, and Netscape is investigating ways to make its software better support accessibility products. Microsoft's Active Accessibility program will make future versions of Windows and its applications more accessible to users with vision impairments. Software developers can use the Accessibility SDK, slated to ship in November, to write adaptive programs that run on top of Windows.

The flagship Active Accessibility product is Microsoft Internet Explorer (MSIE) Version 3.0, which has hooks to enable screen- reader software used by the blind community. MSIE works more effectively with synthesizers, braille displays, large print programs, and other assistive technology.

The Productivity Works (609-984-8044 or info@prodworks.com) wrote its Web browser for the blind from scratch. PWWebSpeak has its own built-in speech processor, and does not require a separate screen reader program. PWWebSpeak parses a Web page's HTML code to present the information in a more speech-friendly manner. You can browse through pages by word, sentence, paragraph, or link units. The program also presents the Web page in enlarged format at the same time. PWWebSpeak can drive a wide variety of speech synthesizers, including the SoundBlaster voice card.

With increasing awareness of adaptive technology among mainstream software developers, the future may loom a bit brighter for computer users with disabilities.

Joseph J. Lazzaro is the author of Adapting PCs for Disabilities (Addison-Wesley, 1996). He is also project director of the Adaptive Technology Program at the Massachusetts Commission for the Blind in Boston. You can reach him at lazzaro@world.std.com or at lazzaro@bix.com.

Return to itdv03n4 Contents Page

Return to Journal Volumes Page

ONLINE INFORMATION AND NETWORKING NEWS

Steve Noble
Recording for the Blind and Dyslexic
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ONLINE INFORMATION SYSTEMS

DIAL-JAN Bulletin Board

The President's Committee on Employment of People with Disabilities' Job Accommodation Network announces the re-opening of its electronic bulletin board DIAL-JAN. The Job Accommodation Network is a consulting and referral service providing information about accommodating people with disabilities. This online bulletin board can be accessed by dialing 1-800-DIAL-JAN (1-800-3425-526). The bulletin board will now be open from 10am to 10pm, Eastern time. If you have any questions, please call 1-800-526-7234 in the US or 1-800-526-2262 in Canada, or you may direct e-mail to jan@jan.icdi.wvu.edu.

PEOPLE WITH SPEECH DISABILITIES NOW HAVE A TELEPHONE SUPPORT SERVICE

If you are a Californian with a speech disability (but can hear) you can now use a new, free telephone assistance service 24 hours a day. This service, called Speech-to-Speech, provides human voicers for people who have difficulty being understood by the public on the telephone. You can dial 800-854-7784 to reach a trained operator who makes telephone calls for you and repeats your words exactly.

Users now make about 3,000 calls a month. Speech-to-Speech is also useful if you use a speech synthesizer. Speech-to-Speech is the only way for many people to telephone others not accustomed to their speech. Many Speech-to-Speech users are people with Parkinson's disease or cerebral palsy.

If you would like to use this free service, please make your first call by dialing 800-854-7784 and then asking the operator who answers to connect you to 916-927-3794. If enough people identify themselves as users, the California Public Utilities Commission will make Speech-to-Speech permanent. Callers from other states may also use Speech-to-Speech to connect to telephone numbers within California following the same procedure.

For further information on Speech-to-Speech, contact Bob Segalman or Cindy Gooch at 916-927-3787 V/TT; 916-649-1665 FAX; or Toll Free at 1-888-3SPEECH. You may also address email to: Bob.Segalman@deaftek.sprint.com

DISTANCE LEARNING OPPORTUNITY

George Brown College offers a home-study Certified Electronics Technician CD-ROM program and presently has many students with disabilities enrolled. The CD-ROM consists of 23 courses and a laboratory software simulation package called Electronics Workbench that allows students to complete over 400 laboratory projects at home, using a computer. Each course contains videos, animations, photographs, text, illustrations, and computer-based testing and evaluation. Students who complete the program will receive a Certificate as an Electronics Technician. To find out if this program can be adapted for your specific disability and computer access environment, as well as pricing and other information, please contact Dr. Colin Simpson, Director, Learning Innovations, George Brown College, Toronto, Canada. You may direct email enquiries to csimpson@gbrownc.on.ca

DISCUSSION LISTS

BASR-L

The Browser and Screen Reader Listserv, BASR-L, is a professional mailing list for the discussion of access to the World Wide Web for individuals who use screen readers. The main focus of this mailing list is to improve access for Web users who are blind.

To subscribe to the list, send email to listproc@trace.wisc.edu with a blank subject line and the following line in the body of the text:
subscribe basr-l

PLLD-L

The Public Libraries Learning Disabilities Initiative Listserv, PLLD-L, is an outgrowth of the American Library Association's project called Roads to Learning, and is intended to be a forum for people who want to learn more about learning disabilities and their implications for public library services and collections.

To subscribe to the list, send email to listproc@ala1.ala.org with a blank subject line and the following line in the body of the text:
subscribe plld-l

AFB

The American Foundation for the Blind, AFB, has established two new listservs. AFB's aging-vision listserv will be used to disseminate updates from AFB's National Aging and Vision Network, as well as legislative alerts, conference announcements, policy and program changes, and other related information. The other new listserv, brl-help, has been established to promote discussion about braille instruction in educational settings. To subscribe to either listserv, send an email message to majordomo@afb.org with a blank subject line and the following line in the body of the text: subscribe aging-vision or subscribe brl-help

SCiE

Students for Computers in Education, SCiE, is a new student group advocating the improvement of the education process through the use of computer technology. SCiE (pronounced 'sky') is still a small group, and still needs members to make it grow. SciE is working closely with several software developing initiatives to make computer based learning more popular. Students with disabilities are encouraged to join and add important input on computer access issues.

One particular project, the Personal Knowledge System (PKS), is being developed to become the standard in computer based learning. SCiE members can influence the development of this exciting project and will even have access to early software releases.

SCiE is currently running three mailing lists: SCiE-News -- The first mailing list is an announcement list. It is designed to keep all SCiE members informed of current developments, and software releases. It functions as an organization newsletter and no postings will be admitted to this list. The output of this list will probably not exceed one or two messages per week. If you decide to join SCiE it is recommended that you join at least this mailing list.

SCiE-PKS -- There is also a PKS discussion list. This list receives messages, and sends them to all members. This is the list for giving input, getting ideas, and some good old fashioned arguing. Contributing to this list is the way to share your ideas and influence the development of the PKS.

SciE-Gen -- This list is designed for other ideas on how the education process could be improved through computers. For this, there is a more general discussion list. This list is an open forum, on all ideas for computers in education.

To join a SCiE list:

Send an e-mail to listserv@listserv.readadp.com and in the body of the message put the following line:
sub
In place of use one of the following:
SCiE-News -- for the newsletter mailing list
SCiE-PKS -- for the PKS discussion group
SCiE-Gen -- for the open SCiE discussion group
In place of type in your first and last name.
For Example: sub SCiE-Gen Bill Clinton

To get more information about SCiE and the Personal Knowledge System, visit the SCiE homepage at: http://ww2.readadp.com/scie/

WORLD WIDE WEB

INDIE

The Integrated Network of Disability Information, INDIE, is designed to be a comprehensive one-stop resource for products, services, and information for the world-wide disability community. To connect to INDIE, use the following URL:

http://www.indie.ca

FCC Disabilities Task Force

The Federal Communications Commission's Disabilities Issues Task Force now operates a WWW site that contains information about telecommunications issues pertaining to persons with disabilities. To connect to their Web site, use the following URL:

http://www.fcc.gov/dtf/dtfhome.html

Return to itdv03n4 Contents Page

Return to Journal Volumes Page

*INTRODUCING _INFORMATION TECHNOLOGY AND DISABILITIES_*

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*_Information Technology and Disabilities_*

INTRODUCTION

Late last summer, several members of EASI (Equal Access to Software and Information), began discussing the possibility of creating an electronic journal devoted to applications of information technology by individuals with disabilities. EASI already had a number of information-disseminating activities underway, including two electronic discussion lists and a directory on the St. John's University gopher (see Zenhausern and Holtzman's article, this issue, _ITD_). In addition, EASI has a regular column in _Library Hi Tech Newsletter_, published by Pierian Press. With general guidance from Norman Coombs, EASI Chair, and technical support from Dick Banks, adaptive technologist at the University of Wisconsin, Stout, and Dr. Bob Zenhausern, professor of psychology at St. John's University, a core group of EASI members began "meeting" on a private listserv established to coordinate all aspects of this fledgling journal.

The first order of business was to select an editorial board, composed of experts in education, librarianship, campus computing, as well as rehabilitation and job accommodations for individuals with disabilities. Assembling the editorial board was easy enough; virtually everyone asked to participate accepted the invitation. Once the private listserv, EASIPUB, became operational, members of the editorial board were able to work out details through meetings held via e-mail. In this article, I will describe the goals of _Information Technology and Disabilities_, at various points asking for your participation and input for future issues; if _ITD_ is to achieve its goals, we need your help in the form of news items, notices of meetings and new or forthcoming publications, research-based and case study articles, as well as ideas for articles or theme-based issues.

The first issues addressed by the editorial board included title, frequency of publication, intended audience and scope of coverage. After considerable debate over several alternatives, _Information Technology and Disabilities_ was chosen as the title and work began on designing this international, multidisciplinary electronic journal. It was decided early on that the journal would appear quarterly, and that our target audience would include users of adaptive technology as well as the many service professionals who are interested in applying new and emerging technologies in their various fields; the latter group includes librarians, educators at all levels, rehabilitation professionals, campus computing and disabled students' service personnel, and others who wish to realize the potential of information sources and technologies by individuals with disabilities.

SCOPE OF COVERAGE

Each of the groups mentioned above, from librarians to academic computing staff, has at its disposal a number of professional journals providing timely information on a wide variety of topics in their field(s) of coverage. Scattered throughout this body of literature are the few items of interest to people who need to know what's happening in the world of adaptive technology, accessible information and other vital news of increasing importance to individuals with disabilities. _Information Technology and Disabilities_ intends to address issues relating to information technology in its broadest sense. While our focus is largely upon practical uses of technology by individuals with disabilities, _Information Technology and Disabilities_ will, in future issues, hopefully include historical, sociological, and legal analysis and commentary.

One of the issues we encountered early on, and which at this writing is still an issue on the editorial board's agenda, is the technical knowledge level we should expect the majority of our readers to have. While it is expected that most will have basic computer literacy, we do not expect that the majority have anywhere near the technical expertise of, say, a professional computer programmer. In response to our first call for articles, we received one highly technical paper which describes in detail a computer scientist's work in the area of access to machine- readable documents. That article is being revised, and has not gone through the process of review. The editorial board is leaning toward including such material in _Information Technology and Disabilities_. We are working with authors to make their work as accessible as possible, but there will be articles in _ITD_ which will be comprehensible only to a limited audience.

While some articles may be extremely technical, others will appeal largely to the novice. We will attempt to provide overviews of specific technologies, written in plain language and intended as information pieces for those whose experience is minimal. For example, "What is a TDD and How Does it Work?" might cover the history of telecommunications for the hearing impaired, describe the current state of the technology, and discuss ADA requirements. Whether highly technical, very basic, or somewhere in between, each of the feature articles in _Information Technology and Disabilities_ will be annotated in the Table of Contents, alerting readers to the article's level of technical sophistication.

DEPARTMENTS

In addition to articles, _Information Technology and Disabilities_ will have a number of regular "departments." These sections will present major news of interest, including notices of new discussion groups, publications, conferences, seminars, and more. Editors of these sections are identified in the table of contents; please keep them informed of news as you hear it (or as you make it!).

Anyone who subscribes to one or more listservs is aware of the meaning of the expression "information overload;" with each quarterly issue, it is our intention to present the MAJOR news of national importance. Think of _ITD_ as a quarterly, selective listing of news obtained from listservs, professional associations, and just as important if not more so, from _ITD_ readers themselves.

In closing, I would just like to say that _Information Technology and Disabilities_ will only be as good as the articles submitted to it for publication. Please, if you have work in progress, or if you're willing and able to do an article on a topic suggested by the editors, contact me, preferably via e- mail.

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Return to itdv01n1 Contents Page

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