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ABSTRACT

Four issues of this newsletter on information technology and disabilities (ITD) contain the following articles: "Building an Accessible CD-ROM Reference Station" (Rochelle Wyatt and Charles Hamilton); "Development of an Accessible User Interface for People Who Are Blind or Vision Impaired as Part of the Re-Computerisation of Royal Blind Society (Australia)" (Tim Noonan); "The Electronic Rehabilitation Resource Center at St. John's University (New York)" (Bob Zenhausern and Mike Holtzman); "The Clearinghouse on Computer Accommodation (COCA)" (Susan Brummel and Doug Wakefield); "ITD Technotes: Speech Synthesis" (Alistair D. N. Edwards); "Project Link: Consumer Information for Persons with Disabilities" (William C. Mann); "C-Note: A Computerized Notetaking System for Hearing Impaired Students in Mainstream Post-Secondary Education" (Andrew Cuddihy and others); "What's Next in Adaptive Technology: MagNum--A Digital Recording Personal Assistant" (Dick Banks); "Ten Years of Computer Use by Visually Impaired People in Hungary" (Terez Vaspori and Andras Arato); "Rehabilitation and Remediation in Educational Disability: The Use of the Direct Access Reading Technique" (Sheila Rosenberg and Robert Zenhausern); "ITD Technotes: Braille Displays" (Gerhard Weber); "Math and Science Symposium at Recording for the Blind" (Richard Jones); "AsTeR: Audio System for Technical Readings" (T. V. Raman); "A Graphical Calculus Course for Blind Students" (Albert A. Blank and others); "Ensuring Usability in Interface Design: A Workstation To Provide Usable Access to Mathematics for Visually Disabled Users" (Helen Cahill and John McCarthy); "Mathtalk: Usable Access to Mathematics" (Robert D. Stevens and Alistair D. N. Edwards); "The Use of Laser Stereolithography To Produce Three-Dimensional Tactile Molecular Models for Blind and Visually Impaired Scientists and Students" (William J. Skawinski and others); "Computer Based Science Assessment: Implications for Learning Disabled Students" (David D. Kumar); "Books for Blind Students: The Technological Requirements of Accessibility" (William A. Barry and others); and "Increasing the Representation of People with Disabilities in Science, Engineering and

Mathematics" (Sheryl Burgstahler). Individual issues also contain new items, reviews, and calls for papers. (DB)

Information Technology and Disabilities

1:1 (January 1994)

Copyright Statement

Articles

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Introducing *Information Technology and Disabilities*
Tom McNulty, Editor

Building an Accessible CD-ROM Reference Station
Rochelle Wyatt and Charles Hamilton

This case study describes the development of an accessible CD-ROM workstation at the Washington Library for the Blind and Physically Handicapped. Included are descriptions of hard

Abstract: ware and software, as well as selected CD-ROM reference sources. Information is provided on compatibility of individual CD-ROM products with adaptive technology hardware and software.

Development of an Accessible User Intervace for People Who are Blind or Vision Impaired as Part of the Re-Computerisation of Royal Blind Society (Australia)
Tim Noonan

Abstract: In 1991, Royal Blind Society (Australia) and Deen Systems, a Sydney-based software development company, undertook a major overhaul of RBS information systems intended to enhance access to RBS client services as well as employment opportunities for blind and vision impaired RBS staff. This case study outlines the steps taken and principles followed in the development of a computer user interface intended for efficient use by blind and vision impaired individuals.

The Electronic Rehabilitation Resource Center at St. John's University (New York)
Bob Zenhausern and Mike Holtzman

Abstract:

St. John's University in Jamaica, New York, is host to a number of disability-related network information sources and services. This article identifies and describes key sources and services, including Bitnet listservs, or discussion groups, the UNIBASE system which includes real-time online conferencing, and other valuable educational and rehabilitation-related network information sources.

The Clearinghouse on Computer Accommodation (COCA)
Susan Brummel and Doug Wakefield

Abstract: Since 1985, COCA has been pioneering information policies and computer support practices that benefit Federal employees with disabilities and members of the public with disabilities. Today, COCA provides a variety of services to people within and outside Government employment. The ultimate goal of all COCA's activities is to advance equitable information environments consistent with non-discriminatory employment and service delivery goals.

Departments

Job Accomodations
Joe Lazzaro, Department Editor
lazzaro@bix.com

K-12 Education
Anne Pemberton, Department Editor
apembert@vdoe386.vak12ed.edu

Libraries
Ann Neville, Department Editor
neville@emx.cc.utexas.edu

Online Information and Networking
Steve Noble, Department Editor
slnobl01@ulkyvm.louisville.edu

Campus Computing
Daniel Hilton-Chalfen, Ph.D., Department Editor
hilton-chalfen@mic.ucla.edu

*INTRODUCING _INFORMATION TECHNOLOGY AND DISABILITIES_*

Tom McNulty
mcnulty@acfcluster.nyu.edu
Editor-in-Chief
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.

Tom McNulty
Editor, _ITD_
mcnulty@acfcluster.nyu.edu
Bobst Library
70 Washington Square South
New York, NY 10012
phone: 212/998-2519
TDD: 212/998-4980

BUILDING AN ACCESSIBLE CD-ROM REFERENCE STATION

Rochelle Wyatt and Charles Hamilton
Washington Library for the Blind and Physically Handicapped
821 Lenora Street, Seattle, Washington 98129

INTRODUCTION

The Washington Library for the Blind and Physically Handicapped created a CD-ROM reference station to provide access to reference materials. The project tests commercial CD-ROM products in conjunction with adaptive technology and provides ways for patrons who cannot read standard print to use reference materials and obtain hard copy in accessible formats. We are pleased to share some of the experiences, observations and recommendations that have come out of this project. In this article, we will discuss the hardware and software used and provide information on vendors when the products described are not widely available. The prices listed are what was paid at the time the products were purchased. Keep in mind that prices change very quickly.

The CD-ROM station is located in our lobby, an area easily accessible by the public. Patrons are encouraged to come and try it out, although we will assist patrons in obtaining information if they are unable to drop by. The station is frequently used by the staff for reference work or just for fun.

The original plan for the CD-ROM station was to build a system that library patrons with little or no vision could use without assistance. To that end, we put together a menu system that would guide patrons through the process of using the CD-ROM products and producing output in regular print, large print and Braille. At the touch of any key, patrons are welcomed to the library and provided with information on how to use the system. They can choose to view the screen's standard text mode, to enlarge the screen text from 1.4 to 12 times standard size, or to access information via voice synthesis. Creating menus is a simple process using DOS batch file techniques. By using multi- disk CD-ROM changers that treat each CD as a separate disk, we were able to develop batch files that open each program without requiring any physical swapping of CDs.

We also developed online help for each menu item. Help batch files display text files that describe using a CD-ROM or accessibility product, step by step. These files are adapted from the manufacturer's documentation, and have been expanded to discuss accessibility issues for each product. Printed copies of this help information is also available at the station in regular print, large print and Braille.

In order to provide users with several choices of hard copy, the system is set up with a a Braille embosser as well as a laser printer that can produce standard and large print. Both are connected via an automatic data switch. Through a free utility called PRN2FILE, we have redirected all printing into a specific file. When users "print" while in the CD-ROM products, the information they want is saved to this file. Upon exiting the program, users are presented with a menu that offers them the choice of printing in regular print, large print or Braille. Making a print choice is as easy as responding with one key after being prompted for a choice. Each menu choice sends the appropriate code to the data switch and the appropriate setup string to the printer. Then it automatically prints the file.

The main accessibility problems seem to be related to interactions between the speech software and the search programs used by the CD-ROM products. Each program has a different format and a different way to access the information. None of the programs were set up to be used with screen access, so some work better than others.

Because of the limitations of accessibility products, and because some patrons are not comfortable using computers, we developed a job description and advertised for volunteers to assist patrons in using the station. To date, we have five very qualified and enthusiastic patron/volunteers who assist others three days a week.

EQUIPMENT

Description

Micro computer - 486 33Mhz
130 megabyte SCSI hard drive (We have used only 60 megabytes of this space to date)
4 megabytes of RAM (memory) (We are now using 8 megabytes, which mainly increases the speed of applications under Microsoft Windows)
5.25" floppy drive
3.5" floppy drive

Video Card

OAK VGA with 512K memory

Monitor

NEC Multisync 6FG 21" 1024 X 768 This is a high resolution, flat screen monitor. This size is probably overkill, especially when using a screen enlargement program, but it's a real attention-getter.

Microsoft-compatible mouse

Screen-enlargement program users can use the mouse with many of the CD-ROM products, in Windows, and to navigate in the magnified screen.

CD-ROM drives

Two Pioneer DRM-604X CD-ROM changers (each changer holds six CDs). They are daisy-chained together and attach to a SCSI interface card inside the computer. The Pioneer CD changers are expensive, but worth it. They allow us to have 12 different programs available, without having to load and eject CDs. This certainly makes it easier for the patrons, as well as the less technically-sure staff. They also have an easy-to-use feature that disables the magazine eject, helping to prevent the CDs from walking out the door.

Laser printer

Panasonic KX-P4430. This printer is used for both large print and regular print.

VersaPoint Braille printer/embosser from TeleSensory Systems.

VersaPoint
TeleSensory Systems, Inc.
455 North Bernardo Avenue
P.O. Box 7455
Mountain View, CA 94039-7455
1-800-227-8418

DECtalk PC voice synthesizer

The DECtalk speech synthesizer is, by far, the most understandable, flexible, and expensive of the speech hardware with which we are familiar. It features seven different voices; an internal dictionary that allows it to recognize and correctly pronounce a large number of words; and the ability to control talking speed, emphasis, use of punctuation and spelling. On the downside, the product has a reputation for being difficult to install, although it was pre-loaded by the vendor when we bought the computer. It uses unusual interrupt and port address settings, which may create problems when adding additional peripherals. The documentation is skimpy, at best.

DECtalk PC
Digital Equipment Corporation
1-800-343-4040

Surge and spike protector

Started with two Isobar protectors--barely enough outlets to plug all the equipment into. We now use a console-type protector (the Isobars are plugged into this), which has a master switch that turns everything on and off.

Emco Autoswitch

This is used to make it easier for patrons to print materials in the format they prefer. They do not have to manually set the switch; through the batch files, the computer "knows" where to send the information.

Cost

HARDWARE	Price (each)	Total
486/33 Micro computer, including:	2,100.00	2,100.00
4 MB RAM		
Maxtor 130 MB SCSI hard drive		
1.2 and 1.44 floppy drives		
SCSI controller card		
16 bit VGA card with 512K RAM		
Mouse		
Keyboard		
Autoswitch box		
6' parallel printer cable		
One surge suppresser		
MS - DOS		
Panasonic KX P4430 Laser Printer	955.00	955.00
Pioneer 6 disk changers	1,465.00	2,930.00
NEC 6FG 21" SVGA Monitor	2,635.00	2,635.00
DECtalk PC	1,680.00	1,680.00
Stereo headphones	17.00	17.00
Versapoint Braille Embosser	4,500.00	4,500.00
Delivery and Installation of all products was included		
One year on-site service	500.00	500.00
HARDWARE TOTAL:	$13,852.00	$15,317.00

SOFTWARE

Operating System Software

Operating System MS DOS 5.0

Memory Management Program

QEMM 6 from Quarterdeck. Memory management is a must, since the CD-ROM drives, the DECtalk and the sound card all require drivers for operation. This product has worked very well and is fairly easy to use.

Quarterdeck Office Systems
1-800-354-3222

Print Redirection program

PRN2FILE is a freeware program that redirects output from CD programs to a file that is then automatically formatted and output in Braille, large print, or regular print, depending on which format is selected.

Batch File Enhancer

KEY-FAKE is another freeware program that allows keystrokes to be sent from batch files to the CD-ROM software programs.

Communication Program

PC-VT is a shareware communication program that allows us to turn the CD-ROM station into an accessible terminal for the library's Online Public Access Catalog. The program also allows transfer of data between the station and our Kurzweil Personal Reader.

Accessibility Software

Screen Enlargement Program

MAGic Deluxe. We tried several screen enlargement programs, and found MAGic Deluxe the easiest to use (it has been compatible with every piece of software we've tried, including Windows programs). Also, it was less expensive than the other screen enlargement programs we tried. We can provide a free working demo copy of this software (it's fully functional, but only lasts 20 minutes before one needs to reboot to use it again). Microsystems Software may still provide free demos, too.

MAGic Deluxe magnifies screen text and graphics from 1.4 to 12 times normal size. It includes programs for DOS and Windows. The program is extremely easy to set up and use. Simple hotkeys allow users to magnify and change sizes. Once magnified, users can move around the screen with the mouse or the arrow keys. The program also has a "pan" function that moves across the screen line-by-line. The display can be stopped and started, and the display speed can be changed.

The program operates smoothly with the CD-ROM products and was less expensive than some other magnification programs. The only problem we've experienced with this program is an occasional lockup when the screen is magnified while changing from a text to a graphic screen. We recommend that users return to unmagnified mode before displaying a picture or other graphic. Some patrons have requested being able to magnify a portion of the screen while the rest remains unmagnified. This feature is included in the Windows version of MAGic.

MAGic Deluxe
Microsystems Software Inc.
600 Worcester Road
Framingham, MA 01701-5342
(508) 879-9000

Braille Translation Program

Hot Dots 3.0. Correct translation to Braille requires manual manipulation by skilled Braille transcribers. Any computerized program will make errors of translation and of format. Generally, though, Hot Dots appears to do a fairly good job of translation for short pieces of text of the sort found in most reference materials. It will not work very well with tables and other complicated formats. We have added a disclaimer to Braille materials explaining the limitations of electronic translation. Although output may not be formatted perfectly, it has met our patrons' needs without any complaints. We've heard that Hot

Dots' big sister, Mega Dots, is even better.

Hot Dots
Raised Dot Computing
408 South Baldwin Avenue
Madison, Wisconsin 53703
(608) 257-9595 or TeleSensory Systems, Inc.
455 North Bernardo Avenue
P.O. Box 7455
Mountain View, CA 94039-7455
1-800-227-8418

Screen Reader

The most consistent problems that we have encountered in setting up the CD-ROM station seem to be related to the software packages needed to read screen text aloud. We have tried three: VOS, Jaws and Flipper. All three have their advantages and disadvantages. We ended up using VOS because it worked with the hardware and software we have. (At this writing, we are waiting for an upgrade to Flipper that is supposed to be compatible with the version of DECtalk we have.) Those with simpler systems may wish to use a different program, since VOS is somewhat difficult to operate, and its documentation is sometimes confusing and not well-written.

Many of the difficulties encountered can be traced to the CD-ROM software rather than the speech software. The following types of programs are likely to create difficulties when using speech:

- Programs that do not use a standard cursor to show screen location. Many menu-oriented software packages let users move around the screen using the arrow keys, and use reverse video or different screen colors to display the active choice. While most screen reading programs can be set up to read, say, only the box with white letters and a red background, setting such parameters for each CD-ROM program separately is a difficult and time- consuming task. Several of our blind users have preferred to learn the appropriate keystrokes by rote ("RIGHT ARROW twice, then DOWN ARROW once, then ENTER") and, as one user said, "take on faith" that they are in the right place.

- Programs that make heavy use of the function keys. Several of the speech programs that we tried use the function keys to adjust the synthesizer. If the CD-ROM software wants to use the same function keys, conflicts may arise. At the least, the user must press another key combination to "pass through" the keystroke to the CD-ROM software.

- Programs that do not use display in text mode. Even programs that do not run under Windows are beginning to use a graphics mode to display text. Most screen programs cannot read screens that are not displayed in the DOS text mode.

In conclusion, voice synthesis can be extremely useful, but it is limited, not easy to learn, and it sometimes leads to system conflicts. If your budget permits, and your users read Braille, refreshable Braille displays are an expensive, but easier-to-use, alternative.

VOS

purchased through:

Computer Conversations, Inc.
6297 Worthington Road SW
Alexandria, OH 43001
614) 924-2885

FLIPPER

From Omnichron

Raised Dot Computing
408 South Baldwin
Madison, WI 53703
608-257-9595

System Software Costs

SOFTWARE:	Price
Flipper	$395.00
Hot Dots	$350.00
Screen Magnification (MAGic Deluxe)	$225.00
MS DOS (came with the computer)	
QEMM memory management software	$68.33
SOFTWARE TOTAL:	$1038.33

IV. EQUIPMENT AND SOFTWARE ADD-ONS, ORDERED LATER

1. Four extra megabytes of memory. CD programs are memory hogs. Although the programs work as is, we are hoping that with the memory management program, we'll be able to increase the speed and efficiency of the computer and continue to add CD products.

2. Command Center surge protector, so that we can turn everything off with one button.

3. Braille translation program. Originally we had thought that computer Braille would do just fine. It will work, however, patrons often must be taught how to read it, if it is unfamiliar to them. The new Braille translation programs (especially the upgraded version of Hot Dots, called MegaDots) are so easy to use, that it is worthwhile to offer the patrons Grade 2 Braille - and it saves on expensive Braille paper!

4. Media Vision Pro Audio Studio 16 sound card. This will allow patrons to hear the sound produced by the multimedia products, such as Groliers Encyclopedia. There is also a Windows screen access program, called PROTALK, that allows users who are blind or visually impaired to access Windows programs using a standard sound card instead of the specially designed voice synthesizers.

5. Security cables to connect the equipment to the furniture. Although this won't stop a serious thief from using wire cutters and hauling something off, it should prevent the quick snatch.

6. Shareware DOS screen saver.

7. Glare screen. See the furniture section for a discussion of screen glare and placement.

8. Large print overlay for the keyboard. Data-Cal (1-800- 223-0123) makes overlays that are high quality and adhere well, but the print is not all that much bigger than the original size, at least for letters and numbers. Where such labels would be most useful--for example, on special keys like the backslash--print size is not all that different, or the key's function is abbreviated rather obscurely, like "P/U" for Page Up. We have used these labels sparingly, for the same reason as the Braille labels, see below.

9. Braille overlay for the keyboard. We've tried making our own, but can't seem to get them to stay on the keyboard very long, so we ordered the overlays from Data-Cal. These labels are placed on top of the large print ones. We've been warned by Braille users not to put Braille labels on every key--only those keys that help orient and on the keys that seem to be in a different place on each keyboard. Apparently, having too many labels is very distracting. A major shortcoming of the Data-Cal Braille labels is that the set lacks labels for some important keys, like the backspace, backslash, and tab. In addition, the shift key is labeled only with the Braille capital sign (dot 6), which is not very helpful.

10. Flipper screen reading program to replace VOS. VOS conflicts with many of the CD programs and the technical support for VOS has been pretty much non-existent. As mentioned earlier, we are awaiting

an update to Flipper that will work with the PC version of DECtalk.

11. Headphones for sound output.

12. A library site license for PC-VT Terminal Emulation software. This has been our favorite communication software for accessible stations. It has been easy to use and is transparent.

This is the software that allows the PCs to talk to the VAX. We simply hook the same cable that would go to a VT220 (RS232, 25 pin with the same pin configuration) to a serial port on the PC, load PC-VT and voila, another terminal.

FURNITURE AND SYSTEM LOCATION

Description

The furniture we chose was very expensive and by no means the only option. We chose the MayLine Hamilton Single Pedestal Workcenter over the less expensive options for several reasons. This computer desk meets ADA recommendations for wheelchair accessibility. It has an easy-to-use power switch for height adjustment, rather than a hand crank that would require more strength on the part of the user. It is also well-built and large enough to hold all the peripherals attached to the computer.

MayLine/Hamilton Single Pedestal Workcenter 30" X 60"

surface; 16" D X 60" L rear shelf including 36" shelf support.

MayLine/Hamilton
The Mayline Company, Inc.
619 N. Commerce Street
P.O. Box 728
Sheboygan, WI 53082-0728
(414) 457-5537

	Cost
MayLine/Hamilton Single Pedestal Workcenter:	$1,500.00
Ergonomic Chair:	**$150.00**

System Location and Setup

Beside the usual considerations for location in a public facility -- security, visibility, etc. -- libraries should consider other factors when selecting a location for an accessible workstation. One that turns out to be of great importance, particularly to low-vision users, is lighting. Due to physical accessibility and power availability considerations, we placed our station so that users are facing large display windows. The outside light proved to be very distracting, so we put a wall hanging behind the monitor to block light from the sides. The glare screen has proved not to be very popular. Many users prefer to remove it because it decreases the amount of light displayed on the screen. Instead, we turned off a light directly above the screen which caused much of the glare.

CD ROM PRODUCTS

Some issues to consider when selecting software:

- Software interfaces have changed considerably in the last few years. The increasing popularity of graphic user interfaces (GUIs) on Macintoshes and in Microsoft Windows have both advantages and disadvantages for large print users -- and overwhelming disadvantages for speech users. For this reason, we have selected only CD-ROM products that display in text mode.

- Since GUIs require the user to read and move about the screen in a non-linear fashion, large-print users find that the cursor or active choice is often not visible. On the other hand, GUIs such as Windows can be set up to increase screen print size without the use of a separate large-print program.

- Some users find mice and other pointing devices difficult to use. The mouse cursor can be hard to see, even for those with normal vision.

- Screen-reading programs that can read aloud screens that display in graphics mode have just recently become available, and are not yet reliable. In general, we recommend CD software that does not run under Microsoft Windows or that displays in graphic mode rather than text mode. We also recommend CD products that are not totally menu-oriented, that is, if they use menus and a mouse, they also have equivalent keyboard commands that are easy to locate and use.

Descriptions

ABLEDATA 1992

This product is a database of products for people with disabilities. The database can be searched by product name, manufacturer and function. As of this writing, the 1993 edition of this database is due momentarily. ABLEDATA is menu-driven, with menus in different parts of the screen depending on location within the program. Speech programs must be set to locate highlighted text so that users can navigate correctly.

ABLEDATA
Information Systems
2701 University Avenue
B1-374
Madison, WI 53705
(608) 263-2309

Bible Library

This program proves that a CD is only as good as its search software. Even without the additional complexities of large print or speech synthesis, the Bible Library is extremely difficult to use. It is necessary to use the online help at just about every step. Reviews indicate that the recently-produced New Bible Library has an improved interface; we have not yet tested it.

CD-BLND (the catalog of the National Library Service for the Blind and Physically Handicapped)

The version we tested is a prototype. Regular issues are expected soon and prices have not yet been set. This program is somewhat disappointing for speech users. To search, the user fills in a form, moving from field to field (author, title, subject, etc.) using the TAB key. The active field changes color on the screen, and our speech program could not locate the active field. Speech users must take on faith that they are in the right place or re-read the screen once they have filled in a field.

Other problems that we have encountered: As with World of Poetry, heavy use of the function keys may cause interference between the speech program and the search program. Occasionally, speech users began hearing garbage characters not displayed on the screen if they read too close to the bottom of the screen. If a user leaves the program for several minutes, the screen becomes unreadable, necessitating a restart of the program.

CD-BLND
Reference Section
National Library Service for the Blind and Physically

Handicapped
Library of Congress
Washington, DC 20542

(202) 707-5100

Countries of the World
Family Doctor
Great Literature Personal Library Series
Total Baseball
World Fact Book

These five CDs use the same search software, called DiscPassage. Menu-oriented, it uses changes in screen colors to indicate the active screens, which can lead to some difficulties in navigation using speech. Generally easy to use.

Electronic Home Library

This program, which includes full texts of literary classics, has an unusual interface. When a user presses the up or down arrow while in a list, the list moves up and down while the cursor remains stationary. The advantage of this setup for speech or large-print users is that they can continue to read the same line while navigating.

Granger's World of Poetry

This program is generally easy to use, although some users prefer screen colors that are easier on the eyes. World of Poetry makes heavy use of the function keys, as do many speech programs, which can cause conflicts.

The New Grolier Multimedia Encyclopedia, 1992 Edition

Although this program is menu-oriented, its keyboard shortcuts are easy to understand and use. Navigation is relatively easy. Printing works well. This program has been a hit with large-print and speech users.

Discs not currently being used:

CD-NewsBank

We tested this product, which includes news articles covering national and international issues and events, and found it to be generally compatible with the speech and large-print programs. We did not purchase it because of its high cost and because many other libraries have similar products available. Prices vary widely, depending on the number of subjects included and the frequency of updates.

CD-NewsBank
NewsBank, Inc.
58 Pine Street
New Canaan, CT 06840-5426
(800) 762-8182

Guinness Disk of Records

This disk, although not requiring Windows, is completely graphical in nature. It is useless with speech, and is extremely slow to display. We removed it for these reasons.

Poem Finder

This product has somewhat more citations than the Granger World of Poetry, but it does not include poem texts or quotations, as Granger does. Patrons seem to appreciate immediate access to the actual texts. In addition, Poem Finder's interface is less than intuitive, so we have removed it in favor of Granger's.

Regional Economic Information System

This disk is published by the U. S. Department of Commerce and takes the prize for having the most difficult interface of any of the CD products we tried. A Commerce staffer told us that most users take the raw data and import it into spreadsheets for further manipulation and that the department doesn't really expect the interface to be used very much. The disk has some very interesting data on income, unemployment and the like, but between the interface and the difficulties encountered in printing tables in large print or Braille, we decided to remove the disk.

Regional Economic Information System
U. S. Department of Commerce
Bureau of Economic Analysis
Regional Economic Measurement Division (BE-55)
Washington, DC 20230
(202) 254-6630

Cost		
ABLEDATA		
Two-issue subscription (one year)	$50.00	
Microsoft Bookshelf (DOS Edition)	$130.00	
Includes American Heritage Dictionary, Bartletts Quotations, Columbia Concise Encyclopedia, Columbia Quotations, Rogets Thesaurus, World Almanac		
Total Baseball		$49.90
Countries of the World Encyclopedia	$395.00	
Columbia Grangers World of Poetry	$699.00	
Great Literature Personal Library	$39.95	
Groliers Multimedia Encyclopedia	$400.00	
Multimedia World Fact Book	$29.95	
Family Doctor	$59.60	
Electronic Home Library	$79.95	
Library		
Bible Library	$69.99	
Not using:		
CD-NewsBank	prices vary	
Guinness Disc of Records	$49.00	
Poem Finder	$300.00	
Regional Economic Information System	$35.00	

VII. CONCLUSIONS

Notwithstanding some accessibility limitations, this project has been very well received, and has been worth the effort it has taken to put the station together. For many of our patrons, CD- ROMs are the only way that they can have access to reference materials.

We have been able to provide additional assistance to our patrons through the use of volunteers. Patrons who do not have basic familiarity with computer operations, and others who cannot easily use the system without assistance, can be helped by volunteers who are asked to:

- assist patrons in using the system, use the CD-ROM products to conduct searches and print materials for patrons who cannot visit in person,

- maintain and upgrade the system, the online and printed instructions, and assist the library staff with special projects that can be simplified using this technology.

A description of this volunteer position is included as Appendix B.

As an additional benefit, the CD-ROM station has been used for experiments with a number of technologies. With a simple hard-wired connection to our mainframe computer and a terminal-emulation program, the station has been turned into an accessible terminal for our Online Public Access Catalog. We were also fortunate enough to have a Kurzweil Personal Reader (a device that scans printed materials and reads them aloud) donated to the library. This has been attached to the CD-ROM station via a serial cable that allows us to scan printed material, send it to the computer, and print the results in regular print, large print or Braille. We can also take electronic texts and convert them to audio tape via the Kurzweil. Finally, we have used the CD-ROM station to make electronic texts available. An increasing number of books are available in electronic form and may be read by our patrons at the CD-ROM station.

FUNDING

The acquisition of the hardware for this station was funded through gift funds from Seattle Public Library (our administrative agency). The CD-ROM products were funded by the Friends of Seattle Public Library. The Americans with Disabilities Act focus on accessibility issues makes community-based funding of accessible technology an appealing project for service groups and grant proposals.

For more information, feel free to contact Charles Hamilton or Rochelle Wyatt at the Washington Library for the Blind and Physically Handicapped, 821 Lenora Street, Seattle, WA 98129; telephone: 206-464-6930; Internet: wlbph@guest.nwnet.net. We will be happy to discuss this project with you.

APPENDIX A. LETTERS TO VENDORS

Following are letters requesting bids from vendors. These are not the actual letters that were sent out. We have to go through Seattle Public Library's Finance Office for this process now, so the information was added to their boilerplate before being sent to vendors. We wanted one vendor to provide, install and set up everything (except furniture) so we wouldn't have problems with one vendor blaming another if one product didn't work with another. We chose the accessibility products and sent out product information to the vendors. The vendor who won the bid learned the access software and did a great job of setting things up and troubleshooting compatibility problems.

FURNITURE

Request for Bid Letter

The Washington Library for the Blind and Physically Handicapped would like to purchase a computer desk for its accessible CD-ROM workstation. The desk must be accessible by individuals using wheelchairs. Mayline Hamilton has a line of computer furniture that meets the ADA specifications for accessibility. The model that we are interested in purchasing is:

Mayline-Hamilton Single Pedestal Table with power height adjustment,

26" to 41" Catalog No: 12560 30"D X 60"L work surface, 16"D X 60"L rear shelf. Includes 36" shelf support.

Please include in your bid, as a separately priced item, a fully ergonomic task chair with the following:

Pneumatic height adjustment (16" - 21") Single lever backrest pivot/seat tilt Backrest height adjustment Padded seat and full backrest Armrests

Please include freight and shipping and state sales tax. We would appreciate hearing from you by Wednesday, August 12. If you have questions please feel free to call me at 464-6930.

Rochelle Wyatt

EQUIPMENT AND OPERATING SYSTEM SOFTWARE

Request for Bid Letter The Washington Library for the Blind and Physically Handicapped will provide an accessible CD-ROM reference station to its patrons who are print handicapped. In order to do so we need to purchase the equipment, programs, furniture and miscellaneous items needed to provide this service. In this Request for Bid we are asking for bids on the hardware, software and furniture portion that will form the base unit (software reference programs will be purchased separately). I have listed what we feel are the required components on the enclosure. Any additional components required to make the system function effectively may be added. Please detail the additional components with complete descriptions and prices, separate from the items listed.

The total price must reflect a complete, operating system (keyboard, power supply, cables, connectors, etc.) and all parts must function together. All components must be new and must be repairable using standard, nationally recognized parts. Unit must be 100% compatible AT.

Selection shall be based on the following:

Component quality and reliability
Price
Completeness of package
System warranty
Ability to provide in-house service for the first year

Priority will be given to vendors who are able to provide the most complete package. Washington Library for the Blind will provide information on the preferred products and their vendors, for accessible items such as the Braille printer/embosser, the speech synthesizer, accessible software and the wheelchair accessible table, etc. in order to assist vendors in bidding on the whole package. More than one configuration option may be submitted.

Prices quoted must be good for at least 90 days from date of bid.

Please respond by July 1, 1992.

If you have questions, please call me at 464-6930.

Thank you,
Rochelle Wyatt
Computer Operations
Washington Library for the Blind
and Physically Handicapped

APPENDIX B. TECHNOLOGY MENTOR: VOLUNTEER JOB DESCRIPTION

POSITION TITLE: Technology Mentor

DEPARTMENT: Readers' Services

GOAL OF POSITION: To provide technical assistance to patrons using WLBPH's CD-ROM reference station and to assist patrons in using adaptive technologies.

FUNCTIONS OF POSITION:

Provide in-person, individual assistance to patrons wishing to search and reproduce information stored on CD-ROM.

Train patrons in use of CD-ROM station.

Record comments, difficulties, and recommendations of patrons for system improvement and pass these on to staff.

QUALIFICATIONS AND SKILLS:

Experience in operating IBM-compatible computers necessary. Experience in using CD-ROM software, screen magnification software, and/or screen reading (talking) software very helpful.

Ability to explain technical information simply and to work patiently with those unfamiliar with computers and adaptive technology.

Ability to interact in a helpful, friendly and professional manner with patrons and staff, in person and by telephone.

Ability to evaluate, record and communicate problems and recommendations for improvement.

TIME COMMITMENT:

At least one four-hour shift per week during regular business hours (8:30 a.m. - 5 p.m., Monday - Friday) by arrangement, for six months. Ability to keep same schedule each week very helpful.

WORK SITE: WLBPH

SUPERVISOR: Charles Hamilton, Program Coordinator.

DEVELOPMENT OF AN ACCESSIBLE USER INTERFACE FOR PEOPLE WHO ARE BLIND OR VISION IMPAIRED AS PART OF THE RE-COMPUTERISATION OF ROYAL BLIND SOCIETY

Tim Noonan, Adaptive Technology Services Manager

Royal Blind Society
4 Mitchell Street
Enfield NSW 2136 Australia
Phone: +612 334 3333
Fax: +612 747 5993

Internet: tnoonan@extro.ucc.su.oz.au

INTRODUCTION

As part of an upgrade of its online computer systems and applications, Royal Blind Society (RBS) has collaborated with Deen Systems (DS) in the development of a new user interface optimised for access by blind or vision impaired (BVI) people. The design and special features of this user interface are the main focus of this article. "User interface" refers to those aspects of a computer program which display information to the user and which interpret and/or elicit input (i.e., commands to be issued from the keyboard) from the user. Because the user interface described below is intended for use by vision impaired people, it is referred to here as the VI interface to distinguish it from the regular interface. Three main groups of business applications will ultimately be available in this integrated environment: marketing and fund raising system, client tracking and service delivery statistics system and, finally, a system to track and coordinate the production of alternative format materials and to handle circulation and cataloguing of library materials.

Screen reading programs for MS-DOS are all tailored to provide access to DOS applications. When developing an application on a remote computer using a terminal program to access that application, the remote application has no way of taking advantage of hardware aspects of the PC as PC-based programs sometimes do. For example, DOS programs can send material to the screen in two ways: one which will speak, one which will not. Programs on a PC can use scrolling text, highlighting and reliable use of cursor keys and remain compatible with most modern adaptive technology. Remote applications can cause major compatibility problems with adaptive technology when they employ similar facilities; this article describes our experiences with and solutions to the issue of compatibility.

OBJECTIVES OF THE DEVELOPMENT

Following a major review of RBS's information technology requirements in 1990, Deen Systems, as part of a consortium, successfully tendered to undertake the development of RBS's new business systems. Deen Systems was responsible for the database design and programming of the online systems but RBS worked very closely with Deen Systems in the development of an accessible VI interface. We began with a list of basic screen design principles (see below) and jointly came up with solutions to material which was more involved than the basic principles could deal with.

Adherence to the following principles was fundamental to ensuring that Deen Systems and RBS did not lose sight of the basic requirements for consistency and minimal differences between the regular and VI interfaces. Our guiding principles included:

- develop an interface which will enable remote clients to access information directly - e.g., to Library Services.

- contribute to people's understanding of methods of man- machine interaction, and in particular to add to our knowledge of VI accessible user interface design;

- stimulate others to make a commitment to efficiently accessible systems for people with disabilities;

- develop a work environment in which blind and vision impaired (BVI) people can seek and achieve promotion in the workplace;

- Develop a system which relies minimally on advanced or product-specific features of adaptive technology access software and hardware. We wanted to develop a generic system which could be accessed with the widest range of adaptive technology. This is why we did not leave the adaptive technology to deal with overly complex screens, even though one or two systems may have been able to do this to some extent with detailed configuration.

- minimise the duplication of software development by modularising the user interface aspect of applications rather than specifically modifying each application for accessibility. We wanted to minimise special coding, of course, but it was DS who actually had the architecture which made this possible. They made substantial alterations to their applications generation system (4GL) to enable the user interface to be kept separate from other code.

HARDWARE AND SOFTWARE ENVIRONMENT

Our new online systems are being developed in a UNIX environment. UNIX is text-oriented, making it compatible with major adaptive hardware and software products by use of terminal emulation software on a PC. UNIX also provides machine-readable documentation which is accessible to all users, as well as a variety of text processing utilities. UNIX is in a good position to become the preferred text environment for BVI people in the 90s as DOS becomes displaced and outdated by the continuing move towards graphical user interfaces and multi-tasking.

All of our online users have access to an MS-DOS PC to access the Unix computer. For BVI users, this PC is equipped with speech, braille or large print technology to enable access to programs on the PC as well as the UNIX applications. We find that MS-DOS Kermit version 3.12 works ideally with adaptive technology devices. While most PCs are equipped with Ethernet connections to the UNIX machine, serial and modem connections are also in use and work well with the VI interface.

Our applications are based on the INGRES Relational Database Management System (RDBMS). Because we will have three or more applications, each sharing much common data (e.g., names and addresses), an integrated relational data base which is managed independently allows us to minimise duplication of data, ensure data integrity, and provide very flexible reporting.

The applications are written in a fourth generation language called Ochre. Fourth Generation Languages are now commonly used for the design of business and database applications. 4GLs aim to minimise the time spent writing lines of code for common tasks thus leaving the programmer time to concentrate on the "what" that the program is supposed to do, and the 4GL deals with the "how" of low level programming. 4GLs allow a more humanly readable program to be written and then convert this into thousands of lines of low-level code which is executed by the database management system behind the scenes.

Advantages of Ochre include:

- Ochre allows programs to be quickly prototyped. Rapid prototyping is a method of application design which involves creating several prototype versions of the software during its development. Because we have been covering such a lot of new ground in our user interface development, rapid prototyping has allowed testing with adaptive technology users and devices at very early stages. This has been very effective.

- Ochre allows the business functions of the organisation to be separated from the input/output components of the system (the user interface). This clear separation of business functionality from user interaction has enabled us to eliminate duplication of programming in the development of two discrete user interfaces. It also offers us the option of adding new user interfaces in the future without requiring major alterations to the program.

- Ochre was developed in Sydney. Because we have been dealing directly with the authors of Ochre, we have been able to have extensions added to the programming language itself which greatly assisted the development of the VI user interface.

- The screen output routines of Ochre were totally re-worked to ensure accurate and meaningful voice output. These changes included ensuring that screens are written from top to bottom (not in a less structured order), screens are always cleared before new text is written to them, field names are re-displayed after a cursor movement command to automatically prompt the user verbally, and error messages always trigger a bell. These and other enhancements are now an integral part of the commercial Ochre product. To our knowledge, this is the only 4GL designed with the needs of VI users in mind.

GUIDING PRINCIPLES OF THE USER INTERFACE DEVELOPMENT

Some of these principles were set out before development of the user interface, others were recognised as we moved further into the development process.

- Sighted and BVI staff MUST ALL be able to access the new applications efficiently, accurately, and with confidence. We decided to develop two user interfaces, optimised for sighted and blind users respectively. Any user can choose either the VI or the regular interface before starting the application. Our experimentation demonstrated that developing a single user interface to meet the needs of both groups of users would have compromised efficiency, accuracy and confidence for both groups.

- Users of both interfaces employ identical keystrokes to interact with the programs. We considered this aspect of design to be essential to ensure effective training, documentation and support, and to ensure meaningful communication between users of the system.

- Screens may differ in presentation, for each group of users, but in most cases the VI screens are a less embellished version of the sighted screens. This commonality allows sighted users to be able to understand VI screens when working with a BVI colleague on an issue.

- All information from the application available to sighted users is also available to BVI users. It sometimes took quite a bit of experimentation to develop a way of making some information meaningfully available to BVI users, but it was considered essential to ensure this.

- Punctuation characters are extensively employed to provide screen layout, colour and context information to users of the VI interface. Examples of punctuation used include the colon (":") to indicate that a field can be updated, the equals ("=") character to indicate that a field is only for view, and the semicolon (";") between column headings on summary screens.

- The system provides both menu-driven and command-based modes of operation. BVI users are likely to take the time to learn the more rapid command approach because of the time it can save by eliminating intermediate screen output, and all users can employ the interaction approach most suited to their style, while hopefully becoming more efficient over time also.

- simple and clear rules for screen design so that all users can quickly master the systems. This will also mean that future client access to related systems should be more straightforward.

- We did not want to develop and maintain two different systems (one for sighted, and one for BVI users). By using Ochre we have been able to develop one primary program which points to either of two user interfaces. For each "sighted" screen there is a VI equivalent, as well as general rules in Ochre about how such information should be displayed for VI users. At this stage we have two user interfaces, but Ochre can deal with additional user interfaces tailored for future users and equipment.

- The system provides a variety of word completion, spelling validation and context-bound choices to maximise efficiency and accuracy of user interaction with the application. For example, when entering an address, the user is prompted by the system to enter the state, then the place name; post code and zip are automatically inserted by the system. If a user enters the first few letters of a place name in the state nominated, the system generates a menu of valid place names to choose from. Similarly, once a place name has been selected the street can be partially entered and the system nominates a small number of valid streets for that place name. These facilities ensure accurate data entry and are very useful for BVI people who do not see place names and street names on a daily basis and would often be less certain about their spelling.

- We made minimal assumptions about the adaptive technology and computer used by the BVI user. After significant discussion and experimentation, we agreed on a minimum access standard of a VT-100 terminal emulator with keyboard mapping, and any speech, braille or large print system. Keyboard mapping and cursor addressing are essential for total compatibility with the interface for sighted users.

SCREEN DESIGN ISSUES

Screen layouts and field ordering must all be well-defined. A limited set of "standard" screen layouts were defined for sighted and VI interfaces. Except in rare special circumstances, such screen standards are used. Some of the screen design principles we follow are:

- Field order on each screen is from most to least significant. Listening is sequential from the top of the screen, so order is very important.

- Headings and messages always appear in consistent screen locations. For example, each screen's unique title is on line 1 and the screen layout type appears on line 2 (such as "list of values" or "update"); similarly, error messages always appear on line 24, and a more complete explanation of the error is always found on line 23.

- Where possible, only one field should appear on a screen line.

- No ornamental characters or borders should appear on VI screens.

- Highlighting and colour should not be used in isolation to provide significant screen information. Punctuation is often used to convey this information. In situations where a cursor is moving from one field to another, highlighting of the current field should be avoided or fields may be verbalised multiple times; highlighted text is repeated because in order to highlight part of a screen, it is necessary to delete the material to be highlighted, send a "highlight on" code, which is followed by the text and a code which instructs the system to turn highlighting off. This obviously means that the text gets read again as it is highlighted. (Imagine a menu which includes one highlighted item. Consider what happens when you "unhighlight" one item and highlight a second item. First, the originally highlighted text is removed from the screen and re- sent as unhighlighted text (which is spoken); second, the un- highlighted text of menu item two is deleted and re-sent as text surrounded by highlighting codes (spoken) and so on. Consequently, both the material being un-highlighted and the material being highlighted are re-verbalised, making clear, unambiguous interpretation difficult.

- Each new screen should fully overwrite previous screen information (no pop-up windows, etc.). Speech output systems work on a line basis, so old information at the start or end of a screen line can cause major confusion. If a line on the screen is being altered, the whole line should be cleared and then re-sent to the terminal. Failure to do this may result in limiting speech output to those characters being changed, resulting in unintelligible speech output.

- Fields which are too wide for the screen should be identified by the ">" sign, and a means of viewing such fields in full must be available; this is because horizontal scrolling (a long line moving from left to right) can be totally meaningless and for users of speech, each time the line moves it is re- announced, causing confusion.

- Error messages must always include a bell to attract the user's attention;

- If the system changes to a new screen without being instructed by the user to do so, a bell should be sounded to alert the user that a screen change has occurred.

- Only one item is displayed on the screen at a time from a vertically scrolling list. This is because most speech programs cannot cope with multi-line scrolling regions over a VT-100 style terminal link without re-reading lines multiple times.

- When a single line summary of an item is displayed, there should also be a way of viewing the summary in a line-by-line basis; and,

- For VI users, menu options (which in our system normally appear at the bottom of each screen) are not automatically displayed until the menu key is pressed. This saves time and increases clarity of screens.

CONCLUSION

We began the planning and development of this system at the start of 1991. We now have our marketing and fund raising systems completed and they are being used extensively by sighted and BVI staff. Although it is recognised that there are further enhancements which could be made to the user interface, the objectives of easy and efficient access to the systems by all users have been achieved.

Working with Deen Systems provided a unique opportunity; as developer of both the programming language (Ochre) and our online applications, Deen Systems' programmers brought an in-depth understanding of all levels of design to each stage of the development process. This collaboration has benefitted both RBS and DS. RBS has greatly enhanced the ease and efficiency of access to its systems by both sighted and BVI users; Deen Systems came away with a superior product and greater understanding of the needs of computer users with disabilities.

Tim Noonan is Adaptive Technology Services Manager at Royal Blind Society. He heads a multi-disciplinary team responsible for providing such services as adaptive technology assessment, training vision impaired people in the use of computers, and the dissemination of product information. Tim is also responsible for the development of systems to improve alternative format production processes and to generally improve the accessibility of RBS positions and activities.

THE ELECTRONIC REHABILITATION RESOURCE CENTER AT ST. JOHN'S UNIVERSITY.

Bob Zenhausern
Professor of Psychology

Mike Holtzman
Manager, Systems Programming

St. John's University
Jamaica, NY 11439
sjuvm.stjohns.edu

INTRODUCTION

Over the past two years, the network facilities and resources located at SJUVM.STJOHNS.BITNET and SJUVM.STJOHNS.EDU have provided a meeting place for leaders in the areas of education, disability, and rehabilitation. Based on the integration of the standard Bitnet and Internet tools and a unique resource--UNIBASE, these Internet addresses have become the locus of a major center for disability information and resources; this Electronic Rehabiliation Resource Center (ERRC) is comprised of three major components: Bitnet Lists, gopher, and UNIBASE.

BITNET

Established Bitnet Lists

Often referred to as special interest groups, Bitnet lists are mailing distribution lists devoted to a special topic. The principle is simple: any message sent by a subscriber is distributed to all subscribers. This results in a rapid exchange of information and ideas. There are a number of these lists located at SJUVM that are part of ERRC.

Altlearn (Alternative Approaches to Learning), a professionally- oriented list, deals with alternative approaches to learning, especially those that are relevant to students in special education. Discussions among academics and classroom teachers are quite common on _Altlearn_. Bob Zenhausern (drz@sjuvm.stjohns.edu) coordinates the list.

Chatback is a project-oriented list, designed to provide guidance and support for teachers who use computer networks in their classrooms. During the past two years Chatback has introduced several projects including: Far Star, where children responded to an Alien Being about the policies and practices of Earth; The Holiday Dinner, where children from all over the world described a holiday meal; Steel, where 10 steel yachts, involved in a race around the world, posted latitude and longitude. Children followed the race by plotting that information on maps. Talkback is an associated list for the children to share ideas and meet new friends. Tom Holloway (xuegx@cvs.warwick.uk) is the founder of the original Chatback Trust in the UK and coordinator of the Chatback and Talkback lists.

Autism provides a forum for those interested in autism and other developmental disorders. Subscribers include parents, relatives and friends of autistic individuals, teachers and researchers in the area, and individuals who are autistic. Ray Kopp (rkopp@suum) coordinates this list.

Bicompal (Big Computer Pals) serves as the "classified ads" for individuals who are looking for network contacts for people with special needs. The initial goal was to develop big brother- sister or mentor-student relationships among those with similar disabilities. For example, a group of blind college students are planning to communicate with school children in the New York City Board of Education's Visually Limited Program. In practice peer relationships have developed in parallel with the mentor relationships. Tzipporah BenAvraham (zippy@sjuvm.stjohns.edu) coordinates _Bicompal_.

Emerging Lists

The five lists mentioned above have been active for several years and have matured into important sources of communication and information in the areas of Education and Disability. During the past several months a new series of lists have expanded the scope of the ERRC in several new directions. These lists are in varying stages of readiness, but will be completely operational by September of 1993.

Voceval (Vocational Evaluation) is a list concerned with vocational rehabilitation and the latest evaluation procedures and adaptive technology. Dick Banks (rbanks@uwstout.edu) coordinates.

TBI-SPRT (Traumatic Brain Injury - Support Group) was created by Len Burns at another site and ported here to sjuvm. It is an active and ongoing support group for parents, relatives, and teachers of individuals with Traumatic Brain Injury as well as individuals with TBI.

RSI-EAST (Repetitive Sequence Injury), created by Rik Ahlberg (rik@world.std.com), is another transport from another site. RSI refers to injuries that arise from keyboarding (and other repetitive movements) and is best typified by carpal tunnel syndrome. The RSI list provides support in the form of treatment, adaptive devices, and a friendly ear.

Four lists devoted to Chronic Fatigue Syndrome already exist, but the leaders of those lists, Molly Holzschlag (mollyh@geis.genie.com) and Roger Burns (rburns@gwu.edu) have collaborated on the formation of several lists that are concerned with the coordination of various organizations and the dissemination of information dealing with CFS.

Compumed (Computers in Medicine) is a list which is an outgrowth of an international conference on the use of computers for medical and adaptive use. It will serve as an exchange center for the latest theory and research in the field. It is coordinated by Dr. Paul S. di Virgilio (virgilio@epas.utoronto.ca) of the University of Toronto.

Equal Access to Software and Instruction (EASI) has a communications center at sjuvm and has established three lists. EASI is a transplant of the original EASI list and serves as an information and communications forum.

EASIplan is a private list dealing with EASI policy and plans.

Easipub is a private list that is concerned with publishing the new electronic journal, _Information Technology and Disabilities_.

AXSLIB is a discussion group devoted to library and information access issues for persons with disabilities.

THE SJUVM GOPHER

A gopher is a piece of software that allows the user to access material anywhere across the networks and to view selections on a menu-type structure. The amount of information that is available by gopher is truly remarkable. Norman Coombs and Jay Leavitt have developed gophers that deal with disability that are accessible via the SJUVM gopher. Anyone with full Internet capability can access this resource using the command: gopher sjuvm.stjohns.edu; once connected, users simply select the Electronic Rehabiliation Resource Center from the menu; others can telnet to the same address (sjuvm.stjohns.edu).

UNIBASE

UNIBASE is an educational network, based on unique software that allows full BBS services, has a CD ROM-based information retrieval system (that scans and updates gopher information), and provides facilities for real-time conversation and conferences. Anyone interested in exploring UNIBASE can telnet to rdz.stjohns.edu and sign on as "student." During the past year several interactive conferences on topics ranging from Learning Disabilities to Violence in the Schools originated on UNIBASE; in September, Olga Galkina from Moscow conducted several interviews on the UNIBASE network. EASI, Chatback, Rehabilitation, and Elder Centers are currently planned for UNIBASE.

The SJU Rehabilitation Gopher

St. John's University has become a world leader in the collection and dissemination of rehabilitation and disability- related (electronic) information. The primary tool for organizing and disseminating this information is the SJU Gopher server.

Internet "surfers" who gopher to sjumusic.stjohns.edu can select a menu entitled "SJU Rehabilitation and Disability Resources" which results in the following menu*:

SJU Electronic Rehabilitation Resource Center

EASI (Equal Access to Software and Information) RSINET (Repetitive Strain Injury) Newsletter Cartharsis (Creative Newsmagazine for CFS/CFIDS/ME) c CFS-Wire (Chronic Fatigue Syndrome News Service) WIDNET (World Inst. on Disability) Disability Listservs UNIBASE Conferencing and Archive SJU Listserv Archives and Mailing Lists File Archives and FTP Sites Gophers and Other Resources

* Note: Due to the dynamic nature of Gopher, these menus may change over time. New resources are constantly being added.

The SJU Electronic Rehabilitation Resource Center is a vast collection of databases, publications, and resources covering all facets of rehabilitation and disability. The major categories include Papers and Articles; Adaptive and Assistive Devices; Organizations, Resources, and Funding; and the Dyslexia Database. The databases included in the ERRC are keyword searchable. For example, all references to adaptive devices for the visually impaired can be selected and displayed almost instantly. EASI is an organization chartered to provide information and guidance to the education community on equal access to information technologies by persons with disabilities. The EASI archives, hosted by St. John's University, contain information on Library Access, Adaptive Devices, and the ADA (American with Disabilities Act).

RSINET, Cartharsis, and CFS-NewsWire are electronic newsletters concerned with Repetitive Strain Injuries, Chronic Fatigue Syndrome (CFS), and CFS News, respectively. New issues of these electronic publications are automatically added to the Gopher archive as they are published.

The SJU Listserv Archives serve as a repository for LISTSERV mailing lists sponsored by St. John's University. The remaining menu selections, "File Archives and FTP Sites" and "Gophers and Other Resources" provide pointers to disability and rehabilitation resources at other Internet sites. By providing links to other sites, St. John's provides "one-stop shopping" for those interested in rehabilitation and Disability information.

It was March and the blizzard of 93 was raging as Leigh Calnek, from Saskatchewan, Canada installed the St. John's UNIBASE System at rdz@sjuvm.stjohns.edu. In the intervening six months, rdz has grown into an international electronic conference center, has been upgraded in terms of both software and hardware, and is the prospective home of a series of Special Interest Centers devoted to Education, Rehabilitation, and Elders. A brief history of the early development of UNIBASE at St. John's University follows.

UNIBASE, THE CONCEPT

UNIBASE has been under development by Leigh Calnek over the past 10 years and there are over 20 systems currently in operation from Manila to Saskatchewan to New York City. It is a comprehensive system which encompasses the most important forms of electronic communications currently available for computers and the Internet. These include:

1) Electronic Mail both within the world-wide UNIBASE network and across the Internet.

2) A Usenet News program that serves as a replacement for the ReadNews programs. As it is integrated with Usenet News, networkers have access to the local and network UNIBASE discussions as well as Usenet and Bitnet discussions from the same user interface.

3) Access to an in-house mail list management system capable of supporting private and public lists to subscribers anywhere on the Internet.

4) The ability to support interactive conferencing across the network. Each UNIBASE host can know about other UNIBASE network hosts, and permit any number of users from each site to engage in an electronic conversation with users at other UNIBASE sites. Discussions are conducted in "virtual rooms", and there are no limits to either the number of users who can participate or the number of rooms which can be opened for use.

5) A powerful library bibliographic system as support for special libraries. This same database engine is used for cataloging full text materials, providing users with a single user interface which can provide access to resources locally and across the network.

6) CD-ROM access added where any resource can be made available at a site under either the local area net mode or the wide area net.

Workstations can be connected to a UNIBASE server using either RS-232, arcnet or ethernet cabling. This permits a school to extend the functional utility of products such as Apple II computers by using them as terminals to access the resources made available through the network host. The UNIBASE host can also perform the function of a Local Area Network Server supporting both MS-DOS and Mac networks.

UNIBASE TODAY

The UNIBASE system at rdz@sjuvm.stjohns.edu has been integrated into the Education and Rehabilitation network that is emerging at St. John's. During the past six months UNIBASE has been used as a real-time conference center. Representative conferences include:

1) A panel on learning styles, with panelists from the US and Canada, including Dr. Riata Dun of the School of Education at St. John's and Sheila Rosenberg, a teacher for special children and student in the School Psychology program at St. John's University.

2) On ongoing live discussion group on violence in the schools, led by Dr. Linda Scott, Principal of the Science and Technology High School in Norfolk, VA.

3) Olga Galkina, from Moscow, was available for several Broadnets on UNIBASE where she was available to discuss her efforts to get disabled children in Russia on the Networks.

Note: A Broadnet is almost the opposite of a Broadcast. A Broadcast sends all the information across the nets in all directions. A Broadnet attracts those who telnet to participate; it is more like a fishing net.

Students from around the world are using the UNIBASE system to reach out into the Global Village. I was demonstrating the UNIBASE system to Dr. Richard Scarpaci, Principal of PS 102 in Brooklyn, when we were joined by Linda Scott. The next thing we knew, students of Anne Pemberton, Network leader from Nottoway VA, as well as Sheila Rosenberg's students in Syosset, NY, joined students from Regina (Canada) and Finland. We sat there and watched as they discussed the "midnight sun", "European geography" and "whether all New Yorkers live in skyscrapers." PS 102 has since installed a UNIBASE system of its own, UNIBASE.stjohns.edu.

During another UNIBASE demonstration, administrators chatted with children from Canada and Syosset. It was hard to tell whether the students were more surprised they were talking to "big shots" or the big shots that they were talking to LD students.

UNIBASE TOMORROW

The latest development on rdz is the creation of Special Interest Centers on UNIBASE which can be customized for specific interests. The structure for the first Center has already been created for EASI and will be operational before the end of the year. Other Centers are planned for Vocational Rehabilitation, Education, Chronic Fatigue Syndrome, and Elders. These are expected to provide resources relevant to the Center, as well as standard Internet resources (gopher, for example). In addition, the interactive conferencing can be used to listen to a lecture, take part in a debate, or just schmooze with some friends.

More real-time conferences are planned, as well as the creation of regularly scheduled UNIBASE Broadnets from rdz.stjohns.edu. The idea has the feel of the early days of radio. Anyone who is interested in exploring the UNIBASE system at St. John's can telnet to rdz.stjohns.edu and use "student" or "guest" as their user ID. Announcements of upcoming Broadnets will be available via gopher.

Bob Zenhausern is a professor of psychology at St. John's University, Jamaica, New York; Michael Holtzman is manager of Systems Programming, also at St. John's.

THE CLEARINGHOUSE ON COMPUTER ACCOMMODATION

Susan Brummel and Doug Wakefield

The Clearinghouse on Computer Accommodation (COCA) is located within the General Services Administration (GSA) an agency of the federal government. Since 1985, COCA has been pioneering information policies and computer support practices that benefit federal employees with disabilities as well as members of the public with disabilities. Today, COCA provides a variety of services to people within and outside government employment. The ultimate goal of all COCA's activities is to advance equitable information environments consistent with non-discriminatory employment and service delivery goals.

Who are COCA's customers? The "customer base" for COCA is comprised of those people who, due to some disabling condition, encounter barriers when accessing and manipulating information in print and electronic form. The bulk of information management in industry and government today is handled through the use of personal computers and computer/telecommunications networks. This fact means that COCA's role in helping people with disabilities gain access to information translates into helping individuals and their organizations solve today's access problems to computers/telecommunications products and services.

COCA's activities can be divided into two broad categories: direct service to individuals, and indirect services through support to organizations. The latter encompasses those activities where COCA staff members work within the national information community to reduce barriers to information access, thus increasing job opportunities and equitable access to services.

1. Direct services - COCA provides direct services to people with disabilities in several ways. First, in its offices at the downtown Washington, D.C. GSA headquarters, COCA runs a demonstration center. At this location people can view and test various accommodation strategies for specific disabilities. A visit to the demonstration center is often a part of the equipment selection process that an employee and his or her manager need to go through in the accommodation process. COCA very strongly supports the concept of involving the person who is being "accommodated" in all phases of the process.

COCA's staff provide telephone consultations to employees with disabilities and managers who are looking for ways to enhance access to electronic information. These phone consultations are often the first step in the job accommodation process. Many times the initial phone contact is followed by a visit to the demonstration center by the employee, supervisor and technical support person of the agency.

Under certain circumstances the COCA staff will make an on- location visit to an employee's work site. Since the staff is quite small it is impossible to satisfy each request for on- location consultation; therefore, when a location visit seems appropriate it is expected that a computer support person from the employee's organization will be on hand during the consultation. An effort is always made to give the local support person enough information to carry on the accommodation effort without the personal help of the COCA staff. Ongoing phone support is available if necessary.

2. Indirect services - The following activities of COCA are classified as indirect because they involve working with another group of individuals or an organization that in turn provides service or products to people with disabilities.

A. Consultations during purchasing - Although legislation is in place requiring that systems purchased by the Federal government be designed so they can be made accessible to persons with disabilities, most people involved in the actual drafting of procurement proposals are totally unfamiliar with access products. COCA conducts workshops for procurement officials to acquaint them with the technology and the access industry. COCA also participates in GSA's Trail Boss program, a high-powered procurement training program for selected federal procurement personnel.

B. Customer requirements identification - On the other side of the coin, COCA has been able to work with organizations that are developing new services or products to meet real needs. For example, COCA is working closely with the Special Interest Group on CDROM Applications Technology, (SIGCAT). COCA has organized and conducted workshops on accessibility for software developers at SIGCAT conferences.

C. Information Dissemination - COCA also produces a resource document on accessibility entitled "Managing Information Resources for Accessibility". This publication gives an overview of current legislation applicable to issues surrounding accessibility, explains how various disabilities can be accommodated, and discusses the various steps that should be taken to resolve accommodation issues.

A second information product from COCA is Opening Windows, a tutorial developed to teach the Windows interface to blind and visually impaired computer users. Like the resource handbook, Opening Windows is available at no charge.

Future challenges for COCA are intricately linked to the speed of technology change in the information age. Just a sampling of current literature shows that advances in such technologies as multi-media programming, electronic document formatting and transmission, interactive video, and ultimately virtual reality are going to radically change the way everyone interacts with computers and with the information they can compile and transmit.

For many this will mean forms of employment in the near future not dreamed of today. But, for persons with disabilities, many of these advances could create barriers to information processing and ultimately to employment. COCA's mission is to stay current with developments in technology, in order to contribute to significant customer service initiatives such as the National Information Infrastructure, in a manner that anticipates the needs of persons with disabilities and intervenes if accessibility and jobs, are threatened. Reacting to lost accessibility after the fact has proven to be expensive and often an unsuccessful way to cope with computer and information accommodation for persons with disabilities.

How to Contact COCA:
Phone (202)501-4906
Internet coca@tmn.com
Address:
GSA/COCA
18th and F. St. NW Rm. 1234
Mail code KGDO
Washington, DC 20405

DEPARTMENT: JOB ACCOMMODATION

EDITOR: JOSEPH J. LAZZARO

Welcome to the Job Accommodations department of _Information Technology & Disabilities_journal. Your editor for this department is Joseph J. Lazzaro, director of the Adaptive Technology Program, Massachusetts Commission For The Blind in Boston, Massachusetts. Mr. Lazzaro is also a freelance writer who has published articles in numerous American magazines such as Byte, Computer Shopper, Computer World, InfoWorld Direct, InCider, LAN Technology, Windows User, CDROM Review, Home Office Computing, Time Life Access, High Technology Business, the New York Times, as well as PC-World and PC-Dealer in the United Kingdom. He is also author of _Adaptive Technologies For Learning And Work Environments_, American Library Association, Chicago, 1993, a 250-page guide on how to adapt microcomputers for persons with disabilities. The text can be ordered by calling 800-545-2433, and pressing #7 from the voice-menu. We are eager to receive job accommodation-related information to be published in this department. Mr. Lazzaro can be reached by telephone at 617-727-5550, extension 4305, or by Internet electronic mail at Lazzaro@Bix.Com.

EDITORIAL

Over the past ten years, the personal computer has created a new world of independence for persons with disabilities. This is due to the fact that computers can easily and readily accept peripherals and software to perform very specific tasks. Standard personal computers can thus be fitted with third-party hardware and software to make them accessible to persons with a wide range of disabilities, resulting in increased independence and productivity. This is most obvious in the workplace, where assistive technology has allowed thousands to maintain competitive employment. For example, persons with vision impairments can use speech, braille, or magnification systems to access personal computers independently. Users with motor impairments can augment or bypass the standard keyboard, and even control the computer using voice commands if necessary. These are only a few of the myriad assistive technologies available, resulting in increased employment and independence of thousands of persons with disabilities.

The subject of job accommodations is of great interest among companies and corporations, now that the Americans with Disabilities Act is in force. Under the ADA, public and private organizations are mandated to provide "reasonable accommodation" to new workers or existing workers with disabilities. What is reasonable accommodation? Reasonable accommodation involves making jobs accessible to persons with disabilities, permitting equal access to the fruits of positive labor. Reasonable accommodation is often translated to mean the provision of assistive or adaptive technology, enabling an individual to perform a job independently. Fortunately, there is no shortage of assistive hardware and software on the open market.

Unfortunately, many managers and individuals still cling to the belief that assistive technology is expensive, but nothing could be further from reality. Moreover, this false belief all too often stands in the way of individuals being hired for gainful employment. Current adaptive hardware and software products are no more expensive, in many cases, than standard computer peripherals. In most cases, it is less expensive to adapt a personal computer for an individual with a disability than it is to add a printer to the existing system.

An example is provided to demonstrate this point: The Echo speech synthesizer (Echo Speech Corporation) costs about $150.00, and the TinyTalk screen reader software (OMS Development) sells for about $75.00, resulting in a DOS-based speech access system for a visually impaired computer user for about $225.00. The Echo synthesizer is an external device, and connects to any standard serial port, and is small enough to fit in a coat pocket, thus making it able to be utilized on more than one system. Clearly, an adaptive device that costs around two-hundred dollars will pay for itself many times over if the individual uses the equipment to obtain or maintain gainful employment.

We are very fortunate to live in a time when electronics and computers can make our lives and work much easier. The trend towards less expensive and more plentiful adaptive technology is on the rise, with many mainstream computer platforms incorporating assistive equipment into their hardware or operating systems. For example, the Macintosh has a built-in magnification program, allowing visually impaired users to increase text to a comfortable viewing size. Key enhancement features like sticky-keys are being built into many computer platforms, making it easier for users with motor disabilities. With all these positive trends, it might be tempting to believe that all the problems have been solved, but difficulties still remain vast on the horizon.

One of the most serious problems today is that adaptive technology often lags years behind mainstream hardware and software development. For example, Microsoft Windows was on the market for several years before speech-based screen readers were available for blind and visually impaired users. Now that a handful of speech access programs for Windows have entered the market, Microsoft is testing yet another version of Windows, which may not work with the current crop of screen access systems. This scenario is all too often repeated over and over again, forcing persons with disabilities to play a constant game of technological tag. But these games are for keeps, with the livelihoods of thousands of individuals hanging in the balance. Every software package that cannot work with adaptive equipment represents lost jobs.

In closing, perhaps we can use our college campuses to make the playing field more level. If we educate our future programmers about the needs of users with disabilities, perhaps future software products can be made more accessible and user friendly to all in the process. Mainstream hardware and software companies need to work closely with adaptive vendors, to assure the compatibility of new products with assistive technology. It goes without saying that technology is advancing without limit, and clearly we are capable of solving many of the problems of the disabled community through the application of mainstream and adaptive technology. Clearly, our problems are not with technology, but with politics. Personal computers can be programmed to perform any function on command, at the press of a single key.

If we wanted to make it a reality, all hardware and software could be accessible, right out of the box. This increased access would lead to more jobs and independence in the disabled community. Indeed, it would result in lower taxes, as rehabilitation costs would decrease significantly. A great deal of rehabilitation dollars are spent forcing uncooperative computer systems to work with adaptive hardware and software. If mainstream systems were adaptive-aware, much time and money could be redirected to other pursuits. If we will take the time to build a new information structure, one that is accessible to everyone, we will create a world where every individual can fully utilize their abilities.

JOB ACCOMMODATION RESOURCES

We will publish in every issue valuable government and private sector resources. The editors encourage you to provide information for publication, as we are constantly searching for useful and interesting material for this section. Please send job accommodation related information to: Joseph Lazzaro, 88 Kingston Street, Boston, Massachusetts, 02111. Internet electronic mail can also be used to submit material to the following address: Lazzaro@Bix.Com. We prefer material in electronic format if possible.

Online Services

The major online services are an excellent source of information regarding assistive technology. CompuServe, Genie, Delphi, and Bix all have conferences and forums dedicated to assistive technology issues. These conferences and forums allow online subscribers to read large message bases of information, and to ask questions of other users and experts in the field. Most services offer software downloads, allowing end users to obtain shareware software, demonstration versions of adaptive software, documentation files, as well as articles and reviews written by end-users. For example, Delphi features the WIDNet service, run by the World Institute on Disability from Oakland California. WIDNet features a large message base that can be searched, as well as databases of information. Software programs are also available for download. The editor of this section is moderator of the Adaptive Technology forumn on the BIX online service. BIX, owned and operated by Delphi Internet Services, features a large base of technically-oriented users. The Adaptive Technology conference on BIX focuses on computers and adaptive hardware and software. Contact the various online services directly for specific information regarding specific availability and pricing structure.

JAN BBS

The Job Accommodation BBS is a free bulletin board service, dedicated to providing information about assistive technology. JAN offers electronic mail and file download areas to its subscribers. The board is a good place to ask questions of the experts, and can be accessed by calling 800-342-5526.

ADA Toll-free

The Americans with Disabilities Act is a long and complex document, and interpreting it can often be difficult. This is particularly true of managers in the private sector, who are not always sure about compliance issues. For free assistance on the ADA, the nearest technical assistance center can be contacted by calling 800-949-4232.

New COCA Handbook

The Clearinghouse on Computer Accommodations in Washington has published a new handbook that describes how to create and support an accessible information management system. The free guidebook describes how to shop for computers that can easily accept adaptive equipment, and describes how to use assistive technology to overcome information barriers. the guide is available in print and electronic formats. The guide can be obtained by calling 202-501-4906. COCA also runs a bulletin board service, 202-219-0132, where the guide can be downloaded free of charge.

Able Inform BBS

The Able Inform bulletin board offers the nearly comprehensive Abledata database of assistive technology that can be searched online free of charge. The system hosts conference areas and electronic mail for their subscribers. Numerous files are also available for downloading free of charge. For those who have a computer and telecommunications software, the board can be accessed 24 hours a day by calling 301-589-3563. Internet users can also access the bulletin board. Simply telnet to the following address: fedworld.gov. Once there, type dd115, which will take the user to the dial-out menu. Subscribers can also make contact via internet mail at: naric@cap.gwu.edu. Readers without a personal computer and modem can access the database by calling an information specialist at 800-227-0216 or 301-588-9284.

SNAP Program

The AT&T/NCR Special Needs Access Program (SNAP) offers job site evaluations and consulting to private companies. SNAP features system integration of both mainstream and adaptive hardware and software, as well as training and extended technical support. Realizing the need for job site engineering in the private and public sector, SNAP works with everyone from individuals to large federal agencies, offering complete turnkey packages for the disabled end user. SNAP also sells both mainstream and adaptive systems, and will thus take responsibility for the complete system package. The program works with all disabilities, and in all regions of the United States. To contact SNAP, dial 800-762-7123 or 301-212-5659.

Accessible Documentation

Digital Equipment Corporation, Maynard Massachusetts, announces new documentation service to serve visually impaired users. The documentation files are available on CDROM in ISO 9660 ASCII format. The files can be read using a voice synthesizer, braille printer, screen magnification software, or other adaptive technology. In its first release, Vision Impaired On-Line Documentation will include information on the following products: ALL-IN-1, DEC BASIC, DEC C, DEC FORTRAN, DEC Pascal, DEC VTX, DECset, DECtalk PC, OpenVMS, RISC C, ULTRIX, VAX C, VAX COBOL, VAX DATATRIEVE, and VAX Document. Vision Impaired On-Line Documentation, available now in the

U.S., may be ordered by calling DECdirect at 800-344-4825. The initial documentation kit sells for $225. A documentation update service is also available, providing three updates annually for $528.

MCB Adaptive Technology Program

Numerous state rehabilitation agencies house adaptive technology programs that can be utilized for job accommodations free of charge to the end user. The Adaptive Technology Program, housed at the Massachusetts Commission For The Blind, is a federally and state funded vocational rehabilitation program that provides assistive equipment to blind vocational rehabilitation consumers within the state of Massachusetts for employment and education. The program works with in-state businesses and schools to facilitate the employment and education of persons with vision impairments. A description of this program is given here for its model status, as an example of a vocational rehabilitation program that provides assistive equipment free of charge to the end user. Readers are encouraged to contact their local rehabilitation agency or commission for the blind for assistance in locating similar local programs. The types of equipment loaned range from low to high tech. The program provides numerous forms of computer adaptations, including speech synthesizers, magnification software, braille printers, closed circuit television systems, optical character reading machines, and other adaptive hardware and software that may be necessary on the job. The program also provides low tech items, such as cassette tape recorders, manual braille typewriters, blank audio tape, talking calculators, and other assistive devices. the Massachusetts Commission For The Blind Adaptive Technology Program can be contacted by calling 617-727-5550 extension 4305.

RESNA Technology Assistance Act

The federal government has funded the Technology Related Assistance Act to streamline the provision of adaptive technology services around the country. Almost every state in the union has now in place an office of assistive technology funded by RESNA in Washington DC. These various programs provide demonstrations of adaptive equipment, training, and advocacy, depending on the state. For more information about specific Technology Assistance state projects, contact Resna at 703-524-6686.

GUI Access

Over the past several years, the problem of accessing Microsoft Windows by blind users has been an issue of great importance. This was chiefly due to the fact that until very recently, Microsoft Windows was not accessible for speech or braille users. There are now three Windows-based screen readers currently on the market: Window Bridge from Syntha-Voice (905-662-0565), Winvision from Artic (313-588-7370), and Protalk from Biolink (604-984-4099). These programs have different capabilities, but allow users to access many features and applications of MS Windows. Development on access to the graphical user interface continues, as companies like Berkeley Systems, GW Micro, Henter Joyce, and Blazie Engineering continue to work on their own access technology for Windows.

DEPARTMENT
K - 12

Anne Pemberton

BEGINNING A NEW VENTURE AND A NEW YEAR

The premier issue of a journal must be a time to look ahead, as surely as the birth of a new year occasions similar flights of fancy. Can we predict the world to come? Will we be ready for the opportunities it will create?

Special education, like much of the education community, is in transition - scrambling to update and realize the potential of available technology. That technology now has the capability to tailor both input and output to the needs and preferences of the user. Accommodations as extensive as a light talker or robotic arm, or as simple as changing colors on a text-filled screen to ease a reading disability, are possible.

In some places, special education lags behind regular education in the availability of hardware, software and teacher training, yet on Long Island, in Virginia, in Seattle, and elsewhere, special educators have been among the pioneers developing educational applications for the Internet. The small groups and flexible curricula of resource and self-contained classes are well-suited to exploring the vast new world. Networks provide an efficient way to distribute content that makes individualization of educational experiences a reality.

Determining the content of the Internet that will be of value to K-12 education, and especially K-12 education for special needs students, is the challenge before us. To explore what may work, what will work, and determine what does work, and what accomplishes the unexpected, will be the task of cadres special educators and those who work with them on the Internet. Teachers and students can share the results of their experiences and observations; these experiences, combined with the output of projects, can also become archives for researchers' in academia.

The Chatback Trust UK and Chatback USA provide content for special education classes around the world from their headquarters in tiny Royal Leamington Spa in the middle of the English countryside. Tom Holloway, a retired IBM executive, spends the trust funds on hardware, software, access, and training for handicapped students and their teachers around England. The Chatback projects are made available on the Internet through St. John's University on Long Island, NY.

There are five chatback lists distributed by St. John's mainframe. Chatback , is a key discussion list used for planning and sharing among the teachers and others involved in Chatback projects. Talkback , originated as a place where students could post the outcomes and responses to the Chatback projects, but it has evolved as a place where students share comments, questions and stories with one another and with the other Chatback adults. Some of the adults assume character roles in their communication with students. Sherose, Z-Man and Doinngg from the project Far Star entertained students of various ages and levels of "belief", and this year's attraction is BW Unicorn, also known as Uni, -:).

Most of the 1993-94 Chatback projects are on lists of their own, but the Nigel Palmer's Bird Tables are discussed on Talkback. The Bird Table project can be a short unit or a year- long (or longer) roject for any classroom with a well-placed window. Students design and construct a bird feeding station they can view from a classroom window. Students write reports on building and stocking the bird table, and describe their feeding station's and feathered visitors. The reports are uploaded and shared with Talkback.

Three more Chatback projects have lists of their own. First is The Time Capsule . Pat Davidson collected suggestions of items to be included in a time capsule which was sealed to mark the end of 1993. The list is archived, so that if you missed it, you can get a copy of everything posted to the list from St. John's gopher.

Memories of England , the brainchild of Tom Holloway, Director of Chatback, helps survivors of World War II in Europe share their memories of those times with school children around the world. Introducing, , asks students to pair up and write an introduction of each other, and post it.

To get involved with the Chatback projects, you should first subscribe to the teacher's list, Chatback. Bitnet and other systems may let you subscibe through their reader, but if not, just write to the listserv at St. John's and subscribe to receive the list via email. Write the following one-line message:

To: listserv@sjuvm.stjohns.edu Subject:

Subscribe Chatback Firstname Lastname

Introduce yourself and describe the students you work with. Learn more about the current projects and those in the planning stages. When you're ready, subscribe to Kidintro, Talkback, and perhaps Memories, too. Share the mail with your students, and let them begin to participate just as soon as they seem ready. All of the Chatback projects are flexible enough to allow you to participate with just one student, or with an entire class. And always, help is just a quesion away on the Chatback list.

There is, of course, no reason that special needs students cannot participate in the wide range of online projects intended for regular students. Information on projects suitable for special students but aimed at ALL of education, is posted to Chatback and Altlearn . Altlearn is a discussion list among teachers and others interested in learning disabilities and similar conditions. Several Altlearn regulars routinely re-post announcements of projects from the corners of the Internet to these two lists.

In closing, let me first of all introduce myself as a special education teacher in a rural high school in Virginia, then ask "y'all" to think about some possibilities. As we've read in this issue, there is a wonderful source of information on rehabilitation for various handicapping conditions being built at St. John's. What information could be added to the Rehabilitation gopher that would be of use to K-12 special education, mainstream, and inclusion teachers? Would up-to-date medical information be helpful? How about tools for assessment? Research on educational methods? Transitioning and vocation resources? Reviews of software? Hardware sources and resources? Would it be useful to have some of that information provided so that students can learn to do their own problem-solving and advocacy? Or should we devote most of our attention to developing curriculum- driven resources for student lessons? Please feel free to share your thoughts on these questions, and to suggest ideas for future "K-12" department news to me or to Bob Zenhausern at:

Anne Pemberton apembert@vdoe386.vak12ed.edu or Bob Zenhausern drz@sjuvm.edu

INVITATION TO JOIN NCIPnet

Readers of _Information Technology and Disabilities_ are invited to join NCIPnet, the electronic network of the National Center to Improve Practice (NCIP). NCIP, funded by the U.S. Department of Education, Office of Special Education Projects is a joint effort between Education Development Center, Inc. (EDC), a nonprofit research and development organization, and the WGBH Educational Foundation, Boston's public television station. NCIP's mission is to improve outcomes for students with disabilities by enabling practitioners (e.g., teachers, technology specialists, occupational therapists, speech pathologists) to effectively use technology, media and materials (TMM) to enhance instruction.

NCIP's Goals:

- To develop a knowledge base about the use of TMM to assist students with varying disabilities
- To develop an approach that brings together practitioners, administrators, parents, and consumers to promote innovative uses of TMM with students with disabilities
- To support NCIPnet

- NCIPnet is an emerging electronic mail and bulletin board system that links administrators, practitioners, parents, and consumers nationwide. Members of this "telecommunications community" have joined to:

- Explore the most effective instructional practices for students with disabilities

- Discuss ways that TMM can be used to enable, enhance and extend these practices

- Share information about what promotes or hinders the successful use of TMM

- Gain feedback and advice from colleagues on common issues and concerns

- Share expertise and experience among schools and districts throughout the country.

NCIPnet currently has over 150 registered users from all over the country, and we are adding more daily. The primary participants are individuals who seek and accept responsibility for bringing about change in the integration of technology for students (K-12) with disabilities. You can join this telecommunications community. All you need is a computer, a modem, and an enthusiasm for sharing ideas about your work with others in this field. NCIP's dial-in number is toll free. For more information, please contact:

Denise Ethier, DeniseE@edc.org.

DEPARTMENTS - LIBRARIES

Ann Neville
Coordinator, Library Services to Users with Disabilities
The University of Texas at Austin
Internet: neville@emx.cc.utexas.edu

The Library Nexus.

Instructional technology. Information technology. Assistive technology. This section is about the intersection of these technologies with library resources and services to users with disabilities.

With new technologies and new resources appearing at an ever-increasing pace, it's all too easy to get caught up in keeping caught up with it all. In this department, I hope we can focus not on the technology as such, but on the effect of the technology on people with disabilities when they use library resources. In no way does this column aspire to be your resource for comparative evaluations of screen readers or Braille translation programs; EASI and AXSLIB (EASI's library access listserv) have experts with valuable experience with assistive technology to assist in these areas.

I'm a reference librarian. I've been involved in library instruction since the early seventies, and with assistive technology since the early eighties. It was a very early Kurzweil scanner that got me involved, but it's the technology of the last few years that has gotten me excited. Finally, the assistive technology is good enough to use in libraries. By "good enough" I mean that it doesn't take hours to learn the basics. Students can learn to use the technology at the same time that they are learning a library resource. It's no big deal now. Students are more comfortable with technology, too, and they are starting to come to the university with some experience of it as well.

At the same time that assistive technology is maturing, library resources are becoming available in electronic format in useful amounts. Faculty who use instructional technology are more open to the possibilities of assistive technology in an academic setting, and help to create an atmosphere in which it becomes possible to integrate the various technologies into the educative process. In the meantime, various initiatives are underway to ensure that the same technology that has empowered people with disabilities does not, during its multimedia evolution, exclude them again.

All of this is good news for libraries, because enabling access to information is our mission, and the combination of technologies is certainly enabling access for many people with disabilities. There are issues, however, that should be explored as we incorporate these technologies with our other resources and services. Consider, for example, how inaccessible to a student who is blind most library resources are, in comparison with those in electronic format. For students who have relied on Recordings for the Blind or depended on aides to do their library research, a university library can be overwhelming. It's not just the number of books listed in the online catalog, or the scores of articles on a given subject in a specialized index. Added to the sorting and evaluating and focusing that are standard library instruction issues are highly problematic issues of format. Many students avidly choose the information sources that are most readily available: the ones in print, not microform, that are here, not across campus, and on the shelf, not checked out. Students with disabilities don't go looking for the hardest path to information, either. If an electronic source or a full-text database is readily accessible, and there's a book or two available on tape, but the most relevant works on a subject are available only in print in old books, or on microfilm and indexed only in printed indexes, just how motivated does the student have to be to choose the materials that are intellectually accessible only with difficulty over those that are in electronic format immediately available to be read, copied to disk, and incorporated into a research paper? What combination of technology and instruction and services can we bring to bear to make the dichotomy less dramatic? Do you have opinions on this issue, or suggestions for issues you'd like raised here? What seem to be the most pressing library issues posed by the confluence of technology and people with disabilities? Readers are encouraged to share with us their thoughts on these and other library access issues.

DEPARTMENT
: ONLINE INFORMATION AND NETWORKING

Steve Noble, Recording for the Blind
slnobl01@ulkyvm.louisville.edu

INTRODUCTION

To all our readers: welcome. Glad to have you aboard. As _Information Technology and Disabilities_ now begins its maiden voyage, I would like to say that I am proud to be a part of this effort, and excited about where our journey may take us. It is very fitting indeed that our first issue is being compiled as an electronic text to be released over the Internet. I am persuaded to believe--and perhaps you will agree--that the combined development of computers, computer networks, screen readers, and the proliferation of written materials in electronic format has been perhaps the greatest single liberating vehicle for individuals with disabilities in this century.

This is not to say that there were not major developments in technology predating the computer that greatly assisted persons with disabilities in accessing information and interacting with others. Take, for example, the invention of the semiconductor transistor that quickly led to the design of truly practical hearing aids, and the production of telecommunication devices designed to be used by hearing impaired and deaf individuals which soon helped to clear the hurdle that was inadvertently erected by an earlier invention of Alexander Graham Bell. And let us not forget the inventions of first the phonograph and later the tape recorder--devices that made possible the Talking Book and gave blind readers a viable alternative to braille. Since spoken books on record and tape formats were so much easier and cheaper to produce than books in braille, a virtual explosion of information on accessible formats happened in the middle part of this century.

To be sure, another explosion of accessible information is happening right now. And thanks to the Internet, our current explosion is of global proportions. It will be the focus of this department column, _Online Information and Networking_, to examine current trends in online information systems as well as computer network communications services accessible over Internet.

I would be pleased to receive any information about news items that you believe would be pertinent to this column. You may contact me via electronic mail: slnobl01@ulkyvm.louisville.edu.

--Steve Noble

NEWS ITEMS:

UPDATE ON RFB INTERNET CATALOG

As many of you already know, Recording for the Blind has had its Master Tape Library online catalog available at the r2d2.jvnc.net host site for over a year. Although the initial test stage of the catalog was rather slow going, the pace has picked up some. The database is now intact, with regular updates to be done every month, if not more frequently.

In addition to having access to RFB's holdings information over Internet, this catalog is also designed with a book ordering feature. Once this service feature is fully functional, registered RFB borrowers will actually be able to order the books they want over Internet, including both audio cassette and available etext books. RFB is currently conducting a structured pilot of the ordering feature to gain needed feedback and experience. A select number of both institutional providers and individual borrowers are being assigned passwords to allow them to place orders over the system. The present RFB time table has the catalog order feature becoming available to all RFB users in January 1995. This date will coincide with implementation of new software that will make the Internet order-filling procedure fully automatic--currently the orders come through electronic mail and must be handled individually by RFB staff.

To access the RFB catalog you can telnet directly to r2d2.jvnc.net 4445, or you can gopher to r2d2.jvnc.net and then chose the _Publishers Online_ menu and just follow the remaining menus till you get to the catalog. Anyone can look things up in the catalog, but only those involved in the pilot can actually order books right now.

NEW DATABASE INTERFACE

The Assistive Technology Database Interface (ATDI) is a public use database to aid consumers in locating disability assistive equipment and services. ATDI is meant to help create a list of vendors in a certain region who provide certain services. To use the database telnet to bongo.cc.utexas.edu and login as tatp.

NEW DISCUSSION LISTS

The Learning Disability Information Exchange List (LD-List) is an open, unmoderated, international forum that provides an information exchange network for individuals interested in Learning Disabilities. Subscribers include persons with Learning Disabilities, family members and friends, educators and administrators, researchers, and others wishing to know more about this topic. Any matters related to Learning Disabilities is appropriate for discussion.

To subscribe, send an email message to:
LD-List_Request@east.pima.edu
Leave the subject line blank, and in the body of the note say:
SUBSCRIBE

You can contact the List Owner if needed at:
LD-List-Owner@east.pima.edu

MOBILITY is a list to help disabled persons gain access and mobility. Topics of discussion include public transportation, wheelchair access, use of private cars, emergency communications, and problems relating to socializing, education and employment.

To subscribe from a BITNET node, send the following interactive message:
TELL LISTSERV AT SJUVM SUB MOBILITY yourfirstname yourlastname

To subscribe by email, send a note to:
LISTSERV@sjuvm.stjohns.edu
Leave the subject line blank, and in the body of the text say:
sub mobility yourfirstname yourlastname

ONLINE SEMINAR ON ADAPTIVE TECHNOLOGY

ADAPT-IT: ADAPTING INFORMATION TECHNOLOGY AND COMPUTING Online Workshop sponsored by:

Rochester Institue of Technology and EASI (Equal Access to Software & Information)

Has the Americans with Disabilities Act left you with more questions than answers about providing computing services for individuals with disabilities? Are you trying to find the most effective and efficient way to support your disabled students, faculty and staff?

Rochester Institute of Technology has developed a two-week, online workshop, in conjunction with EASI, to provide answers to these and other questions about adapting inforl. The workshop will be delivered over the Internet. The course relies on the distance learning technology of RIT, and the adaptive technology resources of EASI .

TOPICS COVERED:

1) Introduction and Background 2) Reasons to Adapt 3) Legislative History 4) Model Adapted Workstation 5) Lab Environment 6) Alternate Output Systems 7) Alternate Input Systems 8) Computing as Compensatory Devices 9) Planning and Funding 10) Review and Other Resources

Participants will be expected to do homework assignments which will focus on the use of the internet to locate a vast array of disability resources and to share with other participants their findings as well as their institution's or organization's experiences in becoming accessible. At the successful conclusion of the workshop, and upon completing at least three specified assignments, Rochester Institute of Technology will issue a Certificate of Completion. The workshop may also be taken to obtain K-12 In-service Credit.

COST AND REGISTRATION:

Workshop registration fee is $99 and includes all resource materials. The workshop will be offered several times a year. For further information send email to:

Norman Coombs
nrcgsh@ritvax.isc.rit.edu
Phone (716) 475-2462

**DEPARTMENT:
CAMPUS COMPUTING**

Daniel Hilton-Chalfen, Ph.D., Campus Computing Editor,

and Coordinator of the UCLA Disabilities and Computing Program

hilton-chalfen@mic.ucla.edu

Campus Computing and Disability in 1994: Emerging Issues for a New Journal and a New Year

Some of the most dynamic applications of adaptive computing technology are in post-secondary education. The Campus Computing department of _Information Technology and Disabilities_ will help you keep on top of this rapidly changing area by offering a broad sampling of news and reviews in the post-secondary education realm.

We encourage our readers to become participants: send us your news items; suggest topics for discussion; send in brief descriptions and vignettes of innovative information technology services on your campus that other schools could learn from (avoiding the reinvention of the wheel is a big concern around here!). We also strongly encourage you to submit articles to the journal for publication, especially more detailed case studies of successful service strategies.

A new year and a new journal present a unique opportunity to take a look ahead. Here are a few key themes that this editor sees emerging as dominant concerns for post-secondary education in the coming year. In future issues of the journal the Campus Computing department will be taking a closer look at these and other important topics.

1. Cost Savings:

All campuses are facing tremendous pressures to reduce costs. Computer support for people with disabilities, never an easy thing to secure resources for, is now faced with new fiscal challenges. Can we turn adversity into our advantage? Can we identify where and how the creative use of adaptive technologies can actually save a campus money? How about that student with a visual disability who used to need note takers, transcribers and readers for classes, tests, and assignments? Now that he or she is using a lap top with a voice synthesizer and working independently, can we identify how much we have saved the campus?

Our answers might surprise and encourage administrators who undervalue the economics of adaptive computing support to the campus.

2. Campus Wide Infomsmation Systems:

The Campus Wide Information System, or CWIS, is the newest development in campus information services, and what a great development it is for people with disabilities! Making campus course catalogs, phone directories, even newspapers, available electronically can help people with difficulty reading due to disability gain equal access to vital academic and employment information. But will this potential be realized? Graphical user interfaces, hyper-media and other means of accessing the CWIS can present new barriers to those with print-impairment -- as imposing an obstacle as paper text. How can campuses realize the full potential of the CWIS?

3. Distributed Computing, Coordinated Support:

Campuses that have tried to implement computer support for people with disabilities quickly learn that it is a real challenge to balance two big needs: How to provide expert support for consulting and training on adaptive computing technologies, while at the same time trying to provide the most integrated setting for people with disabilities to use campus information technologies. Computing is widely distributed on college campuses, and most campus computing support staff aren't familiar with adaptive computing technologies. Campuses need to identify a support strategy that provides both consulting expertise and mainstreaming in an increasingly distributed computing environment.

4. Partnerships

A campus's adaptive computing support service (ACSS -- how do you like that for a new acronym?) is so much more than a training unit. It is a unique agent of change on campus, one that can enhance the missions of many different campus units through partnerships. When an ACSS teams with the computer science department, undergraduate and graduate theses on adaptive computing can create new knowledge, and even new technologies. An ACSS partnering with a campus occupational therapy or rehabilitation unit can introduce new adaptive technologies to help patients, while the OT's skills bring a needed consulting dimension to the traditional clients of the ACSS. Such partnerships not only create more powerful services, they can save the campus money. An ACSS combined with the OT/Rehab department can provide support to campus workers with long- standing or newly-acquired keyboarding difficulty to help them stay on the job, reducing workman's compensation costs, down- time, retraining, and other related, and very expensive, costs.

5. E-Text:

Optical scanners form the basis of today's reading machines that help people with print impairment to read books as electronic text, or e-text. Once campuses become familiar with this technology, they inevitably ask, "Why can't we just get the computer file from the publisher?" As anyone who has tried to do this knows, it isn't so simple. New industry standards are being developed for electronic text, even for disability access to those standards. We in post-secondary education have to be sure that the needs of students are represented in those standards. Mathematical, scientific and linguistic notation, are among the many kinds of textual information that need to be presented electronically in an accessible form for post-secondary students to have equal access to e-text. The same demand holds true for the text books and other academic materials that are being developed in multi-media and hyper-media formats.

6. Transitions

Sometimes campuses are so busy educating students that they overlook where those students are coming from and where they are going. Students with disabilities coming from high schools and community colleges have particular technical support needs. For example, they may have learned technologies at their former school that are not available at the four year college. Establishing a liaison between you and your counterparts at feeder schools is one way to address this need. Then there are the graduating students, moving into a workplace that seldom offers the kind of support available on many campuses. Will they have the tools for independence they'll need to secure and keep a job? Some campuses offer computer training classes for people with disabilities, not only for the campus, but for the community at large. Adult education is an important and often overlooked aspect of disability-related computer support. Attending to the transitions is critical if our other support efforts are really going to make a difference.

These emerging themes are just some food for thought. There are many other key areas of concern. We hope you'll find something useful to your own school's efforts in the Campus Computing department of each edition of the journal. And we eagerly look forward to hearing from you! Your successes -- and failures -- will enlighten us all.

Daniel Hilton-Chalfen, Ph.D.
Coordinator, UCLA Disabilities and Computing Program
hilton-chalfen@mic.ucla.edu
310-206-7133; 310-206-5155 (TDD)

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Information Technology and Disabilities

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Articles

ITD Technotes: Speech Synthesis
Alistair D. N. Edwards
alistair@minster.york.ac.uk

Abstract: This is the first in a series of ITD articles on the basics of adaptive technologies. In simple, non-technical language, the author provides a brief introduction to synthetic speech technology which is currently used by individuals with speech and/or visual impairments.

Project Link: Consumer Information for Persons with Disabilities
William C. Mann, OTR, Ph.D.

Abstract: Project LINK, established in 1993 at the Center for Assistive Technology at the University of Buffalo in New York, is a free information service to help people learn about assistive devices. Assistive devices are essentially to ols--they make it easier to do various tasks. Many people with disabilities are not aware of the wide variety of available assistive devices, or they lack information on where to obtain them. At the same time, companies marketing assistive devices have difficulty reaching people who most need their products, as listings of people with disabilities are confidential. Project LINK bridges the information gap between the people who purchase assistive devices and the companies which make and/or sell them.

C-Note: A Computerized Notetaking System for Hearing-Impaired Students in Mainstream Post-Secondary Education
Andrew Cuddihy, Brian Fisher, Rick Gordon
and Elizabeth Schumaker

For Further Information About C-Note, contact: Elizabeth Schumaker, Learning Support Counsellor, Queen's Counselling Service, St. Lawrence Bldg. Ground Floor, Queen's University, Kingston, Ontario K7L 3N6; Telephone: 613-545-2893; E-Mail: Schumakr@QUCDN.QueensU.CA

Abstract: Computerized notetaking is an effective tool being used by hearing-impaired students at lectures and seminars in mainstream classes in colleges and universities. This article describes C-Note, a program that provides significant benefit over existing computerized notetaking. C-Note -- developed by a computer programmer who is a student with a hearing impairment and a learning specialist -- allows communication between the student and the notetaker, independent use of linked computers, and production of hard copy notes from each. The C-Note system architecture is described in detail. Advantages of the system for the student with a hearing impairment are discussed. Educational implications of using C-Note, and other computerized notetaking systems for hearing-impaired students in the mainstream classroom, are noted. Potential modifications to C-Note are suggested. The need to develop additional learning strategies to help students make effective use of the enhanced quantity and quality of lecture material is identified.

Job Evaluation

Frank DiPalermo
72274.2272@compuserve.com

Abstract: The task of evaluating the job site for a disabled employee can be a complex one, but breaking down the job into its individual components can simplify the evaluation procedure. This article describes the requirements and process used to evaluate, design and implement workplace strategies and technology for a new employee who has a disability.

Assistive Technology Funding in the Workplace

Steven B. Mendelsohn

Abstract: Many employers are unaware of the funding sources available for adaptive technology in the workplace. In this article, Steven B. Mendelsohn discusses some of the potential sources of funding.

An Innovative Interdisciplinary Program: Rehabilitation Engineering Technology

Darlene Miller, Associate Professor
Rehabilitation Engineering Technology
Vermont Technical College, Randolph Center, VT

Abstract: The United States currently faces a shortage of rehabilitation professionals with expertise in engineering technology. The need for rehabilitation engineering technicians, in particular, has been recognized in the wake of new legislation that ensures the civil rights of persons with disabilities and highlights a need for their improved access to rehabilitation services and assistive devices. Responding to this national need, Vermont Technical College (VTC) was the first educational institution in the country to offer an associate's degree program in Rehabilitation Engineering Technology. The curriculum, which focuses on applied science, production, problem-solving and assistive technology modification, promises to produce skilled technicians who can offer a range of specialized products and services to persons with disabilities. As an innovative program, VTC's new Rehabilitation Engineering Technology (RET) program has gained national notice and sparked considerable interest. Other institutions interested in establishing similar programs are eager for information about program content and curriculum.

Departments

Job Accomodations

Joe Lazzaro, Department Editor
lazzaro@bix.com

K-12 Education

Bob Zenhausern, Department Editor
zenhausern@sjuvm.stjohns.edu

Libraries

Ann Neville, Department Editor
neville@emx.cc.utexas.edu

Online Information and Networking

Steve Noble, Department Editor
slnobl01@ulkyvm.louisville.edu

Campus Computing

Daniel Hilton-Chalfen, Ph.D., Department Editor
hilton-chalfen@mic.ucla.edu

ITD TECHNOTES: SPEECH SYNTHESIS

Alistair D. N. Edwards
alistair@minster.york.ac.uk

ABSTRACT:

This is the first in a series of ITD articles on the basics of adaptive technologies. In simple, non-technical language, the author provides a brief introduction to synthetic speech technology which is currently used by individuals with speech and/or visual impairments.

INTRODUCTION

Language is probably one of the most important features which distinguishes humans from other animals and speech is the most important medium of language. So people have attempted over the centuries to build machines which imitate the sounds of speech. It is in recent years, with the advent of digital electronic technology, that this goal has come closest to being achieved. It has to be said that as yet no one has really succeeded in synthesizing a voice which is indistinguishable from a human voice - but I would predict that this is not far away. In the meantime, speech synthesizers are now available which produce speech of a quality adequate for many applications. This article presents a brief introduction to the current technology. Anyone interested in further details might wish to consult my book (Edwards, 1991).

QUALITY

The first characteristic of synthetic speech which a listener notices is its quality, that is to say how closely the voice resembles a human one. It has taken so long to develop adequate synthetic speech because speech is very complex and there are a number of factors which affect its quality. We need to explore some of these factors before we can look at the technology further.

It is generally assumed that the basic building blocks of speech are _phonemes_. The phoneme is the smallest segment of sound such that if one phoneme in a word is substituted with another, the meaning may be changed. For example, substituting the first phoneme in "coffee" could change the word to "toffee."

Because the definition is somewhat subjective, it is not possible to say precisely how many phonemes there are in the English language, but it is generally agreed that there are around forty. One approach to dealing with the problem of differing pronunciations of phonemes is to recognize that variations on the basic phonemes exist which are known as "allophones." So, for example the phoneme "r" may be seen to have two allophones. In a word such as "red" it is voiced, but in "try" it is unvoiced. These are _not_ separate phonemes, because if we substitute one for the other, the word would still be recognizable - it just might sound a little odd. As with phonemes, linguists disagree as to how many distinct allophones there are in the English language, but high-quality speech synthesizers have been developed on the basis of around _sixty_ of them.

In addition to how the individual phonemes or "segments" of speech are generated, speech also includes features which span segments, i.e., "suprasegmental" features. Suprasegmental features impart more information than is contained in the words alone. For instance differences in prosody (the 'tune' of the utterance) can signal the difference between a statement ("It's raining!") and a question ("It's raining?"). Timing is important too. The difference between, "The last time we met Alistair was horrible." and "The last time we met, Alistair was horrible." is signalled by a pause. (Notice how in written language we attempt to communicate some of the suprasegmental aspects of speech through punctuation - in this case a comma). The quality of a voice is judged on both its segmental fidelity (how authentic the phonemes sound) and its suprasegmental features.

The designer of a speech synthesizer has to consider a number of competing requirements; quality is just one of them. In some applications quality is paramount, and in particular this is true when the synthetic voice is being used as a replacement for the natural voice of someone who cannot speak. However, it should be borne in mind that quality is not always so important. There are even situations when a degraded quality is desirable, such as when you want the listener to be aware that they are being spoken to by a machine and not an intelligent person. Also quality may be sacrificed for other factors, notably monetary cost.

TECHNOLOGY

Now that we have some idea of what quality is in this context we can look at the sorts of technologies currently employed to try to achieve the goal. Klatt (1987) provides a very comprehensive review of text-to-speech technology for anyone interested in the details.

If a limited vocabulary is required, then the technique of _copy synthesis_ can be appropriate. This consists essentially of recording a real human voice and storing it in a digital form (much in the way that music is stored on CDs). These stored utterances can then be retrieved and strung together to make meaningful messages. An important choice is how big the stored utterances should be. If you store individual words, then it is possible to create completely new sentences. However they may sound a bit odd because the prosody will be artificial. In particular, the way we say a word depends on its position in the sentence. For example the pitch of words (in British and American English, at least) tends to fall throughout a sentence. Thus, a word at the end of a sentence will be spoken at a lower pitch than if it came near the beginning of the sentence. Copy synthesis is useful in particular applications. For instance, some telephone enquiry systems use it. A telephone number can be pronounced by a program which simply strings together recordings of its digits. Careful listeners may notice that in practice different recordings of the same digit are sometimes used, giving a more appropriate pitch pattern. There are also augmentative communication devices which use copy synthesis. General, useful utterances are stored in the device and can be spoken in response to some form of selection action.

Copy synthesis implies a limited vocabulary - limited to those particular words or phrases which have been stored. Most applications require a much broader, essentially unlimited vocabulary. In general the requirement is to turn text (in a computer-readable form) into speech, usually known as "text-to-speech synthesis." Most such synthesizers are based on translation from text into streams of phonemes (or allophones), which are then made audible by sound-production hardware.

The quality of the pronunciation depends on how good the rules for translation from text to phonemes are. At the same time, pronunciation is often irregular and not expressible in general rules. English is probably one of the worst languages in this respect. For example, what rules could capture the differences between the pronunciation of "bough," "cough," and "though?" To cope with these irregularities, synthesizers generally have "exception dictionaries" which map such words directly into the appropriate phonemes. When a word is passed to the synthesizer, it is looked up in the dictionary. Only if it is not present are the rules for generation of the phoneme strings applied.

Most synthesizers have a male voice. This is mainly because it is more difficult to synthesize a realistic female one; it is not simply a matter of playing the male voice at a higher pitch. Furthermore, most synthesizers speak English - with an American accent. This is not so much a technicality but just reflects their country of origin. There are British English synthesizers and an increasing number of other languages, though the quality of the speech in other languages does not seem yet to match that of the English ones. A few synthesizers are "multi-lingual," the switch from one language to another involving the selection of a different ROM chip.

Most synthesizers are constructed from hardware components. However, with increases in the power of processors and computers having built-in sound generators it is becoming more common to find synthesizers which are implemented in software. A hardware synthesizer may be an external device, in which case it will be attached to one of the computers input/output ports. Alternatively it may be on a "card" which is fitted internally into the machine.

The text fed to the synthesizer is usually in the form of ASCII standard computer code, including punctuation. The connections are usually standard too (such as RS232 serial connection). This level of standardization means that there is some scope for substituting different synthesizers; if you attach any synthesizer to speech-based software you will probably get some kind of output. However, synthesizers vary a great deal in the facilities they have and the way the software controls those facilities. For instance, for one synthesizer it may be possible to embed commands to alter the way the speech will be pronounced (inserting a pause or altering the pitch, for instance). That same command passed to another synthesizer may have no effect - or worse, it may have a completely different effect (inserting a pause _instead of_ altering the pitch, perhaps).

APPLICATIONS

There are many uses to which synthetic speech can be applied, but there are two particular prosthetic applications for people with disabilities: augmentative communication and computer access for blind people.

"Augmentative communication" refers to the use of technology (usually computer-based) to facilitate personal communication. In other words someone who cannot speak for one reason or another may use a device through which he or she can specify utterances to be communicated to another person. The obvious medium of communication for such a device is (synthetic) speech, since it is the voice which is being replaced (though there are similar devices which rely on text - displayed on a screen or a piece of paper). Professor Stephen Hawking, author of _A Brief History of Time_, is perhaps the most celebrated user of such technology.

A person's voice is a very personal attribute; it is part of their self image. Witness people's reaction to hearing a tape recording of themselves. Often their voice does not sound to them as they would like to think they sound to other people. So, for someone who might use a synthetic voice to replace natural speech, its quality is most important. Indeed there are many people who might use this technology but choose not to do so because of the quality.

The other major application relies on the fact that text on a computer screen can be converted into speech. This is carried out by a "screen reader," which is a piece of (usually) software which runs alongside other programs, capturing whatever they display on the screen. The great advantage of a screen reader is that it will work with standard application software, so it is not necessary to develop (say) a talking word processor and a talking spreadsheet. With one screen reader adaptation two standard such packages can be made accessible. The task of a screen reader is quite complex because it is not simply a case of dumping the entire contents of the screen into speech; that would overwhelm the user. Instead the user requires some degree of control. The requirements the user of a screen reader has of the speech synthesizer can be quite different. As a regular user, the person will quickly learn to understand the speech, so that its quality may be less important. Other factors may be brought into account, such as cost and the speed of the speech. Speech (natural or synthetic) is slow - certainly compared to the speed of silent reading. Hence, many blind speech users prefer to hear the speech at an increased speed. In other words, they prefer to put up with a further degraded quality for the sake of efficiency. This is a factor which ought to be borne in mind by more synthesizer manufacturers. (See Blenkhorn, 1994, for a further discussion). Also, cost can be a major consideration and at least one blind user of synthetic speech has suggested that he would rather halve the price of his synthesizer than double the quality.

An important development has been the marrying of speech synthesis with optical character recognition, whereby printed texts can be read aloud by a machine to people who cannot read them for themselves (principally blind people, but also those with other "print handicaps" such as dyslexia). A number of such machines exist and their price has dropped dramatically in recent years. Here again quality becomes important. It is very hard to listen to long passages in a poor quality voice. Given current speech quality, reading machines do not offer a real substitute for a human reader (be they live or recorded) particularly when reading for entertainment.

DEVELOPMENTS

Like all computer technology, speech synthesizers have greatly reduced in price over recent years. As always, the main aim of research and development is to improve quality, and progress is being made. Already synthesizers exist, based on new technology, which produce voices which would be hard to distinguish from a recording of human speech (certainly over a telephone line). What they lack currently is the facility to convert from text to speech in real time. It is only a matter of time before the techniques and technology are developed to the point that this becomes feasible.

SUMMARY

This article has briefly outlined the way in which current synthetic speech technology attempts to achieve the goal of producing human-sounding speech from a machine. Enormous progress has been made in recent years such that synthetic speech of reasonable quality is available at affordable prices. All the signs are that this development will continue, particularly to the benefit of both those people who _need_ to use it because other forms of communication are not available to them.

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Alistair D. N. Edwards (alistair@minster.york.ac.uk)
Human-Computer Interaction Research Group
Department of Computer Science
University of York
York England YO1 5DD

PROJECT LINK: CONSUMER INFORMATION FOR PERSONS WITH DISABILITIES

William C. Mann, OTR, PhD

WHAT IS PROJECT LINK?

Project LINK, established in 1993 at the Center for Assistive Technology at the University of Buffalo in New York, is a free information service to help people learn about assistive devices. Assistive devices are essentially tools--they make it easier to do various tasks. Many people with disabilities are not aware of the wide variety of available assistive devices, or they lack information on where to obtain them. At the same time, companies marketing assistive devices have difficulty reaching people who most need their products, as listings of people with disabilities are confidential. Project LINK bridges the information gap between the people who purchase assistive devices and the companies which make and/or sell them.

To join Project LINK a person calls, toll-free, 1-800-628-2281; alternatively, he or she can fill out a short questionnaire, and return it on the pre-addressed and pre-stamped form. This information is stored in a confidential database. Companies who sell assistive devices can request that Project LINK mail out their product catalogs and other product literature. Project LINK does not give the names of its participants to the companies, but provides a mailing service for information on their products. There is no cost to consumers to register with Project LINK. They join Project LINK knowing they will receive free information in the mail on products that may help them, while having the assurance that no salesperson will contact them. Anybody may cancel his or her free membership at any time. Since the Project LINK database includes information on the types of activities with which people have difficulty, and the types of devices in which they might be interested, companies can have Project LINK carry out very targeted mailings.

DO PEOPLE FIND THE CATALOGS THEY RECEIVE USEFUL?

At the end of last year, Project LINK mailed 1600 catalogs from a company called Maxi-Aids. Included with the catalog was a short questionnaire which asked questions about the usefulness of the information in the catalog and information on assistive devices purchased in the last year. 110 people returned the questionnaire; a summary of their responses is presented below:

- - 88 % responded that they felt the products in the
- catalog were useful.

- 62 % were considering buying something from the Maxi-Aids catalog; examples include: bath lift, cane holder, dressing aids, glucose monitor, needle threader, talking watch, and writing guides. <

- 72 % stated that they discovered products in the catalog that they did not know existed; examples include: automatic lifter seat, autopen, vibrating alarm clocks, dressing aids, jar openers, key holders, and salt detectors.

- Respondents purchased 104 assistive devices in the past year, spending a total of just over $32,000.

- Respondents' acquisitions of assistive devices over the past year were spread among local and national retail stores

- (67%), catalogs (22 %), local doctor or service provider (7 %), and gifts (4 %).

There were many very positive comments about the catalog:

- What a great catalog!
- -Many of these things will be a great help! I will order extensively from this catalog. I had heard of many of these products, but did not know where to purchase them.

Participants also offered constructive criticism, and their comments reflected other difficulties they have in purchasing assistive devices:

- You offered no shower chairs.
- There are several things I would like to buy, but because of low income I can only purchase one thing every few months.
- The index was quite frustrating to use.
- I didn't find any cervical collars.

HOW MANY PEOPLE HAVE JOINED PROJECT LINK?

We now have just under 3000 people who have joined Project LINK. While initially established for elderly persons with disabilities, Project LINK is now open to people disabilities of all ages, their caregivers and service providers. Project LINK seeks new participants, and we hope that people reading this article will call (800)628-2281 - Monday-Friday, 9-5 Eastern Standard Time.

HOW LONG WILL PROJECT LINK CONTINUE TO OFFER THIS SERVICE?

Project LINK is currently supported through funds received from the National Institute on Disability and Rehabilitation Research, as part of a grant for the Rehabilitation Engineering Research Center on Aging at the University at Buffalo. Project LINK's goal is to become self-supporting through funds received from companies that use LINK mailing services. Project LINK will remain a free service for persons with disabilities, their caregivers and service providers, as long as companies continue to use and support this service.

WHO IS THE CONTACT PERSON FOR PROJECT LINK?

Companies and people interested in joining Project LINK can contact Jennifer Weir, Project LINK Coordinator, at:

Project LINK
515 Kimball Tower
University at Buffalo
Buffalo, NY 14214

You can also call Jennifer Weir at the toll free number: (800)628-2281, or register via e-mail: JWEIR@UBVMS.cc.buffalo.edu.

Dr. Mann is Professor and Chair of the Occupational Therapy Department, and directory of the Center for Assistive Technology at the University at Buffalo. Dr. Mann authored the textbook _Assistive Technology for Persons with Disabilities_, and is co-editor of the professional journal, _Technology and Disability_.

C-NOTE: A COMPUTERIZED NOTETAKING SYSTEM FOR HEARING-IMPAIRED STUDENTS IN MAINSTREAM POST-SECONDARY EDUCATION

Andrew Cuddihy
Brian Fisher
Rick Gordon
Elizabeth Schumaker

For Further Information About C-Note, contact:
Elizabeth Schumaker
Learning Support Counsellor
Queen's Counselling Service
St. Lawrence Bldg. Ground Floor
Queen's University
Kingston, Ontario K7L 3N6
Telephone: 613-545-2893
E-Mail: Schumakr@QUCDN.QueensU.CA

ABSTRACT:

Computerized notetaking is an effective tool being used by hearing-impaired students at lectures and seminars in mainstream classes in colleges and universities. This article describes C-Note, a program that provides significant benefit over existing computerized notetaking. C-Note -- developed by a computer programmer who is a student with a hearing impairment and a learning specialist -- allows communication between the student andthe notetaker, independent use of linked computers, and production of hard copy notes from each. The C-Note system architecture is described in detail. Advantages of the system for the student with a hearing impairment are discussed.

Educational implications of using C-Note, and other computerized notetaking systems for hearing-impaired students in the mainstream classroom, are noted. Potential modifications to C-Note are suggested. The need to develop additional learning strategies to help students make effective use of the enhanced quantity and quality of lecture material is identified.

INTRODUCTION

Students with hearing impairments can find the classroom a difficult environment. Classroom learning is predicated on the aural acquisition of information, generally from lectures, questions, answers, and discussion. However, this avenue is blocked for the student with a moderate-to-severe hearing impairment. Universities place a premium on aural learning. Without appropriate resources and support, many people with hearing impairments who want to study within the mainstream university system, find it difficult to pursue their educations.

This article describes C-Note, a recently developed system for overcoming some of these problems. C-Note is a communications package that is designed to allow a student with a hearing impairment to benefit from lectures and participate more fully in the educational process.

PROBLEMS FACING STUDENTS WITH HEARING IMPAIRMENT

Accurate notetaking is exceedingly difficult for a student with a hearing impairment. Reception and transcription of lecture material poses a major challenge because one cannot take notes while simultaniously relying on a visual system of information acquisition. For instance, if the student is an excellent lip-reader, under the best circumstances only about 65% of what is said is received. Additional information is lost when the teacher turns to write on the board, looks down, or walks beyond the point of optimal viewing for the student who is lip-reading. Material presented in an audio-visual format, such as overhead projections, can sometimes be followed, but accompanying verbal explanations are lost.

At present there are a number of strategies being used by hearing-impaired students to acquire classroom, lecture material. For example, manual notetakers may be used, but their interpretation of the material may be selective or incomplete. Some universities use close-captioned systems where a court stenographer types at a keyboard and the text appears on a television monitor, but court stenographers require special training, and their services are expensive and difficult to obtain. Hearing-impaired students may not be able to respond or ask questions unless they and the stenographer are trained in the same signing system.

Some institutions hire oral interpreters or persons trained in sign language to accompany the student. These systems allow the student to follow the lecture as it is happening and ask questions through the interpreter. However, trained interpreters are expensive and scarce. These systems do not permit the student to derive a set of notes without the addition of a manual notetaker.

C-NOTE SYSTEM DESIGN

C-Note uses two linked laptop computers, one for the notetaker and one for the student. The computers are chosen for portability. On each computer the display is divided horizontally into two windows. The upper window displays incoming messages. Text and messages are entered in the lower window and are sent to the other computer.

During the lecture, the notetaker types in lecture material which then appears on both screens. Although previous systems have used this approach, the C-Note system goes beyond this by allowing the student and notetaker to communicate with each other via the computer. With the C-Note software, the student and notetaker can exchange messages over the serial line. The messages are appended into the workspace of each laptop and may be saved to disk on each computer as a permanent record of the session.

Other systems do not generally allow the student to review the lecture material during the lecture. With C-Note, the student can scroll back through the workspace while the notetaker continues to type, facilitating better consolidation of the lecture material.

Special Design Features

C-Note has specific features that assist in the notetaking process. For example, a typist listening to a lecture and typing has little time to make corrections or to observe margins. Simple editing functions are built into the program so that the typist can insert, delete or overwrite text. Automatic word wrap frees the typist to concentrate on the lecture. The word being typed when automatic word wrap forces a new line becomes the first word of that line. When the end of line is reached, the current line is automatically appended to the end of the body of text, i.e., the session log, on both machines.

Each laptop keeps a record of the entire session in its local workspace. Sometimes sections of a lecture must be changed or discarded, for instance, if a lecturer digresses or makes corrections to material presented previously. C-Note has a built-in, full-screen editor that lets the typist or student make large scale changes to the material very easily.

Modes of Operation

In a typical lecture situation, the program is operated in 'chat' mode, which is the default mode of operation. In chat mode, as text is typed it appears in the lower window of the typist's display and the upper window of the student's display. Simultaneously, the student can enter messages. These appear in the lower window of the student's display and the upper window of the typist's display.

The 'edit' mode lets the student scroll back through the material in the local workspace while the typist continues to type. If the student selects edit mode, the typist continues to operate in chat mode, documenting the lecture. Incoming text continues to be appended to both workspaces. If the edit window is displaying text near the end of the student's workspace, new lines of text will be displayed as they are received from the typist.

System Architecture

C-Note is based on a peer-to-peer model. Each machine runs identical software, and participates equally in the communications process. The null modem serial cable is wired so data sent by one laptop is received by the other, and vice versa.

The components labelled 'Popup', 'Editor' and 'PwrEd' are objects operating within the program. Two instances of the PwrEd object have been used. The first is labelled 'PwrEd(1)', to distinguish it from the other, which is labelled 'PwrEd(2)'. When a key is pressed on the keyboard, a scan code is generated. The scan code is selectively passed to the 'Popup', 'Editor' or 'PwrEd(1)' objects depending on the current mode of the program. The default mode is 'PwrEd(1)'.

PwrEd(1) is the power input editor. It handles the task of editing the current line of outgoing text, buffering the data and updating the screen. Scan codes received by PwrEd(1) are echoed to the remote system by passing them to the component 'Tx,' which represents the interrupt driven send routine.

At the other end of the cable, the interrupt driven receive routine, represented by 'Rx' receives the scan code. The incoming scan code is passed to PwrEd(2). PwrEd(2) responds to the incoming scan code in the same manner as PwrEd(1), so the lower window of the PwrEd(1) object looks identical to the upper window of the remote laptop, which is handled by PwrEd(2). This is how the windows are synchronised.

When PwrEd detects the end of a line, either when the user presses RETURN, or if auto word wrap is triggered, then the contents of its buffer are transferred to the local workspace. This is how a log of the session is maintained.

When 'Edit' mode is invoked the users can make changes to the local workspace. They can scroll back through the log, and add, change or delete lines of text. If the edit window is displaying text at or near the bottom of the log, incoming messages will cause the edit window to refresh, so the user gets a true representation of the contents of the log.

ADVANTAGES OF THE C-NOTE SYSTEM

There are many advantages to this system. C-Note lets the student with a hearing impairment receive virtually all of the information presented in the classroom. This is increasingly important in a multimedia lecture environment where more emphasis is placed on interactive learning. The notetaker can not only enter lecture material, but also questions from other students, explanations that follow, and contextual commentary (such as sighs and groans). C-Note also facilitates interactive communication and encourages the student with a hearing impairment to be an active member of the class. The student can type a question or comment and the notetaker can direct it to the appropriate person and then relay the response.

A very important component of the program is the editor window. The scrollback feature (in edit mode) lets the student review portions of the lecture that were missed while copying diagrams or attending to visually presented material. The scroll back function allows the user to catch up and to relate the visual material to the spoken explanation or to a comment or a question. Switching between edit mode and chat mode is accomplished with a single keystroke.

The system is compact, easily portable, and can be stored anywhere. It uses IBM PC compatible hardware, which is easy to acquire and in no danger of becoming extinct. With C-Note, little specialized training is required. The notetaker must have excellent typing skills and be familiar with the course material. Often upper year, undergraduate students or graduate students can be employed.

Educational Implications

The implementation of C-Note pilot project which ran from June 1992 to May 1993 afforded an opportunity to explore the implications of the system.

From the student's viewpoint, difficulties with previous systems included not having complete information to study from: ". . . There is a certain amount of bias and subjectivity on the part of a manual notetaker. It was difficult for me to determine just how complete my notes where. Often it was not until I was faced with an exam that I realized that certain information was not in the text and was also not in my notes. The computerized notetaking is a real boon for me. It never fails to amaze me how much I have missed out on while using a conventional notetaker."

The student, notetaker and lecturer must work as a team. The student and notetaker quickly develop an appropriate short- hand which expedites both note-taking and communication. The student is not a passive member of the team. For instance, one of the student's functions is to follow and transcribe visual material such as overhead projections.

The notetaker must be familiar with the course material, because words and symbols and formulas can be confused. The material comes too fast for the uninitiated to obtain a good verbatim account. Also, notetakers must record all information even if comments or questions by students don't appear to make sense. This gives the student with a hearing impairment a sense of where others in the class are having difficulty.

Clearly, with C-Note, the student's participation in classroom activities can be increased. The student can formulate questions and observations. This can serve to remind the lecturer and class of the student's participation in, and valuable contribution to the learning process. This system thus affords the student some control over the lecture process, and motivates the student to stay 'tuned-in' throughout the lecture. This gives the student a sense of competence, replacing feelings of disconnection and helplessness. Not only is the level of participation in the lecture increased, but after the lecture, the process of reviewing and revising notes from the almost verbatim transcript closely approximates the hearing student's learning experience.

The C-Note Experience in the Classroom

Careful introduction to faculty, staff and students was essential to the success of the C-Note program at Queen's. Objections to the system included concerns about the noise of the keyboard and the continuing distraction for the class because of the new and foreign activity. The student commented that ". . . The noise of the keys was distracting to professors and students early on, but people quickly grew accustomed to the scene and ignored it." Some professors tended to use the noise from the keyboard as a cue for pacing their presentation. The notetakers informed them that this wasn't necessary, and assumed responsibility for alerting the professor, as would any student, when a pause or clarification was necessary. As the school term progressed, some classmates took advantage of the system by sitting behind the notetaker so they could follow along. Consultation and cooperation among student, notetaker, professor, and class ultimately led to increased acceptance of the system. At the completion of the pilot project, the student with a hearing impairment was extremely enthusiastic about C-Note, and commented " . . . I strongly encourage anyone considering trying computerized note-taking to give it a shot ."

It is important to note that technology by its self doesn't solve all problems. The additional lecture information afforded to the student with a hearing impairment requires careful educational support to be properly utilized. If this is not done, the sheer amount of lecture material can overwhelm the student who is accustomed to a more passive role in the lecture process, where decisions regarding quantity and relevance of information have been made by the notetakers. Thus a program such as C-Note dramatically increases both the student's involvement in, and responsibility for, the lecture process. Future modifications to C-Note might involve generating symbol dictionaries, accessible by a single key-stroke, to facilitate notetaking during mathamatics and science lectures. Post- lecture editing functions are now typically accomplished using a word processing program. Word processing functions could be incorporated into the program and tailored to individual needs. The day may yet arrive when professors request a computer of their own linked to the C-Note system to review what has been said during the lecture and perhaps to comment directly to the hearing-impaired student. The time has clearly arrived when technological innovations can reduce or eliminate the educational and social isolation of the hearing-impaired student who wishes to pursue education in a mainstream classroom, and at the same time, prove a benefit to all students.

TO OBTAIN A COPY OF C-NOTE:

1) CNote has been uploaded to CompuServ, IBMSPECIAL forum, to the 'Software' library. The file is called 'CNOTE.ZIP'. The distribution contains the CNOTE.EXE program and documentation.

2) CNOTE.ZIP can be downloaded from the Internet, using anonymous ftp from Kirk.CCS.QueensU.CA, 130.15.246.2, in the /pub/special directory.

3) CNOTE is available on the Queen's Campus at the Micro Information Center in Dupuis Hall. The program may be copied from a master diskette.

JOB EVALUATION

Frank DiPalermo

ABSTRACT:

The task of evaluating the job site for a disabled employee can be a complex one, but breaking down the job into its individual components can simplify the evaluation procedure. This article describes the requirements and process used to evaluate, design and implement workplace strategies and technology for a new employee who has a disability.

EVALUATOR QUALIFICATIONS

It goes without saying that the evaluator should be an expert in the needs of workers with disabilities. He or she should also have up-to-date knowledge of technology available for workplace accommodation. The technology used by people with disabilities is changing even more rapidly than technology used by the general public. This makes it imperative for evaluators to spend at least 10% of their time keeping current with new products. Evaluators should try to attend related conferences such as the "Technology and Persons with Disabilities" conference, sponsored by California State University, Northridge (March in Los Angeles) and Closing the Gap sponsored by "Closing the Gap" (October in Minneapolis). There are many good newsletters dealing with the problems of workplace accommodation. Also most of the companies providing technology for people with disabilities maintain a mailing list and send out product announcements and other items of interest.

THE APPLICANT:

The evaluator should get to know the applicant. As with any applicant, people with disabilities have a wide range of capabilities, education and experience, related to both their jobs and technology. Emphasis should be placed on understanding the applicant's background, as that will help determine levels of training and early productivity expectations. Future aspirations of the applicant will help determine accommodations that will be adaptable to the the employee's job growth.

JOB DESCRIPTION:

Get a copy of the job description prior to visiting the company. This should be examined in detail prior to visiting the job site. Then make an appointment to discuss the job with management. Learn what the decision-makers expect of people who do this job. Ask about limitations associated with the overall environment. What physical space will be assigned to the applicant? The evaluator will need to know if there is sufficient space for things like wheelchair maneuvering and specialized equipment. Determine the financial goals of the company. If the company is paying for accommodations, there are probably expectations in this area.

What is the current level of technology used in this job? An understanding of computer technology used in the job is essential. Most access technology is closely associated with operating systems, software and hardware. Are there technology upgrades in the near future? Most companies are moving into computer systems that use graphics and multi-media presentation. Local area networks are also the rule at many companies. Adapting a network takes skill at resolving conflicts between various hardware and software packages. Care must be taken so that the applicant is not equipped with _dead end_ access technology.

This is also a good time to answer any questions management might have about dealing with a disabled employee. Some people have questions that they might be uneasy asking the applicant, but they might be more comfortable talking with the evaluator.

STRUCTURAL ACCESS:

The next step is an on-site appraisal of the workplace. Start with general accessibility. Is the building accessible? Many buildings have some accessibility already. Some have almost none. Make sure that it is accessible for the applicant. For instance, if the applicant is blind, check for Braille numbers in the elevator and tactile methods to distinguish restrooms and other facilities. Do an appraisal of the office assigned to the applicant. Look for any barriers to your particular client. If the applicant uses a wheelchair, be sure to carefully determine building accessibility. Pay special attention to office layout, corridors, restrooms, and emergency exits.

LINES OF COMMUNICATION:

While on-site, talk with some of the other employees doing the same job. Sometimes what they actually do may vary from the job description. What are the routine duties of the job? Prioritize activities so that important tasks are made a high priority. What are the mobility requirements? If the employees must go to other areas as part of the job, the evaluator should check for barriers along the way and at the other locations.

How is information acquired? Information is the most important part of any job. Make sure that all necessary information is covered in the evaluation. How is the current technology used? Usually employees only use a portion of the technology in computer systems. Make a list of the most important parts. Once again, take this opportunity to answer any questions that employees might have about working with a disabled co-worker.

People who will be working with the applicant will be more comfortable if they know a few basics. For example, don't pet or distract guide dogs. It's OK to ask if a disabled person wants help. This is a good time to search for the _mentor_. Most offices have one person who seems to know how everything works. It is usually a person who likes to help others. Spend a little extra time with that person as he or she will probably take the applicant underwing.

RESEARCH:

During this phase it is important to start with what sort of access technology is available for the systems that this company uses. There are many access products out there, but chances are the list can be narrowed down by finding out which products will work in the company environment. Most often vendors of access technology know whether their product will work correctly in a given environment. It helps to ask for other customers who have the same kind of set up. The pitfalls can often be quickly determined by talking to other users in the same situation. The main mission is to match the access technology to the job and the preferences of the applicant.

This part can be tricky. For instance, let's say that the applicant is blind and the job requires programming. Writing programs is very exacting work. It's important to have every comma in its proper place on the line. Some programming languages even are sensitive to column placement. The obvious choice seems to be refreshable Braille as it gives the user exact representations of the line, but be careful. The applicant may not be a proficient Braille reader, and he might prefer voice output instead. If the job also requires reading a lot of online documentation or email, the evaluator might want to recommend voice and Braille together.

Don't forget the future needs of your client. Make sure that access products have a migration path for the next level of technology. The company might be using DOS text mode applications now, but plans to migrate to Windows in the near future. The transition for the applicant will be easier if the access products also support Windows. Chances are the basics won't change from the DOS to the Windows version, but if a vendor change is necessary, the applicant will have to learn a completely new access product. Try to understand how all accessibility products fit together and whether _bridges_ will need to be built between them. Often vendors will have special adaptations so that their product works smoothly with a product that complements it. For instance, some screen readers can connect to screen enlargers so that as the focus of one changes, it drags the focus of the other along, allowing the user to receive both speech and large print at the same time.

REPORT:

This is the most important phase of job evaluation. The management of the company will respond most favorably if the report covers every aspect of accommodation as well as the costs involved. If the report is complete, it will give management a clear picture of the entire process, including the costs, leaving nothing to chance. It should answer every question before it's asked. The following is a suggested outline of a good report.

- What needs to be done prior to applicant arrival
- Physical barriers that need to be addressed
- Access technology that needs to be acquired and set up
- Customising required for this environment

TRAINING:

Training is a very important issue with job modifications, but one that is all too often overlooked. The typical applicant will often require training before starting a new job. The training should include how the mainstream systems work, as well as how the adaptive technology relates to the total working environment.

FOLLOW-UP:

It's always good to schedule a follow-up session to see if the accommodations are working well and to make any minor modifications to improve productivity. The goal is always for the employee with a disability to learn and function with the same efficiency as others, but the reality is that sometimes there is more for the disabled employee to learn. It's important to explain that to management.

A complete job evaluation ensures the employee with a disability will be competitive with his or her peers and will be able to meet career objectives.

AUTHOR INFORMATION:

Frank DiPalermo is currently the President of Ability Consulting Services, a company chartered to provide consulting services to corporations and individuals that need to meet the requirements of computer users with disabilities. He formerly was the Vision Product Planner with IBM Special Needs Systems and led the Screen Reader/2 development team in making the OS/2 GUI accessible to the blind. To contact Frank call 512 258-1600 or send email:

CompuServe 72274,2272
Internet 72274.2272@compuserve.com

ASSISTIVE TECHNOLOGY FUNDING IN THE WORKPLA

Steven B. Mendelsohn

Technology is key to the performance of a steadily increasing proportion of meaningful jobs in our economy. It has transformed the lives of all workers, but it has been particularly important for people with disabilities because it often represents the best way -- or the only way -- for people with disabilities to perform certain jobs that people without disabilities do in other ways. For example, a worker who is blind may need an optical character recognition system to access printed material, or a worker who is deaf may require a TDD to use the telephone.

The costs of technology are a standard component of the expenses incurred by all businesses. It's hard to imagine the firm without telephones, fax machines, photocopiers or computers.

Nevertheless, when it comes to the added on costs associated with assistive technology, such as the devices noted above, there's still considerable difficulty about how much this technology costs and who should pay.

In analyzing these questions, it is helpful to begin with the premise that assistive technology is part of the continuum of capital costs that businesses incur. For businesses that routinely budget funds for enhancing or upgrading technological capability, the novelty of some assistive technology devices and their difference from what is routinely purchased, may in some cases, be as much the cause of anxiety as the actual increased costs.

Nevertheless, to the degree that assistive devices necessary to employees with disabilities do involve extra costs, it is vital for both employees and employers to understand their respective rights and obligations. Both should also be aware of the third-party resources that exist for subsidizing these costs.

THE ADA

The Americans with Disabilities Act (ADA) can in some cases require employers to provide assistive technology. This occurs in the context of the Act's "reasonable accommodations" requirements, when technology constitutes the most appropriate form of accommodation for a worker with a disability. Applicable to government agencies, nonprofit organizations and businesses that employ 15 or more people, the ADA does not require the provision of accommodations that would impose an undue financial hardship upon the employer. But, assistive technology is not necessarily expensive, and it frequently represents the best solution in the workplace.

Of course employers are free to purchase assistive technology devices whenever needed. When they do, businesses should be aware that the usual range of tax benefits apply. The firm that purchases computer workstations for its employees can always deduct the costs, although sometimes issues arise concerning the period of time over which the deduction can be taken. This tax subsidization is available on precisely the same basis when a business purchases assistive devices to facilitate the work and productivity of employees with disabilities.

SMALL BUSINESS TAX CREDIT

Beyond the usual business deductions, there are additional tax advantages for firms seeking to accommodate workers with disabilities. For small businesses (defined as those with gross receipts under $1 million a year or those with 30 or fewer full-time employees) the Disabled Access Credit set forth in Section 44 of the Internal Revenue Code is of particular importance. This provision allows a business to claim a tax credit for 50 percent of its first $10,000 of ADA compliance expenses each year, above the first $250 of such expenses. In other words, a business that buys $10,000 worth of assistive technology devices for use by employees with disabilities is eligible for almost $5,000 in tax credits to subsidize the cost of "eligible access expenditures."

The business need not have been ordered to provide this technology, and no ADA complaint need have been filed. Availability of the credit does not hinge upon whether the firm would have been required to provide the equipment. Similarly, in the case of a firm with little or no taxable income for the year, it is often permissible to carry otherwise unusable portions of the credit either forward or backward to other years in which taxes are large enough to fully absorb the benefit. Still other tax provisions such as the Architectural And Transportation Barriers Deduction (Internal Revenue Code Section 190) also enhance the tax benefits available for accommodating employees with disabilities.

Finally, the Targeted Jobs Tax Credit, reenacted in the summer of 1993, provides significant tax subsidies for the wages of newly hired people from various disadvantaged groups, including people with disabilities who are referred by state Vocational Rehabilitation programs, and people receiving Supplemental Security Income (SSI).

THE VOCATIONAL REHABILITATION SYSTEM

Many individuals with disabilities enter or reenter employment with the assistance of vocational rehabilitation services provided under the auspices of state programs administered pursuant to the Federal Rehabilitation Act. It is important for disabled workers and job aspirants, as well as current and prospective employers, to bear in mind that these services can properly include the provision of assistive technology devices, or standard tools or equipment, needed for the service recipient to obtain or maintain gainful employment. The determination of services to be provided to each client is made on the basis of the "Individualized Written Rehabilitation Plan" (IWRP), but the authorizing federal statute is now very clear in requiring that assistive technology and "rehabilitation engineering services" be taken into account in formulating goals and in defining the specific goods and services to be provided.

This role of the vocational rehabilitation system is especially important in cases where an employer, in good faith, cannot make the financial commitment necessary to provide needed technology.

CONCLUSION

In this brief paper, only a few of the most important sources of workplace technology funding have been mentioned. Many other sources, ranging from work incentive provisions in Social Security Act programs to nonprofit loan funds operating in a number of states, exist but cannot be discussed here due to space limitations. For the moment workers and employers who need further assistance in this area should be aware of the technical assistance resources available to facilitate compliance with the ADA, and of the resources and information available through the more than 40 state-based programs operating pursuant to the Federal Technology Related Assistance for Individuals with Disabilities Act (The Tech Act). Information about ADA resources can be obtained from the U.S. Equal Employment Opportunities Commission or the National Institute on Disability And Rehabilitation Research. Tech Act programs can be located through local advocacy or service organizations or by contacting the RESNA Technical Assistance Project in Washington D.C.

Steven Mendelsohn is the author of the 1987 book _Financing Adaptive Technology_ and of the new book, _Tax Options And Strategies For People With Disabilities,_ available from Demos Publications, at (800) 532-8663. Mr. Mendelsohn will also be editing a unique new newsletter devoted to assistive technology funding, scheduled to begin publication early in 1994. For more information write to Smiling Interface P.O. Box 2792, Church Street Station, New York NY 10008-2792 (print, Braille, cassette or DOS diskette) or call (415) 864-2220.

AN INNOVATIVE INTERDISCIPLINARY PROGRAM: REHABILITATION ENGINEERING TECHNOLOGY

Darlene Miller, Associate Professor
Rehabilitation Engineering Technology
Vermont Technical College, Randolph Center, VT

ABSTRACT

The United States currently faces a shortage of rehabilitation professionals with expertise in engineering technology. The need for rehabilitation engineering technicians, in particular, has been recognized in the wake of new legislation that ensures the civil rights of persons with disabilities and highlights a need for their improved access to rehabilitation services and assistive devices. Responding to this national need, Vermont Technical College (VTC) was the first educational institution in the country to offer an associate's degree program in Rehabilitation Engineering Technology. The curriculum, which focuses on applied science, production, problem-solving and assistive technology modification, promises to produce skilled technicians who can offer a range of specialized products and services to persons with disabilities. As an innovative program, VTC's new Rehabilitation Engineering Technology (RET) program has gained national notice and sparked considerable interest. Other institutions interested in establishing similar programs are eager for information about program content and curriculum.

INTRODUCTION

Rehabilitation engineers and other rehabilitation professionals have long provided assistive technology to persons with disabilities (Galvin & McLaurin, 1991). An assistive technology device is "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Public Law 100-819). The use of such devices by persons with disabilities has provided important benefits that increase vocational and independent living opportunities for this population.

The number of individuals needing such services is growing. Over 43 million Americans are classified as disabled. In the last ten years, the number of persons with disabilities pursuing degrees on our nation's campuses has tripled (Rothstein, 1991). The need for assistive technology is ever increasing due to better medical treatment, greater advocacy and increasing independence of those that are physically and mentally challenged. This can be seen in the tremendous increase in the number of service delivery programs throughout the U.S. and an increase in the number of manufacturers of assistive devices.

REHABILITATION ENGINEERING AND THE ROLE OF THE TECHNICIAN

Rehabilitation engineering is the systematic application of scientific and engineering principles to address the needs of persons with disabilities (McQuistion, 1992; Childress, 1984). Rehabilitation engineering professionals play a vital role in the removal of barriers to employability and independent living opportunities among this population. Through the use of assistive technology, the employability, education, communication, daily functioning, and recreational activities of persons with disabilities are all enhanced.

A very important factor that must be addressed with regard to educational programs for rehabilitation engineering personnel on the rehabilitation team is recognition that a mix of rehabilitation engineers, technologists and technicians is required. The need for such a mix was recognized by the Rehabilitation Engineering Professional Specialty Group of RESNA, The Association for the Advancement of Assistive and Rehabilitative Technologies. Engineers are not the only professionals involved in the delivery of rehabilitation and assistive technology services. To adequately provide all of the rehabilitation engineering services necessary to enhance the employability, education, communication, daily functioning, and recreational activities of people with disabilities, an effective rehabilitation engineering team must include engineers, technologists, and technicians. Rehabilitation engineering technicians are the team members who fabricate and modify equipment based on the work of the engineer or engineering technologist (Dolan, 1992). They also work closely with the other members of the rehabilitation team: therapists, physicians, vocational rehabilitation counselors, and most importantly, consumers and their families.

New Jersey Institute of Technology (NJIT) was the first institution of higher education in the country to develop programs to train technicians. NJIT's program consists of a 63 credit hour academic program leading to a certificate in Rehabilitation Engineering Technology. Vermont Technical College is the only institution in the nation to offer a program leading to a degree of Associate in Engineering in Rehabilitation Engineering Technology.

VERMONT TECHNICAL COLLEGE'S PROGRAM

To assist in the development of the curriculum for the associate's degree program, VTC established a Rehabilitation Engineering Technology Advisory Committee. Committee members chosen to represent professional members of the rehabilitation team, rehabilitation engineers and persons with disabilities who are themselves the users of assistive technology.

The committee worked closely with the faculty at VTC to develop the curriculum shown at the end of this article. The curriculum is interdisciplinary, incorporating traditional courses in computer, electrical and mechanical engineering technology, technical drafting, mathematics, physics and language arts with specialized studies in biomechanics, assistive technology and physical and psychological aspects of disability. The program uses labs, lectures and a design project to help the students strike a balance between communication skills and technical expertise.

Throughout the program, students have frequent opportunities to interact with people who use assistive technology and with the professionals who provide services. To expose students to assistive technology in all of the areas of rehabilitation engineering, two modifications courses are required. Computer Modifications introduces students to specialized access devices, specialized software, augmentative communication devices, devices for the deaf and hard or hearing, devices for persons with low vision, and environmental control. The Home and Mechanical Modifications course introduces the students to seating and positioning, wheeled mobility, robotics, recreation, adaptive driving, and aids for daily living. In this course, students also learn to assess the needs of the person with a disability in both home and work environments and to design or modify devices to facilitate the employability of the person with the disability.

The capstone of the program is the design project. In the fall semester of the second year, VTC faculty work closely with vocational rehabilitation to identify persons with disabilities who would like to work with the students. Students are paired and assigned a client. In their Disabilities Studies course, students are required to spend time with their client and write a paper assessing the disability and identifying the client's needs. Design projects are completed during the modifications courses and may include design and fabrication of a specialized product or modification of a commercially available product.

The program attracts students with a technical and scientific bent who also listen well to people and value the idea of working on an effective team. The first year of the program attracted eight students from varying backgrounds with varying interests. Three of the students are adults, and three are persons with a disability.

FIRST GRADUATING CLASS

The program will graduate its first class of students in May. The range of interests of this year's seniors varies widely. Of the five students expected to graduate in May, two will complete a dual degree in Electrical and Electronics Engineering Technology, and one will complete a dual degree with Mechanical Engineering Technology. Students are seeking employment in a variety of areas including seating and positioning, computer modifications, devices for the deaf and hard of hearing, sports and recreation, and the modification of farm equipment.

VTC is widely known for its success in placing all of its graduates. Since 1982, an average of 98% of

VTC's graduates have taken jobs within their four months of graduation or have transferred to bachelor's degree programs. The college is also developing an electrical/mechanical technology bachelors degree program which will include a rehabilitation engineering technology option in the near future.

CONCLUSION

Technology for persons with disabilities has advanced past the gadgeteering of early days. Assistive devices are becoming more and more sophisticated and require the expertise of rehabilitation engineering professionals. The rehabilitation engineering technician, as a member of the rehabilitation team, will play a vital role in the delivery of services to individuals with disabilities. Vermont Technical College's Rehabilitation Engineering Technology program will train technicians with the necessary skills to assess needs, identify problems and devise solutions based on available technology.

REHABILITATION ENGINEERING TECHNOLOGY CURRICULUM

YEAR 1

Fall Semester	Spring Semester
Technical Mathematics	Calculus
Physics I	Physics II
English	Manufacturing Processes
General Electronics I	General Electronics II
Computer Software and Programming	Technical Drafting I
Freshman Orientation	Applied Mechanics

YEAR 2

Fall Semester	Spring Semester
Mechanisms	Strength of Materials
Digital Systems	Computer Modifications
Disabilities Studies	Electronic Applications
Technical Drafting II	Home & Mechanical
Modifications	Technical Communication
General Ed Elective	General Ed Elective

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JOB ACCOMMODATIONS

Joseph J. Lazzaro, Massachusetts Commission for the Blind
Lazzaro@Bix.Com

EDITORIAL

I am writing this in hopes that it will spark some healthy debate. As a worker in the rehabilitation field, and a visually impaired person as well, I am very concerned that the very adaptive technology that can assist individuals with disabilities at home, school, and on the job is not getting into the hands of those who need it most. Too many resources are being poured into maintaining large government bureaucracies, and too little goes into actual equipment funding. Thanks to the marvels of the computer revolution, most adaptive systems cost very little, and the prices are sharply declining. A speech synthesizer can be purchased for around one-hundred dollars, and a screen-reading software package for about $75. For less than $200, a personal computer can be adapted for a blind person, a worthwhile cause if ever there was one. But we continue to throw money into programs that do not bear fruit, programs that make us feel good, but provide very little in return. It has been proven that providing assistive technology to persons with disabilities does more than make us feel good. It results in people being put back to work, or entering the work force for the first time. It means that a person goes from a tax burden to a tax payer. It means that a student can enter a college or university, and then move boldly into the work force. For very little investment, we can tap one of our most valuable resources--the skills and determination of persons with disabilities.
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JOB ACCOMMODATION RESOURCES

Braille On the Job:

One of the most frequently ask questions among business persons is how do they produce proper braille for blind workers. In the past, generating braille was a difficult task at best, requiring the skills of a knowledgeable braille transcriber. With the aid of a personal computer and software, producing braille is much easier and faster. Here's what you need to begin printing braille at your job site. You need a personal computer, braille translation software, and (of course) a braille printer. There are numerous braille translation software packages for the IBM PC family of computers and clones. These braille translators consume standard word processing text files, and produce files compatible with braille printers. The first step is to create the source document on a word processor. The output file is then sent to the translator, and the translated file is finally sent to the printer for embossing. Duxbury Systems (Littleton Massachusetts, 508-486-9766), manufactures braille translators for both the IBM PC and Macintosh platforms. Raised Dot Computing (Madison Wisconsin, 608-257-9595), is also a major player in the braille translation market. Braille printers can be purchased from Telesensory (Mountain View California, 415-960-0920), or from Enabling Technologies Company (Stuart Florida, 407-283-4817). Blazie Engineering (Forest Hill Maryland, 410-893-9333), also offers a line of braille access products.

New AbleData CD ROM

The AbleData CD ROM is a trustworthy source of information on assistive technology products. The Trace Center (Madison Wisconsin, 608-262-6966), has created a version of the AbleData database that works well with adaptive equipment. Because of their care to make their product accessible, Trace should be highly praised for their successful efforts. The single CD ROM disk contains about 18,000 listings of various high and low tech products. It is an excellent resource and can be used within an organization or by individuals to perform searches for specific equipment, vendors, or types of devices. Single CD subscriptions are $27.00. Two CD subscriptions are $50.00, which includes the current CD and the next update.

COCA GUI Tutorial:

The ClearingHouse on Computer Accommodations (Washington DC, 202-501-4906), is producing a tape and tactile tutorial on Microsoft Windows. The tutorial is designed to assist blind persons in the comprehension of Microsoft Windows, and its numerous screens, icons, and other graphic objects. As more companies migrate to Microsoft Windows and other graphics-based platforms, the need for specialized training materials will only increase. The tutorial is expected to be available sometime in the first quarter of 1994.

Technology Handbook:

The American Library Association has published a 250-page guide describing how to adapt personal computers for persons with disabilities. _Adaptive Technologies For Learning And Work Environments_ discusses technology for persons with vision, hearing, motor, and speech impairments. The book describes how to select, install, and maintain adaptive equipment for IBM and Macintosh computer platforms. The work also describes how to integrate CD ROM, Network, and online systems with assistive technology. Training and technical support issues are also covered, as is funding for assistive equipment. The book can be ordered from the American Library Association (Chicago, 312-280-5000), or from the Special Needs Project (Santa Barbara, California, 800-333-6867).

Jobs To Be Proud Of:

The American Foundation For The Blind, New York, 212-620-2000, has published a new book focusing on employment of persons with vision impairments. Written by Deborah Kendrick, the text describes numerous jobs held successfully by persons who are blind or visually impaired. The work is upbeat, and covers a wide range of job types.

ADA Toll-free:

The Americans with Disabilities Act is a lengthy and complex series of regulations, and interpretation can sometimes be difficult. For free assistance on the ADA, the nearest technical assistance center can be contacted by calling 800-949-4232. We will attempt to publish this number every issue due to its importance for job accommodation.

Internet Gopher And Jobs:

The Internet contains a wealth of resources relating to employment. However, locating these resources can sometimes be a difficult task. The goal is to locate job-related Internet resources efficiently. Fortunately, Internet tools have been developed that allow for extensive searches to be conducted. You can use the Veronica search utility found with most Gopher menus to search titles of other gophers. Veronica does not search the full text of articles found on the net, but only titles of gophers in gopherspace. Searches of keywords such as "job," "jobs," "employment," "labor," etc, will yield numerous bits of information. Because gopher is menu-driven, navigation is relatively simple. Use "help" or "?" to get assistance from the gopher menu. You can access gopher by typing "gopher" at a Unix prompt or from an Internet provider menu.

U.S. Labor Department Electronic Bulletin Board:

This useful board contains a wide variety of statistical, employment, safety, health and pension information that can now be accessed with a computer and modem. Operated by the U.S. Department Of Labor, information available on the bulletin board includes consumer and producer prices, real earnings, employment and unemployment statistics, job safety and health regulations, job training and other department grants, wage-hour, pension and other enforcement actions. A nationwide listing of federal job opportunities is also available. Call the BBS at 202-219-4784.

Employment Connection BBS:

The Employment Connection is a public bulletin board service for unemployed persons. It operates 24 hours a day, seven days a week. The service is free and provides users with currently available employment opportunities. It also allows users to post their resumes online so that potential employers may view their credentials. The telephone number is 508-537-1862. the board can be called at modem speeds up to 28800 BPS.

DEPARTMENT: K - 12

Editorial Staff K-12 Department

SPRING IS SPRINGING UP ALL OVER

ANNE PEMBERTON, MANAGING EDITOR

Ok, that is a bit trite, but as I write I'm looking out at daffodils, tulips and cherry blossoms, knowing that just out of sight is a new cloud of dogwood that has burst into bloom since morning...

In this issue, our fearless leader Bob Zenhausern, shares some thoughts on the difficult road traveled by LD kids and young adults. Next is a report on Albequerque, and followed by an announcement of an exciting opportunity for high schoolers. This section ends with the introductions and calls for assistance from Mike Holtzman, Technology Editor and Lois Elman, Information Editor. Next issue we will hear from Sheila Rosenberg, Chatback Editor, and Linda Scott, Networking Editor.

Editorial Statement
Bob Zenhausern, K-12 Editor

In August of 1991, I wrote an article on K-12 issues for a special disability-related edition of _Netweave Magazine_. There were two major themes in that paper and those same two themes will embody the editorial framework of the K-12 Department of _Information Technology and Disabilities_.

This Department will focus upon rehabilitation rather than remediation of educational disabilities. This is illustrated in the _Netweave_ article which began:

Learning Disability may be the only handicap in which the affected individual is held responsible for the problem. No one says to a blind child "If you try harder, you will be able to see." Rather we make accommodations for the specific disability and provide alternative approaches. We rehabilitate by teaching them to reach the same goals as the non-handicapped using alternative approaches, e.g. talking books, closed caption, and computers.

The LD child, on the other hand, is often accused of being lazy and not paying attention. The child is told, "If you work harder, you will see it".

Perhaps the best example of rehabilitation as opposed to Remediation can be seen in a series of e-mail messages I received from my nephew at college. Todd was an LD student who fought his way through the special education hoops and hurdles and is now enrolled in a 4 year college. Todd's first message:

School is fine. It is a lot harder then I thought it would be. I'm writing more papers then I did at my last college but I am learned alot more about writing papers so it's not to bad. I'm only takeing 3 class, but I end up having to put alot more time in each of my class then my roommates do just to get the same grades as they do. Sometime it gets to me and I don't feel like going on but I just remind my self of how far I have come and push on. My teachers are good this semester. I go to them alot for help and they set down with me and help me. I also go to the learning center ever day for help on writing. They have helped me get better grades on my papers then if I just did then my self.

A few days later I got the following message:

Hi remmber when I said that I have trouble studing 5 chapters at once well I have to do it for my Tuesday class. This is the class that I know what is going on but when it comes to takeing the test I don't do as well as I want. I know what the problem is. I have trouble remmbering tec words. I can tell you what is going on but sometimes that does not help on a test because the teacher wants just the word.

Todd was saying that his teacher wants the material in a certain way and nothing he learned so far is helping.

Todd has "dysnomia," which is characterized by an individual's inability to find the correct word or words to express himself. We have all probably experienced the frustration of having a word or name "on the tip of the tongue." Ask a dysnomic child "What is a steeple" and they will say, "The thing on top of a church". Ask "What is the thing on the top of a church called?" and they cannot answer. How you evaluate that child depends entirely on which question you asked, even though both questions ask the same thing.

Fortunately for Todd, the teacher was a kind and patient man who gave his time to help prepare Todd for the exam and he ultimately did very well. But that teacher was using remediation! Rehabilitation would have been to ask the questions in a different way! The teacher was helping Todd prepare for a test, rather than preparing a test for Todd. Changing the testing framework would have been easier on both student and teacher.

The whole experience had a very positive effect, as can be seen in this message from Todd after a talk he gave on LD for one of his classes.

This was the first time that I ever gave a speech on this problem and it made me feel special. I liked the idea of telling people of a problem that not too many know about. I also felt that after my speech my class mates treated me a little different. They never treated me bad before but sometimes when I read out loud or spelled something they would make fun of it. Not really me just what I said or spelled. But after, one person came up to me and said I gess I can't bother you about your spelling anymore. I think if it is possible that people who have these problems should say something and teach other people about it so everyone can have a understanding of what a LD person must go threw to learn to make in life.

As Editor of the K-12 Department I intend to press for the application of rehabiliation techniques for the educationally disabled and for education in general. I want to stop preparing individuals for tests and start preparing tests for individuals. Or, from another perspective, design tests to determine what a person does know, instead of what he or she does not know.

The second theme flows from the question: What exactly do we mean by technology? In the Netweave article I gave 4 examples of four different levels of technology, based on published empirical studies and classroom demonstrations.

- Using a verbal imagery approach as an alternative to a verbal repetition approach for children who do not learn by rote memory.

- Using index cards in the Direct Access Reading Technique (DART) which has been shown to be an effective strategy for the reading disabled.

- Using computers for word processing, spreadsheets, communications.

- Using the resources of the Internet.

Does the term technology apply in all 4 solutions? I could make an argument on either side. What I can say unequivocally, however, is that all 4 solutions provide accommodation. As Editor of the K-12 Department I intend to pursue the technology of accommodation as it applies to hardware, software, and mindware.

VIRTUAL REALITY AND THE DEVELOPMENT OF INCLUSION AND AUTHENTIC ASSESSMENT IN EDUCATION

Anne Pemberton, Managing Editor, K12
ALBEQUERQUE, NMr

As we dropped from 30,000 feet to the airport in Albequerque, for the first time the desert landscape became more than just a picture in a book or on TV. My first trip west, I joined Bob Zenhausern, Sheila Rosenberg, Leigh Calnek (Unibase), and Jeanne McWhorter (Diversity University) to present "Virtual Reality and The Development of Inclusion And Authentic Assessment in Education" at the NEA-RMATE conference in Albequerque this past weekend.

To show what K-12 education can do in a moo, we started putting together a play, a Shakepeare play, to be done by small groups of students in distant locations, the groups and intergroups made up of special ed, regular ed, and TAG (talented & gifted) kids middle and high school aged. Hilve Firek, an English teacher at the Southside Virginia Governor's School volunteered to help as director and such (she also chose the play, The Tempest, with the age of the students in mind - with a monster, drinking and fighting - what more could be desired???)

A scene from Act 3 was planned, but the kids needed lots of background in history and lit, and the networks suffered recurring boughts of spring kaflooey, so that most of what I shared in Albequerque was the adventures of getting this far towards the final presentation scheduled for early June.

Jeanne McWhorter, Arch Wizard at Diversity University, shared a glimpse at DU's many distance education projects, including a Freshman English class's interpretation of Dante's Inferno and a 4th grade class's collection of book reviews.

Sheila Rosenberg defined the term Inclusion to mean special students receiving services so that they can work alongside regular students, and Authentic Assessment to refer to the ease of saving the students' learning and adventures for later reference and analysis. Then she shared her New York students' experiences with the networks and showed some student work, including one's brain-storming to describe the character Calaban, the "monster".

Leigh Calnek, from Saskatchewan, talked about the technical side of networking, describing his Unibase system and its ability to make use of a variety of hardware. Leigh added to Unibase the software that makes it possible for language-disabled students to handle the difficult language and vocabulary in the original work. Bob took on the task of pulling all this diversity together. Afterwards enough people came up to get more information to tell us we'd aroused interest!

A powerful weekend was wound down by dinner with Norman Coombs of EASI followed by some tired folks sitting around the lobby of the Doubletree. Eight hours flying home was plenty of time to catch up on sleep and sort out some of the events of the weekend.

DO-IT SCHOLARS: EASING THE TRANSITION FROM HIGH SCHOOL TO COLLEGE

Sheryl Burgstahler

People with disabilities face unique barriers to education and employment. These barriers include lack of encouragement; underdeveloped self-determination and self-advocacy skills; little access to successful role models; social isolation; lack of awareness of and access to technology that can increase independence and productivity; and low expectations of family, teachers, counselors, service providers, and faculty. These conditions result in fewer high school students with disabilities attending colleges and universities than the number capable of college-level work, high drop-out rates, and under-representation of individuals with disabilities in careers that require college-level preparation. Individuals with disabilities are particularly underrepresented in science, engineering and mathematics fields.

The University of Washington has undertaken a project designed to recruit students with disabilities into science, engineering, and mathematics programs. The DO-IT Scholars Program, directed by Dr. Sheryl Burgstahler, helps participants increase their knowledge of science, engineering, and mathematics and gain prerequisite experience to enter these fields of study and employment. The National Science Foundation provides most of the financial support for DO-IT, which stands for "Disabilities, Opportunities, Internetworking and Technology."

The DO-IT Scholars Program consists of three phases. New applicants must apply for admission to Phase I. Admission to phases II and III are based upon successful completion of previous phases and a desire to continue participation as a DO-IT Scholar.

PHASE I

Students accepted into Phase I participate in the following activities.

Internetworking: DO-IT Scholars learn how to use computers to enrich their education and explore career opportunities through information access and communications with college students, faculty, and professionals, on the Internet network. Participants communicate electronically from home using computers, modems, software, Internet network connections, and, if necessary, special adaptive technology. Participants who do not have the required technology are loaned equipment and software for the duration of their participation as DO-IT Scholars. Previous experience working with computers is not required.

Mentoring: Through electronic communications, personal meetings, and joint projects using the Internet, DO-IT Scholars are brought together with mentors (college students, faculty, and practicing engineers and scientists, most with disabilities themselves), to facilitate academic, career, and personal achievements. Participants are matched with several mentors based on shared interests, however, communication with all mentors is encouraged.

Summer Study: During a two-week, live-in, summer program held on the Seattle campus of the University of Washington, DO-IT Scholars study science, engineering, and mathematics and are introduced to college dorm life and campus services. DO-IT Scholars participate in lectures and labs using computer applications, educational software, electronic mail, and resources on the Internet network. Subjects studied by 1993 participants include: oceanography; heart surgery; chemistry; virtual reality; adaptive technology; geophysics; material sciences, civil, mechanical and electrical engineering; mathematics; software training; biology; physics; astronomy; and climatology. Meals and housing are provided for participants and personal care attendants. Accommodations to facilitate a successful academic experience, such as interpreters for those with hearing impairments, are provided.

Other Activities: Throughout the year, DO-IT Scholars and mentors are invited to participate in science-related activities hosted by the University of Washington, corporations, and other organizations. 1993 events included University of Washington Computer and Health Sciences Fairs, lectures, the Westinghouse Science Competition, and a personal visit with Dr. Stephen Hawking.

PHASE II

Upon admission to Phase II of the DO-IT Scholars Program, participants apply their skills and knowledge to independent science projects and return the following year, to the UW campus, for a one-week summer program. Phase II participants also act as mentors to incoming DO-IT Scholars.

Individual Projects: Phase II DO-IT Scholars design and complete independent science projects based on their individual interests. DO-IT mentors and staff act as resources and provide assistance for participants in planning and completing projects. Individual projects currently pursued by 1993 Phase II participants include planning and organizing a tour of Batelle Pacific Laboratories; designing a computer-based CHAT system; working on virtual reality projects; evaluating software; and contributing to an electronic information service.

Summer Study: Phase II DO-IT Scholars return to the University of Washington campus during a one-week, live-in summer program. Participants are given the opportunity to develop knowledge, skills, and interests gained in the previous year by working on joint science projects with faculty and other professionals.

Mentoring: In addition to continuing their current mentor relationships, Phase II participants are given the opportunity to develop and practice communication and leadership skills by acting as peer mentors for Phase I participants, face-to-face during the summer study program and electronically.

PHASE III

DO-IT Scholars who complete phases I and II are eligible for Phase III which includes opportunities to contribute to the DO-IT program through activities agreed to by each participant and DO-IT staff. Specific mentoring responsibilities, scientific resource management, system administration, newsletter editing, working in the summer programs and other DO-IT sponsored events are several of the possible options.

The first group of Scholars began their work and participated in the campus summer program in 1993. They have continued to communicate with each other as well as the mentors, and they continue to access Internet resources throughout the year. They will return for their Phase II follow-up program this summer and will be joined by twenty new Phase I Scholars.

Students with disabilities in the Northwest region (Alaska, Idaho, Montana, North Dakota, Oregon, and Washington), who have an interest in science, engineering, or mathematics as a career, are encouraged to apply during their Sophomore year of high school. Freshmen and Juniors are considered on a space-available basis. Previous experience working with computers is not required to enter the DO-IT program. A complete application consists of three forms:

1. student application, 2. recommendation from a high school teacher or administrator, 3. parent/guardian recommendation and consent.

Personal interviews may also be required before final decisions are made. Applications are reviewed by Advisory Board members. Qualified applicants are selected for participation based on demonstrated interest and aptitude in science, mathematics, and engineering; motivation to participate in DO-IT Scholars; and predicted benefit from the program offerings. For further information or to request application materials in standard print, large print, braille, or audio tape, contact:

DO-IT, University of Washington,
JE-25, Seattle, WA 98195.
PHONE: (206) 685-DO-IT
FAX: 685-4045
EMAIL: doit@u.washington.edu

NOTE: To be considered for acceptance into the 1994 summer program, a complete application must be received by 4/29/94.

INTRODUCTION - LOIS ELMAN

Lois Elman
K12 Information Editor

As Information Editor of the K12 departmen, I roam the fertile fields of Lists, Newsgroups, Gophers and FTP, sorting the wheat from the chaff. I'll be on the lookout for information of interest to educators and parents of children with disabilities in the K-12 grades. This column will be a regular feature of _Information Technology and Disabilities_.

In it, I will summarize online discussions which took place in real time and discussions that consist of posted text in mailing lists and Usenet newgroups focusing on education, various disabilities, and assistive technologies. I will also be reporting on discussions that take place on commercial online systems such as GEnie and CompuServe. At times I will interview the participants of a discussion and ask them to elaborate on their views. Occasionally I will focus on someone who communicates frequently on the Net, as a featured guest.

I will also cover announcements of upcoming events, such as conferences and real-time chats which Internetters have posted. Also included will be postings of relevant computer software programs and new publications.

As the Internet "Gleaner," I will also burrow into GopherSpace and report on relevant depositories of information. Using electronic bread crumbs, I will retrace my steps, and instruct the reader on how to duplicate my path. The column will also include the addresses of FTP sites containing files that will be of interest to many _ITD_ readers. With your help, maybe the Internet Gleaner can spin straw into gold. If you have found an information gem, why not share it? Write to me at

INTRODUCTION - MIKE HOLTZMAN

My name is Michael S. Holtzman, and I will be the Technology Editor for the ITD K-12 section. In my role as Technology Editor, I will troll the Internet and the media for announcements of new technology related to disabilities and rehabilitation. "Technololgy" in this context refers to any contrivance - hardware, software, or combination - that provides alternatives for using any limited-access resource.

In addition to summarizing the latest technological advances, I will be implementing appropriate computer-based solutions at St. John's University. One current project in this area is the St. John's University Electronic Resource Rehabilitation Center. The SJU ERRC is a vast repository of disability and rehabilitation information, consisting of databases and literature unique to St. John's plus pointers to information archived at other Internet sites. I will be coordinating closely with Lois Elman to insure that SJU is the world's most comprehensive and up-to-date source for this type of information.

Future plans include adding World Wide Web access, multi-player virtual reality worlds (MUDs and MOOs), and enhanced network and telecommunications tools. I am always interested in hearing about new developments in technology. Feel free to contact me, holtzman@sjuvm.stjohns.edu, with your discoveries, ideas, and comments.

DEPARTMENT: LIBRARIES

Ann Neville, University of Texas, Austin
neville@emx.cc.utexas.edu

This column discusses library applications of information technology. Instructions for obtaining the resources discussed below can be found at the end of the item.

The Internet and its various navigational tools -- Gopher, for example, or Mosaic, a format for the World Wide Web, provide new ways to get to information, and are becoming standard resources at reference desks that have ready access to them. Developments in this, as in other computer applications, are trending toward graphical and multimedia formats. Mosaic is a very attractive way to package information, and its hypertext access points make it easy to use. Like other multimedia sources, however, Mosaic at first appears to be inaccessible to blind users who have become accustomed to independent access to (text-based) Internet tools and sources.

The information provided below presents a way to make Mosaic accessible to blind users. Darrell Shandrow, a student at Arizona State University and burgeoning Internet expert, sent the information which follows to the EASI discussion list a few weeks ago. Based on his information, we installed it on a server, and users get to it by telnetting to the text-based version of Mosaic.

Below is a revised version of Darrell's post.

A couple of months ago I began to notice something interesting happening on the enormous world of the Internet. It horrified me at first but I have found that there is a solution.

I have been on the net for over 2 years now. At first, email, telnet, and ftp were the only standards in wide use and they were great things. Not only were users able to use these tools to retrieve vast amounts of information but there was nothing in the way of graphics that hampered access to the blind. While the requirement to remember an incredible amount of information necessary to keep track of the various domains for all of the systems was quite a pain, it worked quite well.

Then the wonderful world of gopher came along. Many information resources became available on a great little critter that even allowed you to search much information stored on hundreds of computers around the world. Yes, it was headed for graphics but it was still very friendly to blind users on the net. The gopher critter is still frequently utilized to provide information on the Internet. However, I began to notice a disturbing trend on the Internet. Applications were becoming graphical in nature. There have sprung up numerous Internet tools for Microsoft Windows, Macintosh systems, and Unix boxes running interfaces like X-Windows. I began to think we were going to have a problem. We still might if screen access doesn't improve faster than its current rate but we still have some time. I will now discuss the new trend of providing information via a new interface known as World Wide Web.

When I first heard about World Wide Web (WWW) I began to worry. Those who discussed it on the net and here at school talked about it in terms of X-Windows and the X-terminals down in our Computing Commons. I thought, "Wow, here is another system we are locked out of until adaptive technology companies and researchers get their acts together." I also noticed new services coming online with no gopher access. I was worried since I had become dependent on the friendly interface of gopher. Two examples of Web only services are the mtv.com system operated by Adam Curry and the Palo Alto Weekly newspaper experiment. (Actually, the gopher on mtv.com still exists but Adam was quoted as saying that he was only going to be updating the material on the WWW server.) Well, I used my ability to get around and found us blind users a solution.

I have been a member of the National Federation of the Blind for a considerable time now - over 6 years. (Well, it's a considerable time for me anyhow.) I remembered mentions of a program called Lynx which was a text-based WWW interface. Before my revelation I figured, "well, the web uses hypertext and this depends on highlighted text so how can it possibly work for the blind?" I decided to give it a fair chance.

I was quite surprised to find that the Web is fairly accessible to us after all. No, we can't access any of the image files in a meaningful way but we can most definitely see the text. As I mentioned earlier, the web uses hypertext. WWW uses the concept of a universal resource locater (url) which keeps track of documents that are stored on computers throughout the world. It works like this: The user activates the web program and is placed on the home page of a default server. This page not only has relevant information for that institution but also points the way to other resources. One selects items on the web by placing the cursor on various parts of the screen that contain highlighting. These are known as hypertext links. When a link is selected the relevant document or page is brought up. I guess it's supposed to be like using a hypertext document on a stand-alone computer from something like Hypercard but I wouldn't know that yet. The user also has the option of specifying an url on another machine directly to facilitate quick access to needed information. So, I will now spill the beans on how Lynx works.

As I have stated earlier, Lynx is text-based. However, there are still hypertext links and all the concepts that come with them. Lynx allows the user to select links by pressing the up and down arrow keys only. The cursor is placed on the first letter of the current link. The up and down arrows move between links. There are often several links on a line. The up key moves to the left and wraps up while the down key moves to the right and then wraps down. The user presses either the right arrow or the enter key to select a link. The left arrow key is used to go back up to the previous level. That would be where you were before selecting the link.

Reading links is not difficult. As I said earlier, the cursor is put on the first letter of the link you are pointing at. The user simply directs his/her screen access software to read the current line. Often, there are several links on that line. The user then gets more specific by reading the current word. This word is the first word of the link in question. Since links normally consist of a couple of words it is easy to figure out which words on that line consist of your link. Once the user figures out this process he/she will master reading lines that consist of 3 or more links.

A braille display completely solves this problem. Since at least a forth of the line is on the braille display at one time the user can feel where the cursor is located and the words following it. Often, the link is right under the user's fingers or one advance of the display away from complete visibility. Of course, the display's cursor tracking function must be active when using Lynx in order to have this benefit. I recommend, if possible, the use of both speech and braille when using Lynx. It's this easy, even for a sighted person: after just a few minutes working with Lynx, I was able to turn the screen off and interact effectively and easily with Mosaic. Anything I use routinely at the Reference Desk, and particularly any electronic resource that I use there regularly, I want to make available to library users with disabilities. For blind users and users with other visual impairments, Lynx is a way to make WWW accessible. It seems to work readily with screen review programs; at least, I know that VocalEyes and Flipper present no problems. There seems to be some inconsistency, however, between different communications programs, and it may be that sometimes the tab key will work better than the arrow key.

For the Resources described:

NCSA mosaic: ftp.ncsa.uiuc.edu

LYNX for vt100 sites: ftp2.cc.ukans.edu in pub/lynx

For more information:
Darrell Shandrow
600 E. University Drive
Manzanita Hall
Box 233
Tempe, AZ 85281-2030
(602) 784-0211.
Internet: nu7i@indirect.com
Other Internet addresses:

shandrow@enuxsa.eas.asu.edu
audxs@acvax.inre.asu.edu
GeNie: d.shandrow2 Packet radio: nu7i@n6qmy (directly forwarded to Internet) nu7i@kc7y.az.usa.na (home pbbs)

LIBRARIES AND DISTANCE EDUCATION

The Western Interstate Commission for Higher Education has published a _Guide for Planning Library Integration into Distance Education Programs_. The document, by Vicky York, presents a planning guide which addresses general planning elements as well as specific management issues relating to library service within the context of distance education. In addition, the report presents and analyzes the results of surveys conducted at six institutions of higher education:

- California State University, Chico
- Colorado State University
- University of Alaska Southeast
- University of Maine at Augusta
- University of Nebraska - Lincoln
- University of Wyoming

In addition to survey results and institutional profiles, The _Guide_ provides a bibliography on distance education and library service, as well as "ACRL Guidelines for Extended Campus Library Services." Requests for further information should be directed to:

Mollie McGill
Western Cooperative for Educational Telecommunications
P.O. Drawer P
Boulder, CO 80301-9752
telephone: 303 / 541-0233
Internet: MCGILL_M@CUBLDR.COLORADO.EDU

The Libraries Department is edited by:

Ann Neville
Coordinator, Services to Users with Disabilities
The General Libraries
P.O. Box P
The University of Texas at Austin
Austin, TX 78713-7330
FAC 101
(512) 495-4451
neville@emx.cc.utexas.edu

DEPARTMENT: ONLINE INFORMATION AND NETWORKING

Steve Noble, Recording for the Blind
slnobl01@ulkyvm.louisville.edu

NEWS ITEMS:

A new version of the American Printing House for the Blind's bibliographic database is now being made available to users. The new catalog, _CARL et al_, will eventually contain holdings information for a number of national providers of books available in braille, audio, and e-text formats. The new CARL database uses NOTIS and is in standard US MARC format. _CARL et al_ is currently available only as a dial-in service, however, and users must pay access charges to utilize the catalog. If you are interested in using the database, you can call APH toll-free at 1-800-223-1839 and ask for more details.

AVAILABLE DATABASES ON INTERNET:

A new user interface is now online for the National Distance Learning Center. The new system has been improved to allow greater searching capability and easier methods to download information.

The National Distance Learning Center is a centralized electronic information source for distance learning programs and resources. The NDLC provides users with detailed listings of available courses. The NDLC contains listings of K-12, Higher Education and Continuing Education courses as well as Teleconferences. To reach the NDLC database, telnet to: ndlc.occ.uky.edu login: ndlc

Be sure to read the online documentation. If you have any questions or have difficulty connecting to the database you can call NDLC at 502-686-4556.

Although not a new database, ABLEDATA BBS can now be accessed by way of the St. John's University (New York) gopher. This Internet service allows you to telnet to a government computer which will then use a modem to access the ABLEDATA system for you. To get to the ABLEDATA database, gopher to:

sjuvm.stjohns.edu

Take the following route from the root menu:

Disability and Rehabilitation Resources

EASI: Main Menu

EASI's list of Other Disability Info Access Organizations

ABLEDATA Database

ABLEDATA is an extensive and dynamic database listing information on assistive technology available both commercially and non-commercially from domestic and international manufacturers and distributors. The ABLEDATA project is funded by the National Institute on Disability and Rehabilitation Research of the U.S. Department of Education.

NEW LISTSERV

A new Internet discussion list that may interest some ITD readers is called OCR -- Optical Character Recognition. OCR is open to any discussion relating to the automatic reading of a text by a computer. One of the goals of this mailing list is the creation of a standard suite of TIFF files for benchmark OCR software. To subscribe to the OCR mailing list, address an e- mail message to:

ocr-request@phil.ruu.nl

Since the list is not currently processed by automatic means, your mail need not follow a standard form for subscription. You will be added to the list by the list owners.

DEPARTMENT: CAMPUS COMPUTING

by Daniel Hilton-Chalfen, Ph.D.,
Coordinator of the UCLA Disabilities and Computing Program

hilton-chalfen@mic.ucla.edu tel: 310-206-7133 TDD: 310-206-5155

Campus Information Access, Part I: Recent Study Highlights Access Barriers to Public Information for Print Disabled Students

Course catalogs, schedules of classes and campus events calendars are all essential tools that provide students with timely information that is vital to academic success. But due to their printed format, many students with print impairments, or print disabilities, are unable to take advantage of these key resources. A recent study provides important documentation of these issues in the post-secondary education setting, and identifies pressing legal questions facing campuses today. In his recent masters thesis, Jeffrey C. Senge, of California State University, Fullerton, researched how campuses were implementing print accessibility to campus public information for the print disabled, in compliance with Federal Law (Section 504 of the Rehabilitation Act 1973, and the Americans with Disabilities Act of 1990).

Senge defines print disability here to include students who cannot read standard print due to visual ipairment, learning disability, or physical disability. He conducted a survey of a multi-campus state university system to determine the kinds of accommodations that were being provided to print disabled students to make university public information accessible.

The survey found that in many cases public campus information, including admissions and registration materials, and the university catalog, were not available in any alternative format. Other important materials mentioned included class schedules, university maps, financial aid information, and campus newspapers. The campuses that did provide access relied primarily on live readers.

Senge points out that Section 504 mandates program accessibility, not only environmental accessibility. Further, that Title II, Subpart E of the ADA mandates that "effective communications " be included as a component of program accessibility (28 CFR part 35). Senge states, "This means it is necessary for a public entity to assure communications with individuals with disabilities are as effective as communications with others. This implies if information is presented in a textual format for print readers, the same information should be made available in readable format for non-print readers (i.e., braille, large print, or E-text)."

Senge's research needs to be replicated for other state systems and private colleges and universities. While one must be cautious in generalizing from one university system to the national post-secondary situation, I believe the results represent not a unique situation, but are indicative of the typical barriers to information access found on today's college campuses.

All campuses would benefit from heeding Senge's findings as a wake-up call to become proactive in the area of information accessibility. Campuses that do not may be putting themselves at risk. An important first step for any committee or unit involved in planning campus public information resources would be to consult with your campus adaptive computing specialist on an ongoing basis. Taking a proactive approach is the most direct way to provide equal information access for all.

Coming up...

The greatest opportunities for access to a campus' public information lie in the growing development of Campus Wide Information Systems (CWIS) on college campuses. Adaptive computer technology offers the promise of access to the CWIS for the print impaired. But here too there are significant barriers. In future issues of _Information Technology and Disability_ we'll take a look at how some campuses are addressing this concern.

References:

Senge, J.C., 1993, "Print Accessibility for Print Disabled Students in the California State University System." Unpublished Master's Thesis, California State University, Fullerton.

Senge, J.C., 1993, "Print Accessibility for Print Disabled Students in Post secondary Education." A paper presented at the 1994 CSUN Conference on Technology and Persons with Disabilities."

To request a copy of the thesis or paper send email to the author, Jeffr ey C. Senge, Computer Access Coordinator, Computer Access Lab CS-108, California State University, Fullerton, Fullerton, CA 92634, tel: 714-449-5397, email:jsenge@fullerton.edu

Daniel Hilton-Chalfen, Ph.D.
Coordinator, UCLA Disabilities and Computing Program
Office of Academic Computing/Microcomputer Support Office
5628 MSA
405 Hilgard Avenue
Los Angeles, CA 90024-1557
Voice: 310-206-7133; TDD: 310-206-5155 Fax: 310-206-1700
hilton-chalfen@mic.ucla.edu

Information Technology and Disabilities

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Articles

What's Next in Adaptive Technology: MagNum--A Digital Recording Personal Assistant

Dick Banks

University of Wisconsin, Stout
rbanks@uwstout.edu

Abstract: The MagNum, a device which utilizes digitized recording technology, takes the technology of the recorder one step further by providing the user with an efficient means of accessing notes, books, and other recorded information. This article describes MagNum, a digital recording device which offers many valuable features to the user of recording technology. The present state and future possibilities of digital recording technology are described. While the author is very impressed with the MagNum, this is not a scientific review of this product, and this article should not be taken in and of itself as an endorsement of this or any other product.

Ten Years of Computer Use by Visually Impaired People in Hungary

Terez Vaspori and Andras Arato

arato@iif.kfki.hu

Abstract: This survey is written by the developers of BraiLab, a talking computer family. The authors present an overview of computers and aids based on micro-processing systems used by blind people in Hungary in the past decade. The paper discusses various devices in use in Hungary in the past decade, and the impact of these devices on the education, work and everyday life of visually impaired individuals. Finally, the authors identify some of the tasks looming on the horizon.

Rehabilitation and Remediation in Educational Disability:
The Use of the Direct Access Reading Technique

Sheila Rosenberg and Robert Zenhausern

St. John's University, Jamaica, NY

Abstract: Educational disabilities are treated very differently from sensory and physical disabilities in at least two distinct ways. The first centers around the way the individual is typically held responsible for the disability. The child is told, "Try harder!" or "Don't be lazy!" No one would think to tell a child with a visual, hearing or mobility impairment to try harder to see, hear or move; rather these children are given support and encouragement. Individuals with physical disabilities are given rehabilitation; that is, they are taught alternative ways to approach the tasks that are affected by the disability. Individuals with educational disabilities are given remediation; that is, more and more practice in precisely what they cannot do. The need to "cure" is given more emphasis in educational disability than physical disability where the stress is on adaptation. The purpose of this paper is to isolate two specific disabilities that are the primary cause of reading disability and to show how a rehabilitation approach can have a profoundly positive effect on this ubiquitous problem.

ITD Technotes: Braille Displays
Gerhard Weber

weber@informatik.uni-stuttgart.de

Abstract: Transitory Braille displays provide access to PCs but the displays are different from speech output. Braille is a notation tracking a cursor, and reading the screen and routing are accomplished by the fingers moving across raised dots. This article describes the technology utilized by transitory, or refreshable, braille computer displays.

Review: *Financing Assistive Technology*, A Bimonthly Newsletter
Yolanda Thompson

New Mexico Commission for the Blind

Departments

Job Accomodations
Joe Lazzaro, Department Editor
lazzaro@bix.com

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zenhausern@sjuvm.stjohns.edu

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Ann Neville, Department Editor
neville@emx.cc.utexas.edu

Online Information and Networking
Steve Noble, Department Editor
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Campus Computing
Daniel Hilton-Chalfen, Ph.D., Department Editor
hilton-chalfen@mic.ucla.edu

WHAT'S NEXT IN ADAPTIVE TECHNOLOGY: MAGNUM - A DIGITAL RECORDING PERSONAL ASSISTANT (ITDV01N3 BANKS)

Dick Banks
University of Wisconsin, Stout
rbanks@discover.discover-net.net

ABSTRACT

The MagNum, a device which utilizes digitized recording technology, takes the technology of the recorder one step further by providing the user with an efficient means of accessing notes, books, and other recorded information. This article describes MagNum, a digital recording device which offers many valuable features to the user of recording technology. The present state and future possibilities of digital recording technology are described. While the author is very impressed with the MagNum, this is not a scientific review of this product, and this article should not be taken in and of itself as an endorsement of this or any other product.

INTRODUCTION

For many years, tape recorders have been used by blind and visually impaired users for a variety of tasks including note- taking, reading, and keeping track of appointments and phone numbers. As useful and convenient as this technology is, audio tape technology has some drawbacks. One of tape's major problems is its inability to organize information in an easily retrievable format. For example, looking for a particular chapter in a recorded book can be difficult. Tones are usually recorded at the beginning of each chapter, and the reader fastforwards, listening for the beep which announces each chapter. This can be time-consuming and very annoying.

A tape recorder that could give direct access to recorded information by date, time or subject would be of tremendous value. In order to do this, speech must be recorded, and then translated into a compressed digital format and stored in conventional memory much like computer random access memory (RAM). In digital form, high quality recorded sound would thus be accessible in much the same way that textual information now is.

The development of this new digital technology has been inhibited by the amount of memory required to store even a few seconds of speech of reasonable quality. The MagNum, developed by the Visualaide company, is able to record and store 45 minutes of extremely fine quality speech on a 1.44 MB floppy disk.

The technology required to store speech in an organized manner is very similar to that used by the designers of the Personal Digital Assistant, which stores hand-written information. The ability to store vocalized material in digital form represents a significant innovation for individuals with visual or certain mobility impairments. Plans are in the works for the introduction of a MagNum model which will feature voice recognition input, further extending the potential audience for this new technology.

FUNCTIONAL DESCRIPTION

Recording notes with MagNum is very much like using a tape recorder. In addition, MagNum offers advanced information management functions which allow the user to organize these notes. These information management functions can contribute greatly to the user's efficiency in performing day-to-day tasks. For example, it is possible to keep a "things to do" list in order of priority, manage an agenda, search efficiently in an address book for the telephone number of a colleague, read a book indexed by page number, etc.

MagNum can record as much as 45 minutes of speech on a 3 1/2' disk with a quality comparable to the digitized speech employed by telephone inquiry systems. It is possible to retrieve notes at a rate of 1 to 4 times the original rate without significant distortion and up to 8 times with acceptable distortion.

Because the speech is digitized and indexed, a world of possibilities opens up to the user. In addition to organizing the information as described above, the user can insert new speech without erasing anything, erase speech without losing any space, cut and paste speech blocks, etc.

Magnum's developers have given a great deal of attention to the system's ease of use. The new user will be able to use basic functions of MagNum just by knowing how to use a tape recorder. Power users will like the advanced functions and the shortcuts which enhance efficiency.

TAPE RECORDER FUNCTIONS

The user is greeted with a welcome message at the beginning of each MagNum session. With a disk in MagNum's drive, the user has access to all of the system's functions. That is, she or he can listen to previously recorded notes, record new notes, or insert new information within previously recorded text. When notes are recorded, they are digitized and organized according to Alpha ID, Vocal ID, and Vocal Segment. The Alphanumeric Identifier is composed of up to 8 characters (which can include letters a to z and numbers 0 to 9). It can contain the page number of a book, the date of a meeting, the initials of a friend, etc. The Alpha ID is the element used for indexing the vocal segments and for searching for a specific entry (note, time, etc.).

The Vocal Identifier is the passage of speech recorded by the user for future identification of the vocal segment that follows. It might contain the title of a chapter in a book, the subject of a note, the name of a friend, etc. The length of that message is limited only by the amount of available disk space.

The Vocal Segment comprises the note's content. The user can record notes on a subject, the description of an entry in an agenda, the address and phone number of a friend, etc. Like the identifier, The length of the Vocal Segment is limited only by the amount of disk space available.

These elements (Alpha ID + Vocal ID + Vocal Segment) can be grouped in classes. For example, in the agenda, a day is a class and the hours are elements of this class. This makes the data structure very flexible for all kind of applications.

THE INTERFACE

The user interface is controlled through the telephone keypad. There are three functional levels: the application level, the utilities level and the configuration level. The application level includes the note-taking, agenda or address book applications. The utilities level includes the calculator, clock as well as a disk formatting utility. The configuration level allows the user to control the speech rate, volume, tone, and other aspects of the recorded speech.

NOTE-TAKING APPLICATION

MagNum's default application is the note-taking function; that is, as soon as the system is turned on, the user can begin the note-taking process. With the note-taking application, it is possible to use MagNum as a standard recorder simply by pressing the record key and speaking into the recorder. The user can navigate around these notes using the fast forward and review keys or simply listen by hitting the "play" key. However, limiting use of MagNum to standard tape-recorder functions does not exploit the potential of this new technology, but is rather a little like using a computer as a typewriter.

The process involved in the creation of a note demonstrates MagNum's capabilities. First, the user hits the note key on the keypad, identifies the new note (by entering the Alphanumeric ID and recording the Vocal ID). These IDs will be used for creating a table of contents so that when a note is retrieved, the table of contents will be heard, followed by the vocal ID (the title or subject of the note) and, finally, the Alpha ID. Pressing the "go to" key takes the users directly to the desired note.

In addition to simply recording notes, MagNum's advanced features include navigating the table of contents from entry to entry or from note to note; a "go to" function which moves directly to a desired note or passage; the ability to place markers within a note; and, finally, the ability to block and then cut, paste and move speech segments.

BOOK READING FUNCTIONS

Reading a recorded book is another function of the note- taking applications. Because MagNum aims at offering all functions of the tape recorder and more, special attention has been given to the book reading functions. First, let's say that reading a novel with MagNum does not increase efficiency since one normally reads a novel from page one onward, without needing direct access. But then again, having the possibility to increase the speech rate up to four times the normal rate without degradation is certainly helpful. Those who need to prepare a summary of a novel will appreciate the block functions.

On the other hand, reading a reference book with MagNum is certainly very efficient. Every page of a book can be indexed using the marker function of MagNum. The beginning of a chapter or a section can also be indexed. This allows the user to listen to the table of contents or find a subject of interest in the index of the book and directly access the desired section.

THE FUTURE OF PERSONAL DIGITIZED RECORDING TECHNOLOGY

The future seems to be bright for this type of recording capability. Voice recognition as an input potential promises to extend the usefulness of this product to the physically disabled population. Voice recognition input will permit all commands and functions to be given vocally, a real boon for those with orthopedic disabilities which limit their ability to use the standard keyboard.

There is also an achievable goal for such a product. It is possible to dictate to this recorder and have that recorded message transferred to machine readable text. This would act very much like the voice recognition programs such as Dragon Dictate and IBM VoiceType. Users will be able to dictate text to the tape recorder, and then transfer this digitized speech to machine readable word processing files on a personal computer. The ability to transfer speech from the recorder to the PC, and vice-versa, opens a whole world of possibilities for this emerging adaptive technology.

For further information on MagNum, readers can contact:

Visuaide 2000 Inc.
514-463-1717
FAX 514-463-0120

TEN YEARS OF COMPUTER USE BY VISUALLY IMPAIRED PEOPLE IN HUNGARY (ITDV01N3 ARATO)

Terez Vaspori and Andras Arato
arato@iif.kfki.hu

ABSTRACT

This survey is written by the developers of BraiLab, a talking computer family. The authors present an overview of computers and aids based on micro-processing systems used by blind people in Hungary in the past decade. The paper discusses various devices in use in Hungary in the past decade, and the impact of these devices on the education, work and everyday life of visually impaired individuals. Finally, the authors identify some of the tasks looming on the horizon.

COMPUTERS AND AIDS BASED ON MICRO-PROCESSING USED BY VISUALLY IMPAIRED HUNGARIANS

At the beginning of the 1980s there were nine blind computer programmers in different computer centers in Hungary, where various computers (ICL, Simens, Honeywell) were in use. Some of the programmers relied on their memory from when they could see, sometimes calling on their colleagues for assistance. Five worked with a Hungarian-developed one-cell refreshable braille display connected to the normal display. This showed only one braille character, the character at the cursor of the normal display. The programmers could quickly go through material character by character or line by line with cursor movement keys and could check both texts and messages on the screen. The one-cell braille display was a highly usable tool and it gave its users the ability to work independently.

At the same time, information was available about devices used in the United States and Canada: the VersaBraille System (produced by Telesensory Systems, Inc.) and talking terminals. The school for blind children and the Association for the Blind bought three VersaBraille Systems in 1984 and updated versions in 1989. The equipment was very well-designed and constructed. It was portable and contained a text processing system with braille input and temporary braille output in a twenty-character long line. The VersaBraille could be connected to either a braille or dot matrix printer to produce hardcopy in print or in braille. A terminal program facilitated communication with other computer systems.

Two or three blind teachers used these devices for taking braille notes, writing braille music notations and producing braille materials. Problems emerged, however. Producing inkprint text from braille coded text was difficult, since Hungarian braille does not accommodate the English symbols. Considering only the letters, forty-two dot-codes are necessary for Hungarian. Only twenty-four dot-codes representing letters are common to both English and Hungarian Braille. Instead of the other eighteen letters, different signs were utilized, and of course many other signs also were unique. About forty percent of the characters in an inkprint text would be incorrect.

In addition, the price of this device was extremely high. Except for two or three institutions, nobody in Hungary could afford the Versabraille or similar devices. At the same time the personal computer began to become more common, and it could be seen that many blind people would need to use computers and text editing systems. A cheap, reliable, usable output for the blind was necessary.

We had experience in using tools with a fixed-dictionary speech output (talking watch; SDK85, a System Design Kit combined with a Digi- Talker synthesizer with 144 words). We felt that a new and promising area of development would be synthesized voice output. However, in displaying computer information only a text-to-speech based system can be taken into consideration. The fixed vocabulary system has limited usefulness.

A Hungarian speech system was not, at that time, available on the market. Research was carried out in the field of formant analysis and synthesis for the Hungarian language by the Linguistic Institute of the Hungarian Academy of Sciences. A text-to-speech system worked on a PDP-11 machine in laboratory circumstances. Finally, using the results of the research of the Linguistic Institute, a text-to-speech system was developed in the Central Research Institute for Physics of the Hungarian Academy of Sciences.

On the basis of this artificial speech system, a low-cost, talking personal computer was built in the summer of 1985. The input/output system of the Z80 based microcomputer was modified so that even the screen editing system was usable by visually handicapped people. The following talking programs could be used on the first version of the BraiLab computer: the talking BASIC and the talking Assembler with Disassembler and monitor. 48 Kbyte of free memory was available for programming. This smaller version was designed for teaching purposes.

By the end of 1987, the advanced version of the talking personal microcomputer called BraiLab Plus was ready. It was supplied with a talking version of the CP/M compatible operating system. A talking text editor, a braille printer and a talking database system were also available with the BraiLab Plus computer. The authors developed a contracted braille translator for Hungarian grade two braille. The BraiLab Plus contained 792 Kbyte floppy drive, 64 Kbyte RAM memory, 186 Kbyte built-in RAM floppy, serial (RS232C) and parallel CENTRONICS interfaces. The speech synthesizer was integrated into the computer. The BraiLab Plus was also supplied with a German text-to-speech system. Additionally, the machine could work as a terminal connected to larger computer systems. Both versions (BraiLab and BraiLab Plus) were transportable.

At the same time another talking unit, Mikro-vox, appeared on the market. Together the Technical University of Budapest and the Linguistic Institute developed a Mikro-vox unit fitted to a Commodore microcomputer. That speech synthesizer combined with the Basic-vox software helped blind individuals learn Basic, a programming language. Only five of these devices were purchased.

Since the end of the 1980s, IBM and IBM-compatible computers have been widely used in Hungary. So, in 1991 we created BraiLab PC, an external speech output adapter built with PCF-8200 synthesizer chip, which is connected to an IBM or IBM-compatible PC. The Hungarian text-to-speech software, integrated with an intelligent screen reader program, is loaded into the PC's memory. All the keystrokes, texts and messages appearing on the screen can be heard by the user.

There were other attempts to create an assistive device for Hungarian blind users, namely the PC Talker, by Jozsef Kiraly. He used the SoundBlaster hardware for his purpose. That speech was purer than PCF8200's, cost more and required much more resident memory. About ten Recognita OCR reading devices were sold with this speech.

The developers of Micro-vox constructed a general purpose Hungarian text-to-speech program for PCF8200 formant speech synthesizer. Their version requires about 150 Kbytes of resident memory. This group did not deal with screen readers. Later they developed additional languages for their system.

There were four hundred BraiLab Basic, seventy BraiLab Plus and more than two hundred BraiLab PC adapters sold by the end of 1993. The secret of success for BraiLab devices is in their human engineering solutions.

THE SIGNIFICANCE OF TALKING COMPUTERS FOR HUNGARIAN BLIND USERS

The possibility of computer use by blind people is a great step forward in their obtaining access to information. Let us convey some data about the Hungarian situation to illustrate this fact.

The population of Hungary slightly exceeds ten million people. The Hungarian Association for the Blind and Visually Impaired has approximately 18,000 members. Three primary schools for the visually handicapped serve the entire country. Two of these are in Budapest: one school for blind children and one for partially sighted children. In recent years another two schools with low numbers of pupils (about 30) were established, one in Budapest and one in Pecs. Collectively, these five schools serve about six hundred. There are also 125 visually impaired pupils in secondary schools, and fifty students in higher education. All of these students use talking computers.

The Hungarian Association for the Blind regularly organizes fundamental courses in adaptive technology for beginners. More than two hundred users from all over the country have finished these courses in Budapest. In these lessons blind people get acquainted with the basics of computer operating systems, text editors and data base handlers.

Visually handicapped children learn to use computers in the special school for the blind in Budapest and in the other two schools for partially sighted children. The curriculum includes not only typing exercises on typewriters but on PC's as well. All Hungarian visually impaired pupils learn MS-DOS, text editors and some basic programming by age ten. During their secondary education, which is integrated with that of their non-disabled peers, visually impaired students learn to use adaptive technology.

Computer files are output mainly as braille hardcopy by blind users. Nine braille printers are presently being used in Hungary. BraiLab Plus and BraiLab PC have Hungarian contracted braille publishing systems available for them. These translators are used by the Association for Braille Production, in the primary schools and at the Budapest Eotvos Lorand University. Six programmers recently graduated from the Budapest Eotvos Lorand University and another six graduated from alternative post- secondary institutions.

The use of computers makes many blind peoples' lives easier in several fields of work. Besides computer specialists (about forty people), lawyers (fifteen people) are the largest number of white collar blind workers in Hungary. Lawyers regularly use text editors to prepare and edit their documents. The collection of laws is recorded on CD-ROM and changes to these laws are updated and published monthly. The handling of legal documents by blind users is done efficiently and comfortably with the use of BraiLab PC. CD-ROM publishers have taken into account the special needs of blind users. The screen reader system of BraiLab PC has a special CD-ROM application supplement for this CD-ROM law system.

Ten teachers and linguists work with text editors and they all use and appreciate the advantages of text correction with adapted computers. One of them, a teacher of philosophy, reported that the use of BraiLab computers brought revolutionary changes into blind peoples' lives. Two dictionary programs (English- Hungarian and German-Hungarian) can be used to assist in translation work. These dictionaries are available in both directions as Terminate and Stay Resident programs under the MS-DOS operating system.

The next group of blind computer users (about thirty to forty persons) is more heterogenous. Members of this group include telephone operators, masseurs and librarians. These people mainly use adapted computers in their everyday lives rather than in their work. The talking telephone book and telephone exchange program has just been developed using the BraiLab PC, and it will soon be used by blind telephone workers.

BraiLab users have access, free-of-charge, to the Hungarian developed optical character recognition program _Recognita_ for their personal reading machines. The company which developed _Recognita_ donated the software program free-of-charge to about fifty users. The most common use of talking personal computers is for the writing of inkprinted letters.

The talking Telex program was developed very late. Nowadays telefax machines supersede telex systems. The Hungarian developed PC based Gepard telex systems could not create new employment possibilities for blind people. The talking Teletext systems (from TV broadcast) are used only by two or three users for everyday information retrieval.

Electronic communication is one of the most significant new aids for visually handicapped persons. There are about ten people who have access to the Internet in Hungary. Five of them are university students. Three blind radio amateurs can also use packet radio for electronic communication.

FUTURE TASKS FOR DEVELOPERS

We would like to improve the screen reader of the BraiLab PC. The intelligence of the screen reader can be improved by writing more application supplements for numerous application programs, such as text editors. (We call them application command trees.) These could include "housekeeping systems" (e.g. Norton Commander) and integrated software development systems (e.g. Borlan C++). The other way to improve the intelligence of the screen reader is by creating artificial intelligence algorithms. One can program the main characteristics of windows and the AI algorithm could find the "current window" or the "most important" part of the screen by having it look for its unique screen attribute.

We also plan to develop bilingual screen readers. It is important for a nation whose language is spoken only by fifteen million people worldwide to use a second language. The most common second languages are English and German. In a bilingual screen reader, AI algorithms can be used for sending texts and messages to the proper speech synthesizer.

We intend to build a packet radio extension to the Internet for the use of disabled radio amateur operators. Blind, deaf and mobility-impaired amateurs will then be able to reap the benefits of electronic communication (In Hungary we still have a shortage of telephone lines). The packet radio extension will work with a central full duplex digital repeater with 9600 baud rates in the 430 MHZ broadcast band. We will start in the Budapest area with ten stations. An experimental gateway is already in use with the host name hg5bdu.kfki.hu.

Finally, we are planning to build a self-contained palmtop computer which will include the BraiLab PC features in a compact format. This will enable blind users to carry them anywhere easily, and use them as notebooks, phone books, mobile personal terminals, voice message storage systems, etc.

SUMMARY

The past ten years have provided significant advances for blind computer users in Hungary. This article has illustrated the Hungarian circumstances, the number of blind computer users and the types of devices and applications in common use. Further, this paper has presented a description of some of the projects now under development and others still in the planning stage. While technological progress in Hungary is inhibited by the small number of potential users for such special equipment, significant achievements are still occurring because of the dedication and enthusiasm of the adaptive equipment developers.

REHABILITATION AND REMEDIATION IN EDUCATIONAL DISABILITY: THE USE OF THE DIRECT ACCESS READING TECHNIQUE (ITDV01N3 ROSEN)

Sheila Rosenberg and Robert Zenhausern
St. John's University
Jamaica, NY

ABSTRACT

Educational disabilities are treated very differently from sensory and physical disabilities in at least two distinct ways. The first centers around the way the individual is typically held responsible for the disability. The child is told, "Try harder!" or "Don't be lazy!" No one would think of telling a child with a visual, hearing or mobility impairment to try harder to see, hear or move; rather these children are given support and encouragement. Individuals with physical disabilities are given rehabilitation; that is, they are taught alternative ways to approach the tasks that are affected by the disability. Individuals with educational disabilities are given remediation; that is, more and more practice in precisely what they cannot do. The need to "cure" is given more emphasis in educational disability than physical disability where the stress is on adaptation. The purpose of this paper is to isolate two specific disabilities that are the primary cause of reading disability and to show how a rehabilitation approach can have a profoundly positive effect on this ubiquitous problem.

INTRODUCTION

Kalisky, Zenhausern, and Andrews (1989) distinguished two types of reading disabled individuals that seem to account for a very large percentage of these children. The Phonetic Disabled reader has difficulty converting a word to its sound and the Semantic Disabled reader has difficulty converting a word to its meaning. These are the children who struggle with every word when they read. They are frequently anomic, and suffer from a chronic "tip of the tongue". They have difficulty converting both the printed word and the concepts in their minds into words.

The second type of child is the Semantic Disabled reader. These children will give a perfect word-for-word rendition of text, but have no comprehension of its meaning. They can decode, but decoding does not lead to understanding.

This distinction was verified by the use of two matching tasks. Pairs of words were shown to mainstream, Phonetic and Semantic Disabled readers. The Phonetic group made significantly more errors than either of the other two groups when the task was to determine whether words rhymed. In contrast, the Semantic group made significantly and substantially more errors when the task was to determine whether the words had the same or opposite meanings.

Kalisky, et al. have suggested that these phonetic and semantic disabilities can be directly related to the reading disability on the basis of the standard approaches used when teaching reading. Children come to school with auditory comprehension; that is, when they hear the word "ball" they know it means "a round, bouncy thing." Reading means that when children see the letters b-a-l-l they know it means "a round, bouncy thing". Virtually every reading method is based on the strategy of converting the written word to its phonological counterpart so that meaning is derived from auditory comprehension, that is, the indirect phonological route to meaning. The child sees the word, says the word, and understands the word from its sound. This can be most clearly seen in a phonetic approach, but holds equally well for a sight or "look-say" approach.

This method, while effective for most children, is inappropriate for many of those children who are called "reading disabled." The Phonetic Disabled reader cannot convert the word to its sound, and thus is not able to take the first step required by this approach to reading. The Semantic Disabled reader can translate the words to their sound, but then has difficulty comprehending the meaning of the written word from this sound. Therefore, both the Phonetic and Semantic reading disabilities can be directly related to the indirect phonological approaches typically utilized to teach reading.

Remediation techniques refer to the support system that teachers employ when they alter the direct instructional developmental lessons. They are characterized by utilizing the same learning channels with variation of techniques, instructional group size and demands on student production. Unlike rehabilitation strategies for the blind who learn braille to circumvent their disability, the reading disabled learner tends to receive more of the same instruction (Allington, 1986). While "time on task" and "task analysis" have increased productivity levels, the focus has remained on phonological awareness and segmentation activities.

While the concept of alternate modes of instruction has long been a welcome strategy, alternative techniques such as the Orton Gillingham, Distar, Linguistic Approach, Glass Analysis and the Cassil Span Technique are really variations of the phonological awareness and segmentation procedures which rely on the same neurological systems that are malfunctioning for reading disabled students. A rehabilitative approach is one that does not use those systems.

Fernald (1942) developed a tracing activity which can be classified as a rehabilitative technique when the response of the student is not oral. The student traces the letters either on sandpaper or on a piece of nylon screening to increase the tactile input and then responds in writing, eliminating an oral response. When a student uses large arm kinesthesia and resist methods to learn letter recognition, he is working in alternate modalities. These are rehabilitative techniques that impact on the learner the way braille impacts the blind student, that is, using alternative learning channels. These techniques, however, are time-intensive and are not practical in a large classroom setting. The Direct Access Reading Technique (DART), on the other hand, is more easily incorporated.

DART has been developed as the solution to both Phonetic and Semantic reading disability. If a child has a problem reading that arises because of the indirect phonological route to meaning, then do not use that approach. The child in the Direct Access classroom is never required to read aloud, but is asked to explain what a passage of text means. Trivial deviations in verbiage (e.g., "jet" for "plane") are de-emphasized, at least initially. A typical approach involves pairing the printed word with a picture chosen or drawn by the child.

The picture, rather than the sound of the word, serves as the link between the written word and its conceptualization by the child. Abstract concepts are easily handled by the student. For example, one method used involves a class discussion of a concept (e.g., justice). The children are then asked to draw a picture of the concept based on the discussion. The next section provides a summary of previously successful uses of DART.

EVIDENCE IN SUPPORT OF DART

Maxwell and Zenhausern (1983) isolated 30 first grade children from suburban NY who were considered "at risk" for reading, scoring on average in the 26th percentile on the Metropolitan Achievement Test. Matched samples of 15 students each were selected and randomly assigned to the Direct Access group or to a control group taught by the traditional techniques used by the school.

Both groups were exposed to one of the reading treatments for 25 sessions over a 5-week period. In order to control for differences in teaching ability, both groups were taught by the same teacher who was a reading specialist and who had received specialized training in the Direct Access procedure. At the end of the 5-week period all students were tested with an alternative form of the Metropolitan Achievement Test. The children exposed to DART showed a significant 30 percentile gain in their reading comprehension, while the group using the standard approach showed no change.

Zenhausern, Minardi, and Maxwell (1984) tested 48 Junior and Senior High School students in a New York State B.O.C.E.S. who were considered chronically reading disabled. The students were matched and assigned to the experimental and control groups; the experimental group consisted of 12 Junior and 12 Senior High School students and the control group consisted of an equal number from each level.

Prior to initiation of the study, all participants were given the Metropolitan Achievement Test appropriate for their grade level. The experimental groups received 5 weeks of Direct Access training on a daily basis, while the control group received a special 5-week program in Reading for Meaning. An experienced reading teacher, specially trained in both procedures, was responsible for teaching both groups. At the end of the 5-week period, all students were given an alternative form of the Metropolitan Achievement Test. The Junior HS students exposed to the Direct Access procedures gained 7 months, and the Senior HS students 1.4 years, in their reading comprehension scores; the group using the control condition showed no change.

Kalisky, Zenhausern, and Andrews (1989) tested 200 children in grades 1 through 10, all of whom were reading substantially below grade level. A workshop on the use of Direct Access was presented to the teachers in Greensboro, NC who were then invited to participate in a 10-week trial of the technique. Nine teachers from Grades 1 through 10 volunteered, and the Metropolitan Achievement Test was given on a pre-post basis to all their students. Direct Access was used in the same classroom in which the control groups were taught using standard procedures. The Direct Access group showed substantial gains at all grade levels. The average gain across the entire spectrum was 13.89 NCE (Normal Curve Equivalents), with the 7th and 8th Grade students showing gains of 17 and 18 NCE respectively. The control groups showed an average gain of 2.11 NCE. This study provides evidence that DART can be incorporated into existing classrooms, making it consistent with the goal of inclusion.

In a long term study still in progress (Zenhausern, 1993), students in the Corrective Reading and Resource Room classes of a New York City school were exposed to DART. The students were given DART as part of their regular work for the school years from 1990 to 1992. There is an ongoing consistent trend for students exposed to DART to show substantial gains. There has been a substantial decrease in the number of students falling into the lowest quarter of District-wide norms. The findings must be considered within the framework of virtually unchanged reading scores in District 20, in which the school is located.

The purpose of this study was to report the long term effectiveness of DART with suburban middle school children who were below expectations in reading. This is the first report of its longitudinal use within a consistent and controlled educational framework that allowed the comparison of growth in reading vocabulary and comprehension both before and after the introduction of the program.

OVERVIEW

The study is a longitudinal study of 60 children who were exposed to DART or served as a comparison group. The study took place in a suburban NY middle school in the Learning Lab facility. The Learning Lab is a diagnostic teaching facility for the mainstream where students are assigned by the Support Team for instructional interventions based on developmental skills and learning styles. A multi-disciplinary team assigns mainstream students for assessment and instruction to assist students in meeting curriculum based requirements. Students identified as learning disabled may be assigned to the Learning Lab as well.

Subjects

Sixty middle school students completing grades 6, 7 and 8 were monitored over a two year interval. During the first year no experimental treatment was employed. During the second year, 30 students were included in the experimental DART group and another 30 were included in the comparison group. Of the 60 total subjects, 30 had a special education identification of learning disability and 30 mainstream students were included in the study. The special education students were assigned for reading and language difficulties and/or as a foundation for mainstream inclusion. All were included in the mainstream for non-academic subject assignments.

The 30 mainstream students were referred for services in the Learning Laboratory by the Support Team. These children had learning difficulties which interfered with classroom performance and have been maintained in the Developmental but did not qualify for special education since their achievement scores reflect adequate progress from year to year.

Dart Procedures

Students participated in the expansion of vocabulary utilizing picture association at the rate of five words per session. An individual card file was established with rehearsal strategies that reflect rate of recall. Pictures were either drawn or placed on the back of each card. Students had the choice of using 3 x 5 cards or 4 x 6 cards. Vocabulary was chosen from personal and assigned reading tasks appropriate to their diagnosed instructional level. Students were encouraged to use trade books as their primary source. Some basal material was employed. All students used printouts from network activities as a source for vocabulary development. A green highlighter was utilized for "known" words in students' oral vocabulary but not in reading vocabulary. A blue highlighter was used for "unknown" vocabulary, that is, words not in the student's oral vocabulary. Blue vocabulary words were introduced on the blackboard using colored chalk. Students were encouraged to formulate their own image. Markers were provided for personalization.

Several sessions a month were restricted to rapid drawings with a pencil. Peers and teacher aids worked to develop a visual image of words that were not presented to the group for instruction. Students were invited to choose between drawing pictures and cutting pictures from magazines. National Geographic magazines proved to be an effective source for all cognitive levels. One student who developed most slowly utilized his social studies text as a source with a loose leaf notebook with clear plastic pockets 8" x 11" to retain picture and vocabulary. All students were required to rehearse for no less than five minutes a day with a study buddy.

Reinforcement strategies varied. Memory games, including concentration, were introduced. Once a word was consistently retrieved without cues for three sessions, the card was placed in the mastery list where vocabulary was eligible for assessment in context. Monthly assessment was conducted on each word in the card file to determine automatization. For each student, no more than five words at a time were permitted to migrate from mastery to working list. Students were allowed to use cards during weekly assessment of comprehension tasks. Progress of students was assessed without access to the file box every two weeks. The students engaged in peer assessment, in which 18" x 36" drawings of phrases were evaluated for accuracy by peers; some examples include dense forest, craggy mountain peak, steel yacht, shimmering river.

Evaluation was on the basis of the Iowa Test of Basic Skills (Forms G and H) which were part of the standard testing program of the school. Scores for the spring 1991, 1992, and 1993 tests were used.

Results

The scores on the Iowa tests for both experimental and comparison groups are presented below (Table 1). These data were subjected to a split-plot analysis of variance with Group (Comparison and Experimental) as the between factor and Area (Vocabulary and Comprehension) and Year as the within factors. The analysis indicated that the main effect of area was significant ($F_{1,58} = 9.97$, $p < .01$) with the Vocabulary subscale (Mean = 43.68) higher than the Comprehension subscale (Mean = 40.01). The main effect of Year was also significant ($F_{2,116} = 19.33$, $p < .01$) and Neuman-Keuls analysis indicated that the scores for 1993 (Mean = 44.75) were significantly higher than the scores for 1992 (Mean = 39.81) and 1991 (Mean = 41.06).

Table 1

PERFORMANCE (NCE) FOR DART AND COMPARISON GROUPS FOR THREE YEARS FOR VOCABULARY AND COMPREHENSION SCORE

	1991	1992	1993
Vocabulary			
Comparison	45.13	45.00	43.77
Experimental			

Comprehension	39.40	39.17	39.67
Comparison	45.03	41.83	39.67
Experimental	34.67	33.23	45.93

Of most importance, however, was the significant interaction between Group and Year ($F_{2,112} = 47.01$, $p < .01$). The means for this interaction can be seen in Table 2. A simple effects analysis showed that there was a significant difference among the three years of the study for both the Comparison and Experimental groups, but the pattern was different for the two groups. The Comparison group showed a steady and significant decline for the three testing periods, but the DART group showed a similar initial drop, followed by a substantial gain. The Comparison group scored higher than the Experimental group for the first two testing periods, but this was reversed for the year following the introduction of DART when there was a substantial gain in mean performance.

The results are clear and need little interpretation. Two groups were followed for three testing periods. Initially, the Comparison group scored significantly higher than the Experimental group and the scores for both showed small losses after the control year of the study. The Comparison group continued this gradual decline after the treatment year, but the Experimental group showed a sharp increase.

Table 2

INTERACTION OF YEAR AND GROUP PERFORMANCE (NCE)

	1991	1992	1993
Comparison	45.07	43.42	41.57
Experimental	37.03	36.20	47.79

GENERAL DISCUSSION

The most important practical implication of this study is that a Direct Access approach has been shown to be effective with a chronic special education population. There are, in addition, theoretical implications underlying the effectiveness of the technique. DART is based on the neuropsychological framework of individual differences and the isolation of two distinct subtypes of students with reading achievement problems. The Phonetic Disabled child has a syndrome of problems that are related to the functioning of the brain center that deals with the conversion of mental concepts and perceptual input to the spoken word. They show evidence of dysnomia and phonetic disability. This pattern is consistent with a problem with the left hemisphere speech centers of the brain.

The neuropsychological basis of the problem for the Semantic Disabled child is less clear although the behavior itself is evident. This child has learned to make the connection between the printed word and its sound, but has not learned to make the connection between the printed word and its meaning. It is not an uncommon experience for any of us to suddenly realize that instead of understanding what we were reading, we were merely mouthing words. Whatever this state may be, it is a chronic state for the Semantic Disabled reader.

This model has important social and political implications. A student with an educational disability (e.g., chronic dysnomia) has a disability as surely as a student who is blind and is just as entitled to an accommodation for that disability. The accommodation, however, cannot be typical remediation techniques where the student is given help doing the task within the standard educational framework. Rather the student must be offered an alternative approach which is based on his or her strengths rather than weaknesses.

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ITD TECHNOTES: BRAILLE DISPLAYS

Gerhard Weber
F.H.Papenmeier GmbH, Schwerte and Universitaet Stuttgart
Institut fuer Informatik, Breitwiesenstr. 32, 70565 Stuttgart
weber@informatik.uni-stuttgart.de

ABSTRACT

Transitory Braille displays provide access to PCs but the displays are different from speech output. Braille is a notation tracking a cursor, and reading the screen and routing are accomplished by the fingers moving across raised dots. This article describes the technology utilized by transitory, or refreshable, braille computer displays.

INTRODUCTION

Louis Braille (1809-1852) developed a code that is read by fingers moving across a series of raised dots. Braille has come into use worldwide, and can even be used in those languages that have pictorial alphabets, as well as in languages with phonetic- based alphabets.

With dedicated programs the transcription of text into Braille can--to some degree--be handled automatically through Braille printers that emboss Braille on paper. Braille is a useful alphabet for blind people when they use computers. The design of Braille displays and their common features are described below. Besides speech-based interaction, Braille is a good alternative for those who have learned to read it, and the combination of Braille and screen-readers is beneficial for many people. The initial cost for a Braille display (compared to a text-to-speech synthesizer) may be worthwhile in the workplace, because it offers faster interaction with standard MS-DOS software (Espinola & Croft, 1992).

LEARNING BRAILLE

Let's look at an example where a student learns Braille Grade I and contracted Braille (Grade II) in her native language. If she takes courses in mathematics, chemistry, music or foreign languages, she also needs to learn the proper notation used in these subjects. Of course, the core alphabet remains the same but special symbols are added (for example an integral sign in mathematics or punctuation marks that differ between European and U.S. Braille).

Each character in six-dot Braille consists of a combination of raised (and lowered) dots in a (2,3) matrix. Figure 1 gives an example. Touchable (raised) dots are drawn with the character 'o', untouchable dots are marked with a period. Above each Braille cell the corresponding print character is shown. The first character in Fig.1 announces the capital B character. Six-dot Braille codes use other "escape characters" to enlarge the character set.

```
   B  r  a  i  l  l  e
.o o. o. o. .o o. o. o.
.. o. oo .. o. o. o. .o
.o .. o. .. .. o. o. ..
```

Fig.1: Sample text "Braille" in German six-dot Braille

An appropriate Braille display working as a computer terminal shows every character in Braille on a one-to-one basis as it would appear in print on a screen. Traditional Braille is sufficient for note-taking (as it is possible with Braille laptops) but the character set of modern computers is based on seven bits or even eight bits, hence requiring more Braille characters. Most modern Braille displays make use of a technology for Braille with eight dots instead of six dots to extend the number of characters. Fig. 2 shows an example of eight dot Braille. Besides a standard for seven-bit ASCII, an industry standard exists for eight- dot American computer Braille. For European languages a similar industry standard exists which is based on code pages for the IBM PC. The main difference between computer-oriented Braille codes used in Europe and North America is the way digits are treated: the digit n in Europe is coded by the nth character of the alphabet with an additional dot 6 (for example, c = dots 1 and 4, 3 = dots 1,4 and 6) while in North America the nth character is shifted down one row in the matrix to represent digit n (c = dots 1 and 4, 3 = 2 and 5).

A D A 9 4
0. 00 0. .. .0 00
.. 0. .. .. 0. .0
.. .. .0 .0 0. 0. 0. .. ..

Fig. 2: Sample text "ADA 94" in eight-dot Braille

The speed of experienced Braille readers (58 words per minute) is in some cases superior to readers using a CCTV (30 words per minute) (Denninghaus & Hupfield, 1987). Since Braille can be produced with only a stylus and a slate, its basic technology is cost effective and portable. A mechanical note-taker is much faster than writing on a slate, also portable, and very reliable. The use of transitory Braille displays connected to a computer is also suitable for communication with sighted readers.

TECHNOLOGY

Transitory Braille displays consist of a varying number of Braille modules. The number of modules built into commercial Braille displays is 20, 27, 40, 80 or 2x80. One manufacturer produces a Braille display with a vertical array of tactile pins in addition to the horizontal Braille modules. The exact number of Braille modules depends on issues such as portability, price, and the type of applications that are primarily used.

Technology for a single pin which is either set or reset can be electromagnetic or piezoelectric. The piezoceramic pins used in the Optacon are not used in transitory Braille displays as they are vibrating. An electromagnetic pin is in a casing (less than 3 mm in diameter) which contains a spring to set the pin (default) and a coil around a tiny rod of iron. If the iron is magnetized by the coil through induction, it pulls the pin (approximately 40 mm long) downwards. The pin is no longer raised.

A piezoelectric Braille display is a combination of a piezocrystal and a strip of metal (approximately 40 mm long, 2 mm wide, horizontal orientation). The piezocrystal reduces its length if a voltage of about 200 V is applied. As the metal does not change its length the stripe bends upwards and lifts a little pin. The force applied by the piezocrystal can reliably withstand the mass of the finger. When the voltage is stopped, the strip returns to its normal shape and the pin is no longer raised.

Because of the differences in orientation of the attenuators, piezocrystals cannot be built in arbitrarily large arrays. The only large tactile display--the pin-matrix device with 60 rows, each with 120 pins--is based on electromagnetic technology. The advantages of a piezocrystal are low power consumption and low noise emission, which make it the preferred technology.

Several approaches exist for virtual Braille displays. A virtual Braille display uses only one Braille module in combination with a pointing device. This can be a mouse with one Braille module built in (Braille Mouse). Another approach for a virtual Braille display is to put one Braille module into a little carriage that can be moved horizontally. Whenever a new position is reached it is detected by the computer and a new character is displayed. While cost effective, none of the currently tested virtual Braille displays has been suitable for the majority of Braille readers.

A transitory Braille display with 80 modules can display exactly one line of text shown on an Apple II computer, IBM PC or compatible. By using two extra-large keys, the reader can select other lines through going upwards or downwards. Reviewing does not interfere with an application program and is made easier through extra-keys to go to the top or bottom of the screen, to marked lines or to the cursor.

The cursor is a unique character, usually marked by all dots raised. In some cases it is only marked by dots 7 and 8 to allow (partial) reading of the character below the cursor.

Whenever the cursor changes its position, the Braille display tracks it. Hence the position of the cursor changes, the line shown on the Braille display changes. Tracking the cursor is not easy in modern application programs because of the use of softcursors. A softcursor marks a particular spot by a unique character or a unique attribute (e.g., a highlighted word). The softcursor may be many characters wide (even covering many lines) and so the user must decide which end is to be followed.

Modern Braille displays have an extra input key or sensor (called the Braille or "routing" key) above the Braille pins. While working in a text editor the user starts reading the contents of the screen using the up/down keys. If he wants to change a particular word he has spotted, he should go back to where the cursor was and press arrow keys to bring the cursor to the desired spot. Using the Braille key, this task is much easier and faster. After pressing the Braille key, the Braille display automatically generates the right kind and number of arrow keys to make the cursor move to the Braille module being pointed at.

Tracking and routing are techniques that also apply to the mouse cursor whenever it is useful in DOS applications. Some new Braille displays are capable of replacing the use of a mouse with the use of the special Braille keys.

There are many different Braille applications and ways to use them. Adapting a Braille display to a particular non-standard application can be handled by experienced users through various input methods: a) through the use of function keys found on the Braille display while working with the application, b) through a separate application program which generates a file containing parameters, or c) through a combination where the user can write some parameters on the screen and tell the display to read them only from there. Nevertheless, the preferred input method is through parameter files being sent to the Braille display whenever a particular application is about to start and only occasionally changing the settings on the fly. As with screen-readers for speech output, there is no common way to adapt.

DEVELOPMENTS

The first generation of Braille displays was used to convey less structured text, and were used for telephone operator displays, or for personal note-taking. The second generation of Braille displays was used to adapt existing devices such as terminals or typewriters. Only with the third generation, access to personal computers with random access to the screen and tracking of softcursors has become available. Finally, the fourth generation of Braille displays is also capable of cursor routing and has facilities for adaptation to non-standard application programs.

Braille displays can also be used in portable computers. Several new developments have been made to integrate 20 or 27 modules with a 486 notebook computer. Some even have Braille keys for routing input. Of course, review is more time-consuming as each line can only be read by three or four extra keystrokes, but the resulting portable devices can be operated approximately six hours without an external power supply.

The main difference between portable Braille computers and desktop systems stems from the lack of a hardware solution. Braille displays for desktop PCs can be built around an adapter card that implements tracking, review and routing independently of any operating system. Hence such a Braille display is also immediately suitable for a UNIX environment, during start-up of the PC (for instance to handle "setup"), or can run simultaneously with a speech-based screen-reader. Nevertheless, there are several Braille-based screen-readers for DOS that can interface through a serial or parallel port with a large or small Braille display.

Finally, Braille-based screen readers for access to graphical user interfaces (MS Windows) are now available or under development. We do not yet know if either Braille or speech is more suitable for access to GUIs, but a combination of both has been beneficial (Mynatt & Weber, 1994).

SUMMARY

Braille is a different modality to get access to computers, compared to speech output. Braille is read by the fingers and is produced through mechanical typewriters or through a QWERTY keyboard using a PC. Each module of a transitory Braille display consists of six or eight pins. The technology that makes a little pin move upwards or downwards is either electromagnetic or based on a piezocrystal. Braille displays--like speech-based screen- readers--implement tracking of the cursor, reviewing the screen, and routing. Unlike speech output, the user can effectively and accurately recognize each character while reading, and he may point at it for routing. Four generations of Braille displays exist, each providing more features to work efficiently and accurately with standard application programs.

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REVIEW *_FINANCING ASSISTIVE TECHNOLOGY_: A Bimonthly Newsletter (ITDV01N3 REVIEW)*

Edited by Steve Mendelsohn

Smiling Interface
P. O. Box 2792
New York, New York 10008-2792
Telephone: (415) 864-2220

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Reviewed by: Yolanda L. Thompson

The focus of this newsletter addresses a concern of consumers, service-providers, and public policy makers: How can assistive technology be funded? The first issue not only examines one possibility of funding, but shows promise of exploring the topic in depth in subsequent issues.

The newsletter is broken down in to five sections:

1. Editor's Welcome
2. Feature: Reauthorized Tech Act Provides Funding as a priority
3. Program Focus: What Does a Technology Funding Specialist Do?
4. Reviews: Books and Directories on Funding
5. Small Business Corner: The Disabled Access Credit: A Tool for Lowering the Cost of Assistive Technology

EDITOR'S WELCOME

In this section, Mr. Mendelsohn sets the foundation of the newsletter by establishing its goal: "...to enhance the level and utilization of resources to pay for assistive technology that so many Americans want and need." The methods used to achieve this goal are: to provide information on assistive technology funding resources, to offer a vehicle for the sharing of experiences, to establish a venue for discussing and marshalling proposals for making technology more affordable and accessible.

The importance of technology in employment, education, and personal life is discussed, but Mr. Mendelsohn states that technology remains illusory for far too many people. He continues by stating that living with a disability costs more than living without a disability, and this is evidenced in technology. Two reasons are given for this:

Sometimes technology is needed to perform tasks which normally don't require it. In other activities, technology may be needed for anyone to perform the task, but people with disabilities require assistive peripherals in order to access the original technology.

Mr. Mendelsohn concludes by stating that efforts to increase the availability of assistive technology make good sense for businesses who need customers and employees, good sense for government that seeks to reduce dependency, good sense for every institution from every point of view.

Mr. Mendelsohn ends this section by providing his credentials for editing such a newsletter. These include a decade of research and advocacy for assistive technology funding, a book published in 1987 (_Financing Adaptive Technology: a Guide to Sources and Strategies for Blind and Visually Impaired Users_), and his new book (_Tax Options and Strategies for People with Disabilities_). He concludes by stating that as an attorney, as an individual with a disability, and as a citizen, he can bring perspective and commitment to his role as editor.

FEATURE: REAUTHORIZED TECH ACT INCLUDES FUNDING AS PRIORITY

This article begins by stating that on March 9, 1994, the President signed into law the Technology-Related Assistance for Individuals with Disabilities Act Amendments which will be extended through September 1998. Mr. Mendelsohn states that in the area of assistive technology this means many of the original positive programs can be retained, and some features worth knowing about have been added. He then moves in to the background of the original Act.

According to the author, the Tech Act was the first major federal legislation to specifically address assistive technology as a topic worthy of Federal attention and financial support in its own right. He discusses Title I which authorizes grants to states to operate statewide programs of "Technology-Related Assistance."

Title II of the Act provides authorization for programs of national significance. These programs are not operated through states, but are implemented by grants, contracts, or other agreements between the federal government and various entities. Mr. Mendelsohn notes the productive studies which have been conducted with Title II funds, and comments on the excellence of the March 1993 "Study On The Financing Of Assistive Technology Devices And Services For Individuals With Disabilities."

He points out how Title I is not a direct-service program like Vocational Rehabilitation, or an Entitlement program such as Medical Assistance. Even if a state wanted to spend the bulk of its funds on equipment purchases or services delivery, Mr. Mendelsohn shows how with a limited annual allotment of funds-- ranging from $500,000 to $1.5 million, states would be able to do little.

According to Mr. Mendelsohn, the Amendments of 1994 were implemented by Congress because despite states' efforts, there is still a lack of resources to pay for assistive technology. He then discusses some of the programs states might implement with the funds: demonstration centers, information centers, short-term loans, and redistribution centers.

He discusses advocacy, and takes an in-depth look at redistribution as an option. He discusses "universal design" and shows how mainstream technology should take the responsibility of adapting equipment for "all" potential users thereby reducing the need for assistive technology.

Mr. Mendelsohn points out that Title III is called "Alternative Funding Mechanisms" and its name should portray the potential importance of this Section. He explores Title III in depth, discussing its duration, dollar amount limit, and goals.

He concludes by commenting "Even in this era of budget stringency, the Tech Act, as is possible with small but highly visible and effective discretionary programs, has witnessed a steady increase in appropriations levels, to the point that total authorized expenditures for FY 1994 have risen above 50 million."

PROGRAM FOCUS: WHAT A TECHNOLOGY FUNDING SPECIALIST DOES AND HOW CONSUMERS CAN BENEFIT

This is an interesting interview with Pat Ourand, Technology Funding Specialist for the Maryland Technology Assistance Program (MD TAP). The interview begins with how Ms. Ourand became interested in Technology Funding, and continues by discussing the MD TAP. The discussion then moves to the job duties of a Technology Funding Specialist.

The interview is well done, and the knowledge that all states except Arizona have Technology Funding Programs give consumers a starting point. The RESNA telephone number is also listed so that consumers can find out who manages the Technology Program in their state.

REVIEWS

In this premier issue, a bibliography of work underway in the technology area is provided in lieu of book reviews.

SMALL BUSINESS CORNER: THE DISABLED ACCESS CREDIT CAN REDUCE THE COST OF ASSISTIVE TECHNOLOGY FOR SMALL BUSINESS

The information in this article was taken from the Editor's new book, _Tax Options and Strategies for People with Disabilities_. The article is well written, and can be an excellent tool for individuals with disabilities who are promoting access in buildings and job accommodations. The article defines what a "small business" is, and the dollar amount which can be deducted. The question and answer format makes it easy to follow, and would be easy to reference for quick access to the information.

This newsletter shows much promise as a reference tool for businesses, individuals, and agencies. Although the focus seems to be a little heavy on the legal side, the outlined article prospects for the coming year include a more rounded menu. A variety of authors would assist in giving each morsel of information a different flavor, but it is difficult to be too critical of the "first" issue.

DEPARTMENT: JOB ACCOMMODATIONS (ITDV01N3 JOBS)

Joseph J. Lazzaro
lazzaro@bix.com

EDITORIAL

Since the early 1980s, persons with vision impairments have witnessed the birth of a new generation of information access. Gone forever are the days of waiting weeks and months for audio tapes and Braille books to be manually transcribed. This long awaited change in our capability came in the form of the personal computer and adaptive technology merged with the online world. Assistive systems like speech synthesizers, Braille embossers, and screen magnification software have allowed the blind community to independently access stored online information on demand. So far, the online world has greatly expanded information access. But in the future, we may lose the high degree of access we have come to depend upon. Future technical developments on the Information Superhighway and the Internet may pose grave dangers to the current level of information access. We shall discuss some of these potential problems and some solutions in the next paragraphs.

Currently, individuals with vision impairments using adapted personal computers can employ the Internet to perform many functions: sending and receiving electronic mail, transferring text and other files, accessing document archives, searching databases, reading newsgroups and mailing lists, even live chatting and social interaction. Clearly, the Internet is a powerful tool, one that we would not want to lose under any circumstances.

The problem is fairly simple. As a whole, the computer industry is moving towards the graphical user interface. Following this trend, the online world is also going graphical, with many services building new graphical user interfaces even as these words are being written.

The new graphical online services and Internet tools may effectively close the door on information access if bold steps are not taken immediately. This is not to say that the graphical user interface should be banned or disallowed. We merely require a graphical user interface that can be used effectively and reliably with adaptive equipment.

Currently, the bulk of adaptive technology is compatible with text-based interfaces, although there are a few emerging graphics-based access technologies. Although the various adaptive vendors have performed a heroic feat with the creation of several graphics-based screen reading programs, these programs are not yet as reliable as their text-based counterparts. the current generation of graphics-based screen readers does not always reliably read all information. Moreover, these screen readers do not always reliably track the mouse as it is moved around the screen, causing the blind user to become lost in a myriad tangle of information. This problem could easily be solved if mainstream software companies and online access providers cooperated with screen reader manufacturers in the design stages of their graphical applications.

The storage of online documents and other data as graphics images, not text, presents another potential barrier for blind computer users. Current adaptive systems rely on ASCII-based text to perform reading functions. Documents stored as graphics images cannot be read by current adaptive hardware and software, and are thus inaccessible to blind users. This could prove to be a very difficult problem for people who are blind as graphics-based documents are expected to be in widespread use in everything from office correspondence to graphical electronic mail systems. This problem could easily be solved if a document standard across platforms could be developed.

Interactive video systems distributed on the Internet also pose serious problems of access for persons who are blind and visually impaired, unless alternative display methods are enacted. These systems include, but are not limited to, document delivery systems, electronic shopping, online encyclopedias and magazines, even games. Again, we could solve these problems if only the mainstream vendors would cooperate with the adaptive vendor and user community in the design stages of their products.

Another disturbing trend is that of public information terminals or kiosks. These dedicated computer terminals, connected to the Internet, can pose grave dangers for blind users in their current conceived form. These information terminals are expected to rely heavily on graphics to display information to the user, and will also rely on touch-screen technology, both difficult for persons who are blind or visually impaired to access. These public access terminals, if not adapted properly, could pose a serious threat to information access as they will be used for office building directories, airline reservations, search and retrieval systems, office equipment, and are expected to be as commonplace as public telephones. There is no reason why these public access terminals should be choke points of information for the blind community, for there is no such thing as an inaccessible computer. We merely have to write the software to take the needs of all users into consideration, and we will have built a machine that is truly accessible for all its users.

Yet another danger factor is the merger of the cable television system with the Internet. Companies are beginning to offer information and other services that can be accessed using a standard cable decoder, with the information displayed on television video screens. The user controls the system by tapping keys on the cable box, reading visually any information displayed on the screen, a system clearly inaccessible to persons with vision impairments. Moreover, the current configuration does not permit the installation of current adaptive systems in its present form. A new generation of adaptive systems would have to be created for this environment.

So how do we solve our current information crisis? We need a series of laws and regulations to establish minimum guidelines, and specific regulations, for information technology so that both the hardware and the user interface software will be accessible to all disabilities. In simple terms, we need an Americans with Disabilities Act (ADA) for technology products and services, where product is defined as any device interfaced to the Information Super Highway. The disabled population need inter- operability among user interface options, not just inter- operability among applications. an example of this might be a blind person using speech, a deaf/blind person using a Braille device, a motor disabled person using a puff switch, while a non- disabled individual employs a touch-screen. This adaptive inter- operability is no less do-able than inter-operability among applications, but has received little attention.

Some other solutions include, but are not limited to, the inclusion of persons who are blind or visually impaired in the creation, testing, and debugging process of new products. Open ended systems should be created that can interface with adaptive hardware and software devices. Where applicable, mainstream devices should have built in access features, or be able to easily interface with adaptive devices. User interfaces must become standardized, and easier to use, and customizable for the individual needs of each end user. Documentation and training materials must be provided in accessible formats. Mainstream and adaptive vendors should work together to create products that are accessible from the design stage to final production. Access to the superhighway by persons who are blind or visually impaired must be as fast and efficient as that enjoyed by non-disabled users. Overall, success should be measured by ease of use and accessibility. Successful access is defined as receiving visual information through other means, including (but not limited to) speech output, Braille output, or enlarged output. We should not forget that successful access technology leads to jobs, and jobs lead to a higher quality of life among the disabled community. We encourage our national leaders to champion this cause, as it is a just one. Inaccessible computers and information results in lost jobs, with individuals unable to realize their full potential. We must create a world where information can be accessed by all, according to their abilities, and not their perceived limitations.

RESOURCES

Braille Lite:

The Braille Lite, Blazie Engineering, Forest Hill, Maryland, 410- 893-9333. is a personal data assistant for users who read Braille. The thick paperback book-sized computer has a Braille keyboard for data entry, an unlimited vocabulary speech synthesizer for output, and a 17-character refreshable Braille display that works hand-in-hand with the voice synthesizer. You can read stored information with speech output, Braille output, or a combination of both. The unit uses a mechanical Braille display to produce the individual Braille characters, and no paper is required. Useful for classroom or vocational settings, the Braille Lite can be used for word processing, telecommunications, and other functions. The unit can also interface with a personal computer and function as a stand-alone voice synthesizer. Braille Lite is battery powered, and has a built-in serial and parallel port.

Window Bridge:

The first Windows based screen reader, Window Bridge, Syntha-Voice, Stony Creek, Ontario, Canada, 905-662-0565. Window Bridge can read both MS DOS and Windows applications. The software can provide voice output, Braille output, or a combination of both. Window Bridge can drive a number of commercially available voice synthesizers and refreshable Braille displays. Documentation is available on tape, disk, and standard print.

WinVision:

A product of Artic Technologies, Troy MI, 313-588-7370. Winvision is a DOS and Windows screen reader. The program will drive the line of Artic voice synthesizers, and the DECtalk PC voice card from Digital Equipment Corporation. The software will read many Windows-based applications such as word processors, data bases, spreadsheets, and other packages. Documentation is available on audio tape, computer disk, and print.

Windows Master:

Blazie Engineering's Windows Master is a Windows only screen reading program. This is the newest screen reader for Windows to enter the adaptive market. The software can drive a number of commercially available voice synthesizers, and will also work with the Braille 'N' Speak. Since no DOS reading component is supplied, Blazie recommends using third-party DOS screen readers to verbalize non-Windows applications. For more information or a demonstration disk, contact Blazie Engineering, Forest Hill, Maryland, 410-893-9333.

ProTalk:

A product of Biolink Research And Development LTD, North Vancouver, British Columbia, Canada, 604-984-4099. ProTalk is a Windows-based screen reader that will drive many commercially available voice synthesizers. ProTalk will also work with the popular line of Sound Blaster synthesizers. According to the company, ProTalk reads many Windows-based applications.

CDROM Book:

Over the past several years, CD ROM has proved to be an empowering technology for many workplace applications. Now a new book on the subject brings it all together with clear and detailed writing. _The CD ROM Advantage_ from National Braille Press, Boston, MA, 617-266-6160, gives a clear overview of CD ROM technology, and discusses one hundred titles that work with speech output systems. The work is available on computer disk, audio tape, and Braille.

NoteTeller:

An-age old problem for persons who are blind, the reading of paper money, can create a serious barrier at home or on the job. Thanks to microprocessor technology, computerized devices can identify paper currency and read the denomination aloud. The NoteTeller is a battery-powered paper money identifier manufactured by BryTech Inc, Nepean, Ontario, Canada, 613-727-5800. The NoteTeller can identify U.S. currency, from $1 to $100, and can speak both Spanish and English. A model is also available with a tactile display for persons who are deaf-blind. The company also offers a unit that can recognize Canadian currency.

Careers & the disABLED:

This magazine focuses on career guidance and role model profiles for persons with disabilities. Published quarterly, the magazine is intended for college students and career counsellors. According to a contact person at the publication, the magazine is distributed free by many college disabled student service centers and career counsellors. The magazine is available on IBM ASCII computer disk. A Braille summary is also available. The magazine is published by Equal Opportunity Publications, Hauppauge, New York, 516-273-0066.

DEPARTMENT:
K - 12
(ITDV01N3 K12)

Bob Zenhausern Anne Pemberton
Executive Editor Managing Editor

Assistant Editors

Lois Elman Michael Holtzman Sheila Rosenberg
Information Technology Chatback

SUMMERTIME, AND THE LIVING IS EASY!
Anne Pemberton

Well, at least for teachers and students in most of K-12land! Summertime is for vacations and family and friends and sun and water and sloppy good foods!

Summertime is also time to think about what worked this year and begin plans for a new school year. In this issue you will meet two new members of the editorial staff of this section, Dr. Sheila Rosenberg, and Tom Holloway, Director of Chatback UK. Both Sheila and Tom have brought some very special young people to the nets, and the nets to some very special young people.

There is also a brief note on the new Deaf Education gopher, a note about free books on the Internet for K-12 schools, and an announcement for a new resource for K-12 teachers in Pennsylvania.

If this column seems a bit short, it's not just the summer heat, but the fact that I'm knee-deep in housework getting ready for Tom Holloway's first visit to Virginia. As soon as this column is finished and on it's way to you, I'll post invitations to my students who have chatted and enjoyed Tom online and are anxious to meet this witty Brit in person. As exciting as it is to make net- friends, it is even more exciting to finally meet them in person! Have a Happy and Hot Holiday One and All!

CHATBACK AND INCLUSION
Sheila Rosenberg, Chatback Editor

Welcome to ITD. I am your Chatback Editor. As the Director of Chatback USA I have been privileged to meet an international team that is working to benefit students with special needs around the world. A brief introduction to Chatback and the people who make it all possible is the first order of business.

Chatback is an online planning group that provides a unique forum for professionals who work with students from kindergarten through grade twelve. The forum is dedicated to support curriculum- based projects that enable students to relate to the world with "global awareness" and sensitivity to our mosaic of varied cultures as well as our physical environment. A recent project was the "Far Star Alien" project where students engaged Z-Man and SHEROSE through e-mail. The enthusiasm for this project extended beyond the first year in order to enable a wider group to participate. "Project STEEL" engaged youngsters nationally as well as internationally as they documented the course of ten yachts that followed the route of Magellan around Cape Horn and its return to Southhampton, England.

"Kidintro" and "Talkback" have been two successful projects where special needs students have received support from peers as well as professionals. Many students who are identified because of their academic challenges find a level playing field where they are welcomed warmly and professionally. The range of projects introduced each fall consistently work into curriculum areas that we are all responsible to develop as well as communication skills that need to be stretched and expanded. The online process provides an environment that enables teachers and students to monitor growth and development through the automatic archiving process housed at St. John's University in New York, where the forum is housed.

Dr. Robert Zenhausern, International Director, has provided leadership for the professional planning group on Inclusion. The philosophy of inclusion reflects the activities that support an environment that enables a student with a variety of disabilities to succeed along with his peers without being isolated to receive instruction. The Content Mastery environment of a Pueblo school as well as the Learning Lab of a New York middle school are two environments that provide a place for the curriculum-based projects where gifted as well as academically challenged students sit side- by-side, supporting one another in computer skills and global activities. Recently, text-based Virtual Reality activities have been added to the professional discussions. Successful engagement of a wide range of students has been noted.

Authentic assessment and portfolios have enabled teachers to provide the Inclusion in both the physical and the virtual reality world. Individualized Educational Plans (IEP) can be designed by the educational evaluator to include the content rich activities as well as the communication skills needed for growth and development. The archiving process offers a unique opportunity to monitor and provide feedback to all the members of the diagnostic-instruction team.

Tom Holloway, the UK Director, is another key leader who is determined to create an environment that both the physically and the academically challenged can succeed. He describes e-mail as a process that was "once a solution looking for a problem." He describes how Chatback projects provide support for an important communication gap. Now his vision of special students with both communication disorders and physical disabilities functioning as total members of the global village provides a platform for each of the directors to spring forward into the twenty first century. I will be sure provide _ITD_ readers with many opportunities to learn more about the work of Tom in both the UK and globally. The work of several other directors will be shared as space allows.

In the fall I will be talking to you about the introduction of EASI K-12 as well as sharing the project for the 94-95 school year. In the coming months I will be providing examples of these projects as well as the strategies that teachers find most useful to incorporate these projects in their classrooms. In addition I will be describing the parental responses to the addition of online forums to our K-12 environment.

By way of introduction, I am a middle school consultant teacher in New York, where I provide both direct and indirect services. As a teacher educator and as an educational evaluator I look forward to sharing information about the wonderful successes of Chatback and the many students, both here and abroad, who are touched daily by it.

CHATBACK IS FOR KIDS

Tom Holloway, Director, Chatback UK

Once seen as "a solution looking for a problem," electronic mail (e-mail) is now emerging as an exciting new way to cross cultural barriers and provide motivation to children with low skills in written English. It also fills an important communications gap for the speech impaired and hearing impaired children of the Chatback Project.

Mike Burleigh, a teacher at a school for emotionally disturbed children, was becoming increasingly concerned about the new boy, "Ross." The lad appeared bright enough, but he was withdrawn in the presence of all adults and most children and, even worse, in spite of every inducement he continued to be totally and obstinately mute.

"Ross" was willing to write however, especially on the word processor, so Mike decided to apply for a mailbox funded by CHATBACK - a charity set up to provide electronic mail (e-mail) support for children with communication impairments.

It worked. Chatback extended his opportunities for writing, providing him with a wider audience, and also gave him a reason for communicating with the other pupils of his school, in demonstrating his use of Chatback. One year later he was so communicative that he was able to be integrated into mainstream education.

The school as a whole, and not just "Ross," felt a great deal of pride when they saw an article they had written on the environment published in a scientific newsletter produced by adult students with learning difficulties attending Selkirk College, British Columbia. Faced with a wide audience, they had good reason for redrafting and revising their work before sending it.

Chatback is a free electronic mail service for children with speech, hearing or learning difficulties, supported by IBM, British Gas and British Telecom. The children will already have access to a computer through their schools; Chatback supplies them with a modem, networking software, and an electronic mailbox.

E-mail is especially useful for children and young adults who find difficulty in communicating by speech. Indeed, it has become speech for them. E-mail enables them to establish contact with other people and form relationships, just as if they were in a school playground. Their language does not need to be Standard English, with correct spelling or punctuation, as long as their meaning is clear, just as their speech in the school playground might not be in Standard English. By electronic mail, they are able to chat with each other, exchanging information about themselves, which they otherwise might find difficult. Indeed, communication through Chatback might be their only means of contact with the outside world, if they live in a remote area, or if they have physical or emotional difficulties.

A key aspect of Chatback lies in the fact that it encourages speech impaired or communications impaired children by means of simple everyday education projects. The current project, called _Breakfast -- Second Helpings_, asks the 200 plus children of Chatback to tell each other about their breakfast. _Breakfast -- Second Helpings- has received e-mail replies from children in this country as well as from computer pals in New Zealand, Australia, Canada, USA, Europe and the Soviet Union.

It makes no difference between the child who has difficulty in learning, and the child who is physically able, nor is it possible to tell the colour or age of the person replying -- each reply is interesting in itself. One of the questions in the project was to imagine having breakfast with a famous person. The persons chosen varied enormously, but all descriptions of breakfast with them were vastly entertaining!

Another recent project, _Remembering_, involved pupils in interviewing someone who had been a child during the years 1940-45. The pupils had then to draft an account of the person's life as a child during the war, and send it into the project. Again, pupils from Europe as well as the United Kingdom participated in this project, which proved very illuminating and fascinating.

Several pupils wrote about the blackout. "All the houses were blacked out and wardens used to shout at people `Put that light out!'" "People were often unhappy because it was very dark. They had to put black paper on the windows because if planes came over they would know where they were. Lights had to be out. If you disobeyed, the police would knock on your door to tell you to do what you were told."

Others wrote about the shortages: "There were no bananas and there was not that much fruit...my gran never had chicken or turkey at Christmas. At Christmas they had steak pie... Clothes were rationed too. One of our friends told us a barrage balloon blew up and landed in her garden-they cut the material and made dresses with it."

One frightening incident came from Belgium: "My grandfather and his brother were young during the war. They went to school on foot. Under the bridge, there were two sentries and on the bridge there were horse droppings. My granduncle took the droppings and threw them over the bridge. ..onto the sentries. They ran for their lives. Some other boys got caught by the soldiers (but they were innocent) and these poor boys had to stay in prison for one day. My grandfather and his brother were too scared...Luckily the other boys were released the next day.'

In another school, pupils with learning disabilities, using their Chatback mailbox, have enjoyed writing letters and searching databases to obtain information for their projects on the environment and on the rainforests. Any disabilities these pupils might have are bypassed by using technology, which they are able to do on a par with their more able-bodied peers. This is a tremendous boost for their self-confidence, such an important factor for youngsters with learning difficulties. In the same school it was found that a girl with Downs Syndrome could communicate her feelings much easier by writing than by speech.

Recently a group of students travelled up the Orinoco river in Venezuela and e-mailed reports about the plant life there and their curative effects to pupils in this country, who compiled a book on all the information they had received. The pupils also asked their grandparents about old country remedies they had heard of, and read a compilation of remedies in the book _Folk Medicine: Fact and Fiction_, by Frances Kennett.

When two schools from Cambridgeshire visited the Isle of Wight during the halfterm, they sent back information via Chatback software and lap-top computer for those remaining at school to use in their project about the island. From the text sent by e-mail, the children remaining at school were in immediate contact with those adventuring on the island; when they returned, they compiled a book about their trip with the help of their own teachers and a teacher on the Isle of Wight with whom they are still in contact by e-mail.

Through Chatback and their Computer Pals the world is truly becoming a "Global Village," and through communication, perhaps the "Villagers" will understand and appreciate the differences which make each individual "Villager" so valuable to the village. For many teachers, electronic mail has seemed to be "a solution looking for a problem." For the children of Chatback it is more than just a solution, it is also a new way of learning.

NEW DEAF EDUCATION GOPHER

A gopher has been established by the Bureau of Research, Training and Service of the College of Education at Kent State University, Kent, Ohio. One of the major sections of the gopher concerns Deaf Education. The gopher address is:

shiva.educ.kent.edu

FREE BOOK FOR K-12 SCHOOLS

We publish Ed Krol's _The Whole Internet User's Guide & Catalog_. We have just released a second edition, which means we have a good quantity of the first edition in stock. We'd be very interested in donating copies of the first edition to K-12 educators for course or training material. We can't send single copies out but instead are looking for schools and organizations to which we can send books in bulk.

Those interested in receiving donations should send e-mail explaining how they'd use the books to Olivia Bogdan at

olivia@ora.com.

Many thanks.

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University of Texas, Austin
neville@uts.cc.utexas.edu

For some years now, I've met for two or three class sessions each summer with a group of students with visual impairments in the "college prep" course at the nearby rehabilitation center (Criss Cole Rehabilitation Center). The first session is a lecture with handouts on library resources and the role of the library research assignments in their college courses. I stress that the research they are assigned in the courses they take is part of what they are supposed to be learning in the course. It is their obligation to make the intellectual decisions involved in the research process: to choose this topic, not that one, to choose to read certain books and articles and not others, to focus on this aspect of a topic and not another, and to come across the unexpected, the exciting new insight, on their own. Not too many years ago, that lead to a discussion of what the librarian can do to help the student and reader to get started, why the student had to direct the reader, and other issues of that nature. The possibilities have certainly expanded in the past few years.

Three years ago, few students in this group had any experience with computers, and some couldn't type. This year, everyone in the group of 45 knew how to use a keyboard. This year, only two in a group of 15 blind students had no previous experience with computers. Over half considered themselves to be "very experienced" with computers.

Last year, we were able to introduce students to gopher as a library research tool. For the first time, the students in the prep class got genuinely excited. Instead of feeling intimidated by all the technology they were going to need to learn to use, this group found less intimidating technology, and much less complicated ways to get to resources. There were easily understandable ways to get to periodical indexes and book catalogs. It seemed odd to me, but many were downright thrilled with the weather report! The students last year seemed to be much more comfortable with the idea of doing their own research.

However, as that group of students went on to their colleges and universities, I began to get phone calls, just a few, from students who said they had no online catalog or Internet access on their campuses, and what could they do? I didn't have a good answer then. But now the Texas Commission for the Blind has an answer. For students who need internet access in order to do research independently, their transition counsellors can authorize an Internet account. It's a resource, "just like a textbook," said Andy Weir at the Texas Commission for the Blind.

This year's crop of students came to yet a different online library...the World Wide Web provides new resources and new formats for familiar resources. This year's session featured LC MARVEL and CARL UnCover as library research tools available over the Internet. World Wide Web wowed the students with visual impairments, since we were able to give them a hands-on demonstration of the Mosaic interface to it. Using a line reader such as LYNX to access World Wide Web is harder to learn to use than gopher is, but information is migrating to that format really fast. The list Web4Lib@library.Berkeley.edu can provide a forum for librarians interested in influencing how information is organized and accessed on the Web. On this list, in mid-July, the University of Waterloo library announced its Web page.In one place, it combines Web and gopher access to information arranged by subject discipline with traditional library approaches to guiding users through a library research process. Under each discipline, there are pointers to the library's research sources in that subject and instructions on how to use them; there are sections an electronic journals and books; there are pointers to discussion groups on the topic, and there are guidelines on evaluating sources. It seems to me to be a good way to organize information for library users.

Connections:

**Web4Lib@library.Berkeley.edu
To subscribe, address your message to LISTSERV@library.Berkeley.edu
Put nothing on the subject line, and in the message section put
nothing but: SUBSCRIBE Web4Lib and your name.**

**Waterloo library
http://www.lib.uwaterloo.ca/ (World Wide Web)
gopher://watserv2.uwaterloo.ca:70**

DEPARTMENT: ONLINE INFORMATION AND NETWORKING (ITDV01N3 ONLINE)

Steve Noble, Recording for the Blind
slnobl01@ulkyvm.louisville.edu

NEWS UPDATE

Recording for the Blind's Internet catalog pilot is looking for more people to join our test group. Although the catalog is open to anyone looking for accessible book titles, the ability to order books online is being given only to a select number of participants at this time. Our test group of pilot members needs to be expanded at this time in order to glean more information about ways to improve the database, and to allow our personnel to find the best way to integrate orders generated by the online system. In particular, we would like to include about 20 more college disabled student services offices or similar providers on university campuses. It is important that we enlarge our test group before the start of the fall 1994 semester, since this is usually the busiest time of the entire year for textbook ordering. If you would like to be part of this study, please send me a note using my email address:

slnobl01@ulkyvm.louisville.edu

GOPHER NEWS

The World Institute on Disability Public Library is now available at the cpsr.org gopher site, and can be reached via the St. John's gopher as well. The WID Public Library contains a number of disability-related documents with emphasis on research and training. To connect through St. John's, gopher to sjuvm.stjohns.edu and follow this route:

/Disability and Rehabilitation Resources

/EASI: Equal Access to Software and Information-Main Menu

/EASI's List of other Disability Info Access organizations

/+World Institute on Disabilities' Gopher

While you are visiting the St. John's gopher, you may also want to explore the new Handicap News BBS section which can also be found using the above route, but for the last menu substitute: /+Disability Resources (Handicap BBS)

Please be aware that gopher access to the Handicap News BBS is still in the building stage, and some sections may not yet be complete.

Kent State University offers a nice collection of deaf education resources at the shiva.educ.kent.edu gopher site. From the gopher root menu choose:

/Quick-Link to the KSU Deaf Education Resource Archive

The Kent State gopher includes news and information concerning deaf education, instructional strategies for teachers and parents, and links to other deafness-related gophers.

NEW DISCUSSION LISTS

VAT - Vendors of Assistive Technology SpedTalk

A new unmoderated mailing list is now available that focuses on the more practical side of assistive technology. Vendors of Assistive Technology (VAT) is open to vendors of assistive devices who want to make themselves known to the public, and of course to assistive technology consumers who would like to receive product information or become aware of new services being offered. To subscribe to the VAT mailing list, send mail to:

listserv@kramden.phaedrav.on.ca

leave the subject line blank and in the body of the message say:

subscribe vat Yourfirstname Yourlastname

SpedTalk

Spedtalk is an open, unmoderated list hosted by the University of Virginia. It is a forum for people to discuss current practices, policies, and research in special education. The list encourages participation by faculty, students, researchers, clinicians and other interested individuals. Spedtalk does not focus on any one area of disability. To subscribe to Spedtalk, send mail to:

majordomo@virginia.edu

leave the subject line blank and in the body of the message say:

subscribe spedtalk

DEPARTMENT:
CAMPUS COMPUTING
(ITDV01N3 CAMPUS)

Daniel Hilton-Chalfen, Ph.D.,
University of California, Los Angeles
hilton-chalfen@mic.ucla.edu

NEW OFFICE OF CIVIL RIGHTS LETTER A WAKE-UP CALL FOR CAMPUS COMPUTER AND INFORMATION ACCESSIBILITY

Below is an important Letter of (voluntary) Resolution from the Office of Civil Rights (OCR) to a community college district. The letter concerns a complaint from a student unable to obtain access to print materials and computers, among other things. The OCR letter makes clear that under the ADA, "effective communication" covers printed materials and that preference is given to the individual with the disability as to what format should be used for access, including Braille or electronic text. Note the explanation of "timely manner" for providing such access. This letter spells out a campus' obligation in in more detail than the Office of Civil Rights' earlier Loyola Marymount Letter of Finding. Note too the emphasis on new technologies for providing access, according to Department of Justice ADA guidelines.

This letter should alert all campuses to the need to examine their guidelines for providing public and course information in accessible formats--on a timely basis--to their students with print disabilities; to the need to make computing and library facilities accessible; and to the role of adaptive computing technology and related support services in making this possible. Ask yourself these questions:

- Can my campus meet these OCR recommendations?

- What changes in services, and campus awareness, would be necessary to meet the intent of the ADA as interpreted in this OCR letter?

- Who on our campus must be aware of this letter?

Consider initiating a working group to discuss developing a campus computer and information access policy. Key participants might include the campus ADA office, campus disability advisory committee, disabled students office, campus computing services, library services, the faculty senate, and the teaching assistant organization. Examine the potential of your Campus Wide Information System (CWIS) for making printed public information available in electronic format.

Organizations like AAHE's EASI (Equal Access to Software and Information) have resources (materials, seminars, consultants, Internet discussion lists) that can facilitate your efforts, based on the experience of many campuses around the country (email: easi@educom.edu tel: 310-640-3193).

Think proactively! The OCR letter follows:

UNITED STATES DEPARTMENT OF EDUCATION
OFFICE FOR CIVIL RIGHTS

April 21, 1994

REGION IX

Old Federal Building
50 United Nations Plaza. Room 239
San Francisco, California 94102

Dr. Queen F. Randall
Chancellor
Los Rios Community College District
1919 Spanos Court
Sacramento, CA 95825-3981

(In reply, please refer to Docket Numbers 09-93-2214-I, 09-93-2215-I, 09-93-2216-I.)

Dear Chancellor Randall:

On September 22, 1993, the Office for Civil Rights (OCR), U.S. Department of Education (Department), received the above referenced complaints filed against the American River College (hereinafter ARC), Cosumnes River College (hereinafter CRC), and Sacramento City College (hereinafter SCC). The complainant alleged that these colleges discriminated against her on the basis of her disability (visual impairment) in that their campuses are allegedly not fully accessible to visually impaired students with regard to written materials, the computer laboratory, the library, physical education courses, and student employment services and opportunities.

OCR has the responsibility under Section 504 of the Rehabilitation Act of 1973, and its implementing regulation at 34 C.F.R. Part 104, to ensure that a recipient of Federal financial assistance through the Department does not discriminate against persons participating in its programs and activities, such as students, on the basis of disability. OCR also has jurisdiction as a designated agency under Title II of the Americans with Disabilities Act of 1990, and its implementing regulation at 28 C.F.R. Part 35, over complaints of disability discrimination filed against public educational entities, including public elementary and secondary systems and institutions. The Los Rios Community College District (District) campuses at ARC, CRC, and SCC, receive Federal funds through the Department and are public educational entities; OCR therefore has jurisdiction to investigate these complaints pursuant to Section 504 and Title II.

Under Section 504 and Title II, as to a recipient of federal funds and a public entity, respectively, no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities, or be subjected to discrimination.

Under Title II of the Americans with Disabilities Act of 1990, 28 C.F.R. SS 35.160, a public entity shall take appropriate steps to ensure that communications with applicants, participants, and members of the public with disabilities are as effective as communications with others. A public entity shall furnish appropriate auxiliary aids and services where necessary to afford an individual with a disability an equal opportunity to participate in, and enjoy the benefits of, a service, program, or activity conducted by a public entity. In determining what type of auxiliary aid and service is necessary, a public entity shall give Primary consideration to the requests of the individual with disabilities (emphasis added).

The Department of Justice (DOJ) interpretive guidance accompanying section 35.160 states that "Deference to the request of the individual with a disability is desirable because of the range of disabilities, the variety of auxiliary aids and services, and different circumstances requiring effective communication.". The DOJ guidelines are clear that printed materials are within the meaning of "communication." In describing the auxiliary aids and services that are appropriate, the DOJ guidelines recognize the critical role that modern technology now plays in providing program access to persons with disabilities.

OCR provides the following technical assistance. Due to the "range of disabilities" and the "primary consideration" accorded the individual's preference in the manner accommodation is offered, the post-secondary public institution should be prepared to deliver in a reasonable and timely manner the printed materials relied upon in its educational program in all of the following mediums: auditory, tactile (Braille), and enlarged print. Although there may be circumstances when the student's preferred medium is not, on balance, the medium selected by the post-secondary institution to provide the student appropriate aids and services, the institution may not categorically refuse to provide accommodation through a particular medium (e.g., Braille). Rather, the post-secondary institution must be prepared to timely offer access to its printed materials in all three mediums, with the particular medium used for the student's request dependent on a case by case analysis. It should be noted that if the student with the visual impairment prefers, and the public entity is willing to provide, access through "E-text" (electronic text in a digital format read by computer), such method may be used in lieu of access through another medium.

In most instances, "timely" will mean within a reasonable number of days from the student's request, with materials for which "time is of the essence" being made available sooner, and other more voluminous printed materials (e.g., textbook) taking longer. Materials that the public entity is on notice that the student with the visual impairment will need, such as course handouts/examinations in a class the student is enrolled, are to be provided to the student with the visual impairment on the same day as they are made available to nondisabled students. The importance and consequences of student comprehension is a critical factor in determining whether to honor the student's preferred medium. Thus, for example, there is a strong presumption that examinations will be provided in accordance with the student's request, whereas there is more latitude with regard to a student events/activities calendar. The term "printed materials" includes (but is not limited to) post-secondary publications such as student handbooks, admissions applications, class schedules, financial aid information, as well as publications from other sources relied upon by the post-secondary institution in its educational program, such as textbooks. Provided that under the circumstances the method is timely and effective (e.g., voice quality, correct pronunciation, convenience, etc.), auditory access may be accomplished through a variety of methods such as audio-tapes, personal readers, or synthesized speech.

At any point in an OCR investigation prior to a determination, OCR may administratively close the case if the recipient indicates a willingness to resolve all issues raised by the complaint, and provides OCR a written commitment specifying actions that will appropriately resolve each issue. During the investigation of these complaints, the District expressed a willingness to resolve the issues raised by the complaints by providing OCR with a written commitment that specifi

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Copyright Statement

Articles

Math and Science Symposium at Recording for the Blind

Richard Jones

Telephone: 602-965-1234
icrrj@asuvm.inre.asu.edu or icrrj@asuacad.Bitnet

Abstract: Computer technology is revolutionizing our world. The last advance in information dissemination of this magnitude was the printing press. Revolutions have never been defined as fair or predictable, and this revolution is no exception. This article will describe computer technology's promise of access to information for individuals with disabilities - a promise that is becoming vague and ephemeral as the benefits of this technology become an essential part of the definition of professional competence. Next, this article will discuss some of the reasons for the revocation of technology's promise of access to information for individuals with disabilities. In the subsequent sections this article will describe a remarkable gathering of experts from around the world at Recording for the Blind headquarters in Princeton, New Jersey on May 14-15, 1994. The goal of this group was nothing less than reformation of a revolution.

AsTeR: Audio System for Technical Readings

T. V. Raman

Digital Equipment Corporation
One Kendall Square, Building 650
Cambridge MA 02139
Telephone: 617-621-6637
raman@crl.dec.com
http://www.research.digital.com/CRL/personal/raman/raman.html

Abstract: The advent of electronic documents makes information available in more than its visual form; electronic information can now be display-independent. In this article, the author describes a computing system, AsTeR, that audio formats electronic documents to produce audio documents. AsTeR can speak both literary texts and highly technical documents (presently in La)TeX) that contain complex mathematics. Visual communication is characterized by the eye's ability to actively access parts of a two-dimensional display. The reader is active, while the display is passive. This active-passive role is reversed by the temporal nature of oral communication: information flows actively past a passive listener. This prohibits multiple views - it is impossible to first obtain a high-level view and then "look" at details. These shortcomings become severe when presenting complex mathematics orally.

Audio formatting, which renders information structure in a manner attuned to an auditory display, overcomes these problems. AsTeR is interactive, and the ability to browse information structure and obtain multiple views enables active listening.

This article describes a system for producing audio renderings. Print is not the ideal medium for describing such renderings, (and ASCII is an even poorer one!). RFB members can acquire an audio formatted version of the author's thesis, (this article is a slightly edited

version of the first chapter) rendered by AsTeR, from Recording for the Blind (RFB order number FB190). Non-RFB customers may request a two track (standard commercial format) tape of AsTeR examples. Requests should be addressed to info@RFB.org; ask for Raman's Math Examples Tape.

Finally, readers with access to the WWW can experience an interactive demo of AsTeR at http://www.cs.cornell.edu/Info/People/raman/aster/aster-toplevel. html or http://www.research.digital.com/CRL/personal/raman/aster/aster-toplevel.html.

A Graphical Calculus Course for Blind Students

Albert A. Blank, Professor
Computer Science Department, 1N215
College of Staten Island, CUNY
2800 Victory Boulevard
Staten Island, NY 10314-6600
Telephone: 914-738-7678
u1555@f.nersc.gov

Karen Luxton Gourgey, Director
Computer Center for the Visually Impaired
Baruch College, CUNY
17 Lexington Avenue, Box 515
New, York, NY 10010
Telephone: 212-802-2146
klgbb@cunyvm.cuny.edu

Michael E. Kress, Professor
Computer Science Department, 1N215
College of Staten Island, CUNY
2800 Victory Boulevard
Staten Island, NY 10314-6600
Telephone: 718-982-2850; FAX: 718-982-2856
u1551@f.nersc.gov

Abstract: The study of advanced mathematics is prerequisite to higher education in technical or scientific subjects. For students interested in pursuing technical careers, mastery of the calculus is fundamental. For blind and visually impaired college students, the graphical nature of the calculus poses a formidable hurdle to independent access. In this article, the authors describe an innovative method of producing accessible tactile materials for the study of the calculus.

Ensuring Usability in Interface Design:
A Workstation to Provide Usable Access to Mathematics for Visually Disabled Users

Helen Cahill and John McCarthy

Department of Applied Psychology
University College, Cork, Ireland

Abstract: This paper presents an account of the formative evaluation of a multi-media "MATHS" workstation which is being developed to provide usable access for blind and partially sighted students reading and manipulating mathematical expressions. We argue that there is a crucial difference between notions of accessibility and usability in interface design.

Traditionally, assistive technology has been concerned with providing access to disabled users. However, unless such access embraces usability, it does not necessarily overcome the access limitations imposed by the user's disability and provide usable access. Therefore, it is essential that interface designers recognize the difference between the traditional design concept of accessibility and the more user-centered design concept of usability. The MATHS workstation is being designed with a concern for usability. In this paper, the broad context of usability is introduced. The processes of measuring usability according to ISO9241 (CD) and the development of the MATHS workstation usability requirements specification according to ISO9241 (CD) are presented. (Ed. note: These code numbers refer to a draft software usability standard prepared by the European Commission Technology Initiative for Disabled and Elderly People. They are defined more fully in the text of this article.)

We hope that this account of the application of a usability standard to the development of the MATHS workstation will be valuable to other assistive technology designers.

Mathtalk: Usable Access to Mathematics

Robert D. Stevens and Alistair D. N. Edwards

Department of Computer Science
The University of York
Heslington, York UK YO1 5DD
robert@minster.york.ac.uk

Abstract: This paper describes the design of the user interface to the Mathtalk program, which aims to give visually disabled readers an active reading of standard algebra notation. The paper introduces the themes of enhancing external memory and control of information flow as the guiding principles behind the design of the user interface. Fast and accurate control of the information flow is vital for active reading. Mathtalk uses structured browsing functions and a specially developed command language to achieve this active reading. Finally, an audio glance called algebra earcons is introduced that enables readers to get a high-level view of an expression and plan the reading process.

The Use of Laser Stereolithography to Produce Three-Dimensional Tactile Molecular Models for Blind and Visually Impaired Scientists and Students

William J. Skawinski, Thomas J. Busanic, Ana D. Ofsievich,**Victor B. Luzhkov*, Carol A. Venanzi and Thomas J. Venanzi ****

Department of Chemical Engineering, Chemistry, and Environmental Science, New Jersey Institute of Technology, 323 King Blvd., Newark, NJ 07102

***Institute o f Chemical Physics, Chernogolovka, Moscow Region, Russia 142432**

****Department of Chemistry, College of New Rochelle, New Rochelle, NY 10805**

SKWINSKI@TESLA.NJIT.EDU

Abstract: Laser stereolithography, a rapid prototyping process that produces three-dimensional plastic models from the images created in certain computer aided design (CAD) programs, has been used to fabricate tactile molecular models for blind and visually impaired individuals. The process uses a computer-controlled laser to cure and solidify a light-sensitive, liquid polymer in the shape of the image. The models can be customized and used for educational and research purposes. Several models built using four different scales are described. Surface textures are varied to allow atom types to be distinguished.

Computer Based Science Assessment: Implications for Learning Disabled Students

David D. Kumar

College of Education, Florida Atlantic University
2912 College of Education, Davie, Florida 33314

Abstract: Computer technology can be invaluable for assessing learning disabled students in science since it opens up opportunities for developing innovative assessment tools in science education. The nature of computers as information processing tools, the role of computer technology in user-friendly interactive learning environments, and the possibility of designing instructional tools to meet individual needs of students, make computers potentially powerful tools for assessment. Computer-based assessment applications used in science, such as Computerized Adaptive Testing, Figural Response Item Testing, Computer Simulations, and Anchored Assessment can be appropriated for assessing students with learning disabilities.

Books for Blind Students: The Technological Requirements of Accessibility

William A. Barry, John A. Gardner, and Randy Lundquist

Department of Physics, Oregon State University
Weniger Hall 301, Corvallis, Oregon 97331

Abstract: This paper describes three new developments that hold great promise for improving the accessibility of scientific literature for people who are visually impaired or who have significant vision-related learning disabilities. All rely on the availability of information in high-level electronic form. A brief review of methods for storing high-level information and an example of their use in printing Dotsplus documents are given.

Increasing the Representation of People with Disabilities in Science, Engineering and Mathematics

Sheryl Burgstahler

Assistant Director-Information Systems
Computing & Communications, University of Washington
JE-25, Seattle, WA 98195
Telephone: 206-543-0622
sherylb@cac.washington.edu

Abstract: There are three main factors that cause individuals with disabilities to be under-represented in science, engineering, and mathematics fields: preparation of students with disabilities; access to facilities, programs, and equipment; and acceptance by educators, employers and co-workers. Technology can have a positive affect on all of these factors and help open doors to new areas of study and employment. This paper explores the role of information technology, describes a campus program designed to positively influence each of the factors, and makes a series of recommendations for action.

MATH AND SCIENCE SYMPOSIUM AT RECORDING FOR THE BLIND

Richard Jones(602) 965-1234

Internet: ICRRJ@ASUVM.INRE.ASU.EDU
Bitnet: ICRRJ@ASUACAD.Bitnet

ABSTRACT

Computer technology is revolutionizing our world. The last advance in information dissemination of this magnitude was the printing press. Revolutions have never been defined as fair or predictable, and this revolution is no exception.

This article will describe computer technology's promise of access to information for individuals with disabilities - a promise that is becoming vague and ephemeral as the benefits of this technology become an essential part of the definition of professional competence. Next, this article will discuss some of the reasons for the revocation of technology's promise of access to information for individuals with disabilities. In the subsequent sections this article will describe a remarkable gathering of experts from around the world at Recording for the Blind headquarters in Princeton, New Jersey on May 14-15, 1994. The goal of this group was nothing less than reformation of a revolution.

SECTION 1 -- INTRODUCTION

Before microcomputers automatically converted information from one format to another, there were very few individuals with disabilities who could succeed in post-secondary institutions. The established models for "assisting" individuals with disabilities that continued well into the 1970's were sheltered workshops and menial, home-based, contract labor.

The microcomputer offered a revolutionary change in the way information was used. A separation between the information and the form of the information became apparent. For instance, each time a computer user sends information over a modem to another user, a series of questions is automatically asked by both participants, "Is the other party seeing exactly what I sent?" and "Did I receive what the other party sent?"

These questions may appear to be common sense, and therefore simplistic, but they represent a new level of sophistication. The use of a computer to transfer information is not the same as converting sound to electricity and saying,"Watson, I need you!" Rather than converting a human act into another form, a computer is making choices about the data. This data has no ideas or subjects or meaning. It is a flow of binary bits with which one computer "talks" to another computer. We, as operators, are not involved in this communication. Our communication goals are very different from the objectives that were used to create a computer link. We must verify that meaning has accompanied the form of communication.

The "meaning" that I am referring to is not a metaphysical meaning. The questions asked by the two computer users who are using a modem simply defines a human communication with a machine and not another person.

The American Standard Code of Information Interchange (ASCII) is a correlation between the world of the user and the computer. This code attempts to assure the users of computers that there is a standard for the transmission of information which combines meaning and form.

The purpose of this simplistic epistemology is to define what a computer does with data as opposed to what a human does with data. The reason for the establishment of this distinction is that it is the basis of both the promise and the possible failure of computers to present information to individuals with disabilities.

SECTION 2 -- THE PROMISE AND THE PROBLEM

During the last fifteen years, computers have been used for sophisticated communication by the general public, and computer-based information could be presented in several different formats from the same source. The computer can display most types of information in large print, Braille and speech synthesis from a common computer file. All that was necessary was to write software to convert the computer-coded information into the appropriate form.

There were several small problems, perhaps the most crucial being the representation of math and science notation. Beyond basic math, the symbols needed for professional communication were not included in the computer code, ASCII. The task of trying to standardize such a mathematical coding system was and is daunting. The two-dimensional display of mathematical equations in an environment which was designed around the presentation of serial and therefore linear information was not feasible, except as a graphic or a picture of the equation. By describing the presentation of symbolic information, such as math and science notation, as a picture, the connotation is that the individual characters that appear on the screen have no meaning, no standard code. Such a picture can be sent to another individual or worked with on a computer, but the information cannot be converted into another form because there was no standard for the image that was presented. It is just binary ones and zeroes.

The promise is that by separating meaning from form, the form can be changed to accommodate the individual user. This process can only work if there is a conversion standard between form and meaning, such as ASCII. The problem, again, is that ASCII does not cover many forms of information needed in professional areas. The math and science information currently used on computers is in the form of dedicated software packages that do not allow conversion into other presentation formats.

SECTION 3 -- THE SLIGHT-OF-HAND

The current slight-of hand is postscript. Postscript begs the questions by first stating that documents saved in this format through several commercial software packages can be transferred to different platforms and retain their form. When pressed on the issue of conversion of text into alternative formats, those who claim that postscript will allow one to transfer documents across platforms fall back on the claim that they can save their postscript file as ASCII on any machine. In fact, what is transferred is a picture of the document. For purposes of conversion of text into alternative formats, it is useless.

SECTION 4 -- CURRENT ATTEMPTS AT THE SOLUTION

The future for individuals with disabilities who must rely on traditional forms of computer information is bleak. Despite federal and state regulations mandating access, meaningful access will be denied to individuals with disabilities. The major cause of this isolation is the increased sophistication of the computer interface, particularly as a result of the increased emphasis on postscript file formats, multimedia and hypertext links in electronic documents.

International organizations are working on various aspects of the problem. The International Committee for Accessible Document Design (ICADD), has been working on the problem for several years. They see this issue as much larger than just access to text, math and science notation. A new basis for correlating meaning with form must be established. This new correlation of meaning and form must be capable of changing as new methods of presentation and new types of documents are developed. These modern documents include hypertext, mosaic, multimedia and full-motion video. To work for anything less is to establish a system which cannot grow with future presentation strategies. ICADD believes that the Standard Generalized Markup Language is currently the most useful tool to perform this vital function. The ICADD minimum SGML DTD (Document Type Description) has been accepted by the State of Texas as a document for all texts purchased by the State of Texas for grades K-12. The ICADD SGML DTD has been included in the American Association of Publishers SGML DTD and included in the International Standards Organization standard, ISO 12083(1) SGML is a structured description of the document. It was designed to allow the translation of documents into various formats. It is currently being used by the Center for Electronic Texts in the Humanities, CETH(2) and the Text Encoding Initiative, T.E.I., which is supported by the National Foundation for the Humanities, the European Community and the Mellon Foundation. The purpose of T.E.I. is "to develop a standard for the interchange and encoding of electronic text."(3) "The standard is being developed with the participation of scholars and researchers from around the world, organized into work groups and work committees to deal with certain text types and disciplines (e.g., linguistics, spoken texts, dictionaries) and technological problems (e.g., hypermedia)."(4) T.E.I has been active since 1988.

The Communication and Access to Information for Persons with Special Needs has used SGML to provide access to newspapers in Germany on a daily basis. The CAPSNEWS DTD is designed to allow the newspaper to use a single source file to print the daily paper, archive newsprint and transmit the daily paper over satellite to individuals with disabilities. The transmission is possible in different languages and different access formats, including Braille, large print and speech.(4)

The current limitation of SGML is that, although it is possible, there is no comprehensive SGML DTD for math. The International Standards Organization ISO 12083 contains the ICADD DTD and a "math fragment attachment" which is not useful to several countries that require that math symbols be displayed differently in Braille, depending on the symbol's position in an equation.

While ICADD and the CAPS program are working through many of the obstacles that must be solved to provide an international solution, the current demand for access to information in science and math has reached a crisis. The Americans with Disabilities Act mandates access to this information. There is, however, no comprehensive, computer-based, automatic, conversion of mathematics into alternative format.

Last year, Dr. T. V. Raman presented his AsTeR system at the California State University at Northridge, 8th Annual Conference on Technology and Persons with Disabilities. AsTeR was Dr. Raman's dissertation at Cornell University. His system shocked everyone in attendance. AsTeR is a comprehensive speech synthesis system for higher mathematics. The revolutionary aspect of Dr. Raman's system is the full use of auditory cues to add meaning to mathematical equations. (6) His product reads a LaTeX file.

TeX was originally written by Dr. Knuth as a print utility to provide accurate printing of mathematical equations. TeX and its derivatives are excellent for printing equations. The logic is that AsTeR intercepts the TeX commands going to the printer and converts them into a user-friendly, auditory representation of the original equation.

Dr. John Gardner of Oregon State University has been an active proponent of providing access to math and science notation. Dr. Gardner has developed Dotsplus, a system which takes a TeX or LaTeX file and converts it into a presentation which "incorporates both Braille and (tactile) graphics in an integrated fashion."(7)

The limitations of TeX are that it is at the end of the publishing process. One has no control over the original document. While excellent at printing math equations, TeX is not very demanding on the presentation of text. There are extensive possibilities for the presentation of text. And finally, most telling, TeX does not present a structured document. It suffers from some of the same flaws as a "picture" of the document in that it contains no inherent structural definition.

On May 12 and 13 at the Recording for the Blind headquarters in Princeton, New Jersey 41 individuals met to discuss the problem of math and science notation. Dr. George Kerscher of Recording for the Blind (RFB), and formally with Computerized Books for the Blind, had invited us to attend a working symposium. Dr. Kerscher had reviewed Dr. T. V. Raman's work and felt that it was part of the solution.

Those in attendance represented every conceivable point of view. Most had agendas that they felt were essential to a complete solution. Several representatives of publishing and academic associations were present, as well as individuals mentioned earlier in this article. The meeting was an instrument designed to respond to the tension of the problem. As Dr. Kerscher stated at the beginning of the first day, the format of the conference was, "somewhat dangerous." Members of the symposium were going to devise a structure for the conference, break into groups, and work on each topic as they saw fit.

The format succeeded beyond anyone's expectations. The group started with a presentation by Dr. T. V.

Raman. Members then devised a symposium format by working backward from a secondary mathematical text through speech. The conclusion of the conference was nothing less than a definition of access requirements for math and scientific notation.

The group divided into three topic areas; Porting, User Interface and Data Structures. The two-day symposium was a work of enlightened self-interest. The central objective of defining a medium which supported the needs of all individuals with disabilities was never lost. The demand for a system which would be open to future information strategies led to several objectives aimed at the further development of data structures utilizing LaTeX and SGML.

The symposium was a declaration and definition of the problem. It transcended a simple wish list by attaching many objectives to the powerful work of T.V. Raman. Everyone agreed that AsTeR was obviously part of the solution. Not only was a set of objectives achieved, but several members agreed to begin work on various aspects and objectives agreed upon by the committee.

It was a meeting that actually accomplished its objectives. Dr. George Kerscher and Recordings for the Blind deserve praise for the pioneering work done at the symposium.

The following information represents an unofficial summary of the results of the Symposium.(8)

THE PORTING GROUP OBJECTIVES:

1). Set up an AsTeR server for use in a remote client Server arrangement with E-MAX interface. (AsTeR currently runs on a DEC work station)

2). Begin work on porting AsTeR to another version of LISP. (part of attempt to put AsTeR in a more open architecture)

3). Create an on-line manual for use and extensions of AsTeR. (attempt to provide some structure for programming in LaTeX)

A long term goal is to:

4). Port operating systems independent of LISP and UNIX. preferably C Code. (goal to port AsTeR to PC environment)

THE USER INTERFACE GROUP DEFINED SEVERAL GOALS THAT SHOULD BE FOLLOWED AS AsTeR IS DEVELOPED AS A COMPREHENSIVE PC-BASED ACCOMMODATION:

1). User-interface should be consistent across platforms. The control and navigation of the user-interface should be simple and easy.

2). User-interface should include a complete set of features that are found in modern on-line search and retrieval systems.

3). Output modality should include but not be limited to AFL, Text-to-speech, non-speech audio, graphics (sound graph), scalable large character display, hard copy output, (Braille and print), refreshable Braille.

4). Interface should facilitate communication between people without regard to disability, facilitating simultaneous use by a student and a teacher, for example.

5). Interface should be interactive (read, write, edit). Input should be supported form keyboard, alternative adaptive equipment, e.g., 6 and 8 dot Braille input, etc. These input devices should also be usable for navigation.

6). Should undertake development of Braille output module that will interface with the AsTeR

front end.

7). Research the techniques for synchronizing the focus of the currently presented object in various output modalities (provide a method of each output device being able to point to the same character at the same time).

THE DATA STRUCTURES GROUP OBJECTIVES:

1). Write guidelines for providing the semantics behind the LaTeX macros. (An attempt to standardized some aspects of LaTeX as they relate to AsTeR.)

2). Determine the strengths and weaknesses of SGML, experiment with the ISO-12083 math fragment as input to AsTeR.

3). Educate publishers and other content providers about the need for well-structured files.

3.1). Process documents and send taped AsTeR renderings to the provider, i.e., publisher or author, for review.

4). Create a qualification test to determine the usability of structured document files.

4.1). Determine the test's suitability by other organizations.

5. Work with the ISO-12083 committee on extensions to deal with end-user defined constructs. (This is an interesting objective which addresses the obligation of any math system to allow creativity. In essence, a standardized system should not permit creativity. The question is, "How does one incorporate change in a procedure that will be recognized as not substantially changing the original DTD?" To do otherwise would allow uncontrolled changes in the structure of the documents described by the original DTD and thus lead to a uncontrolled use and display of information, in short, structural anarchy.

GENERAL RECOMMENDATIONS:

1). Develop, disseminate and maintain a resource list of products, components and research efforts currently underway.

2). Encourage the development of an accessible Graphical Calculator.

FOOTNOTES

1. ICADD, International Committee for Accessible Document Design:

Contact:
Vicki Lee Norbury
Recording for the Blind
Research and Development
P. O. Box 7068
Missoula, MT 59807
(406) 728-7201
Icrrj@ASUACAD.Bitnet or
ICRRJ@asuvm.inre.asu.edu

2. Center for Electronic Texts in the Humanities CETH
169 College Avenue
Alexander Library, 3rd Floor
New Brunswick, NJ 08903
Email: ceth@zodiac.rutgers.edu

3. & 4. E-mail Correspondence, Text Encoding Initiative, Wendy Plotkin, T.E.I Assistant, to Richard Jones on 10/01/92.

Text Encoding Initiative Computer Center (M/C 135)
1940 W. Taylor ST. Room 124
Chicago, IL 60612-7352
Email: u35395@uicvm.bitnet to C. M. Sperberg-McQueen

5. Communication and Access to Information for Persons with Special Needs CAP, Dr. Gerhard Weber, University of Stuttgart, weber@informatik.uni-stuttgart.dbp.de

6. Paper presented at California State University at Northridge, Eighth Annual Conference, "Technology and Persons with Disabilities" and at the RFB Math and Science Working Symposium by T. V. Raman. Based on Dr. Raman's dissertation. Audio System for Technical Readings, AsTeR, T. V. Raman, Cornell University, Department of Computer Science, 16 December, 1993. An abridged version is on the ICADD listserv. Subscribe to Listserv@ASUACAD.bitnet; one line in the body of the text; Subscribe icadd your email address your first and last name.

7. Dotsplus - Better than Braille?, John Gardner, proceedings of California State University at Northridge Eight Annual International Conference, "Technology and Persons with Disabilities", p. 87, 1993.

Note: While not directly mentioned in this article, the Equal Access to Software and Information project (EASI), under the American Association for Higher Education (AAHE) has been a strong advocate of access to all areas of information for individuals with disabilities, particularly in the post-secondary environment. You may contact them at easi@sjuvm.st.johns.edu or: Carmela Castorina at (714) 830-0301; TDD (206) 206-5155

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AsTeR: AUDIO SYSTEM FOR TECHNICAL READINGS

T. V. Raman

Digital Equipment Corporation
One Kendall Square, Building 650
Cambridge MA 02139
Tel: 1 617 621 6637
Email raman@crl.dec.com WWW
http://www.research.digital.com/CRL/personal/raman/raman.html

ABSTRACT

The advent of electronic documents makes information available in more than its visual form; electronic information can now be display-independent. In this article, the author describes a computing system, AsTeR, that audio formats electronic documents to produce audio documents. AsTeR can speak both literary texts and highly technical documents (presently in La)TeX) that contain complex mathematics. Visual communication is characterized by the eye's ability to actively access parts of a two-dimensional display. The reader is active, while the display is passive. This active-passive role is reversed by the temporal nature of oral communication: information flows actively past a passive listener. This prohibits multiple views - it is impossible to first obtain a high-level view and then "look" at details. These shortcomings become severe when presenting complex mathematics orally.

Audio formatting, which renders information structure in a manner attuned to an auditory display, overcomes these problems. AsTeR is interactive, and the ability to browse information structure and obtain multiple views enables active listening.

This article describes a system for producing audio renderings. Print is not the ideal medium for describing such renderings, (and ASCII is an even poorer one!). RFB members can acquire an audio formatted version of the author's thesis, (this article is a slightly edited version of the first chapter) rendered by AsTeR, from Recording for the Blind (RFB order number FB190). Non-RFB customers may request a two track (standard commercial format) tape of AsTeR examples. Requests should be addressed to info@RFB.org; ask for Raman's Math Examples Tape.

Finally, readers with access to the WWW can experience an interactive demo of AsTeR at

http://www.cs.cornell.edu/Info/People/raman/aster/aster-toplevel.html

or

http://www.research.digital.com/CRL/personal/raman/aster/aster-toplevel.html

1. MOTIVATION

Documents encapsulate structured information. Visual formatting renders this structure on a two-dimensional display (paper or a video screen) using accepted conventions. The visual layout helps the reader recreate, internalize and browse the underlying structure. The ability to selectively access portions of the display, combined with the layout, enables multiple views. For example, a reader can first skim a document to obtain a high-level view and then read portions of it in detail.

The rendering is attuned to the visual mode of communication, which is characterized by the spatial nature of the display and the eye's ability to actively access parts of this display. The reader is active, while the rendering itself is passive.

This active-passive role is reversed in oral communication: information flows actively past a passive listener. This is particularly evident in traditional forms of reproducing audio, e.g., cassette tapes. Here, a listener can only browse the audio with respect to the underlying time-line -- by rewinding or forwarding the tape. The passive nature of listening prohibits multiple views -- it is impossible to first obtain a high-level view and then "look" at portions of the information in detail.

Traditionally, documents have been made available in audio by trained readers speaking the contents onto a cassette tape to produce "talking books." Being non-interactive, these do not permit browsing. They do have the advantage that the reader can interpret the information and convey a particular view of the structure to the listener. However, the listener is restricted to the single view present on the tape. In the early 1980's, text-to-speech technology was combined with OCR (Optical Character Recognition) to produce "reading machines." In addition to being non-interactive, renderings produced from scanning visually formatted text convey very little structure. Thus, the true audio document was non-existent when we started our work.

We overcome these problems of oral communication by developing the notion of audio formatting-and a computing system that implements it. Audio formatting renders information structure orally, using speech augmented by non-speech sound cues. The renderings produced by this process are attuned to an auditory display audio layout present in the output conveys information structure. Multiple audio views are enabled by making the renderings interactive. A listener can change how specific information structures are rendered and browse them selectively. Thus, the listener becomes an active participant in oral communication.

In the past, information was available only in a visual form, and it required a human to recreate its inherent structure. Electronic information has opened a new world: information can now be captured in a display-independent manner -- using, e.g., tools like SGML and LaTeX (1). Though the principal mode of display is still visual, we can now produce alternative renderings, such as oral and tactile displays. We take advantage of this to audio-format information structure present in LaTeX documents. The resulting audio documents achieve effective oral communication of structured information from a wide range of sources, including literary texts and highly technical documents containing complex mathematics.

The results of this thesis are equally applicable to producing audio renderings of structured information from such diverse sources as information databases and electronic libraries. Audio formatting clients can be developed to allow seamless access to a variety of electronic information, available on both local and remote servers. Thus, the server provides the information, and various clients, such as visual or audio formatters, provide appropriate views of the information. Our work is therefore significant in the area of developing adaptive computer technologies.

Today's computer interfaces are like the silent movies of the past! As speech becomes a more integral part of human-computer interaction, our work will become more relevant in the general area of user-interface design, by adding audio as a new dimension to computer interfaces.

2. WHAT IS AsTeR?

AsTeR (2) is a computing system for producing audio renderings of electronic documents. The present implementation works with documents written in the TeX family of markup (3) languages, i.e., TeX, LaTeX and AMSTeX. But the design of AsTeR is not restricted to any single markup language. Though motivated by the need to render technical documents, our system works equally well on structured documents from the non-technical subjects.

AsTeR is founded on the belief that all information is display-independent. Information has structure, and this structure is rendered on paper or on a visual display, but the information itself is not restricted to these output modes. Thus, AsTeR renders this same information in audio. AsTeR recognizes the logical structure of a document as embodied in the markup source and represents this structure internally. The internal representation is then rendered in audio by applying a collection of rendering rules written in AFL, a language for audio formatting. Think of AFL as a high-level audio analogue to a visual rendering language like Postscript. Rendering an internalized high-level representation enables AsTeR to produce different audio views of the information. A user can either listen to entire documents, or browse the internal structure and selectively read portions of a document. The rendering and browsing components of AsTeR can work equally well with high-level representations we may get from sources such as OCR-based document recognition.

This article gives a high-level view of how the various components of AsTeR are used. AsTeR is implemented in CLOS (4) with an Emacs front-end. The recommended way of using the system is to run Lisp as a subprocess of Emacs. Throughout this chapter, we will assume familiarity with basic Emacs concepts. Section 3 introduces the system by showing how simple documents can be read and browsed. Section 4 explains how AsTeR can be extended to read newly defined document structures in La)TeX (5). Section 5 gives some examples of changing between different ways of rendering the same information. Section 6 presents some advanced techniques that can be used to advantage when reading complex documents such as text books. AsTeR can render information produced by various sources. We give an example of this by demonstrating how AsTeR can be used to interact with the Emacs calculator, a full-fledged symbolic algebra system.

3. READING DOCUMENTS

This section assumes that AsTeR has been installed and initialized. At this point, text within any file being visited in Emacs (in general, text in any Emacs buffer), can be rendered in audio. To listen to a piece of text, mark it using standard Emacs commands and invoke read-aloud-region (6). This results in the marked text being audio formatted using a standard rendering style. The text can constitute an entire document or book; it could also be a short paragraph or a single equation from a document. AsTeR renders both partial and complete documents.

This is the simplest and also the most common type of interaction with AsTeR. All markup commands appearing in the text are recognized to produce audio renderings that reflect the structure represented by the markup. The input may be plain ASCII text; in this case, AsTeR will still recognize the minimal document structure present, i.e., paragraph breaks, quoted text etc. La)TeX markup helps the system recognize more of the document logical structure, and as a consequence produce more sophisticated renderings.

3.1 BROWSING THE DOCUMENT

Next to getting the system to speak, the most important thing is to get it to stop speaking. Once an audio rendering has been launched, rendering can be interrupted at any time by executing reader-quit-reading (7) The listener can then traverse the internal structure by moving the current selection, which represents the current position in the document, by executing any of the browser commands reader-move-previous, reader-move-next, reader-move-up or reader-move-down.

To orient the user within the document structure, the current selection is summarized by verbalizing a short message of the form " is ", e.g., moving down one level from the top of the equation

ABC = 0
(1)

produces the message "left hand side is a product ". The user has the option of either listening to just the current selection, or reading the rest of the document. In the interest of brevity, we will not give all of the browser key-bindings.

3.2 EXAMPLES OF USE

AsTeR can be used:

- To read technical articles and books: The files for such documents may be available on the local system or on the global Internet (8). Resources retrieved over the network can be audio formatted by AsTeR since they are just text in Emacs buffers. Currently, the system audio formats 10 text books available to the author on his local system. In addition, AsTeR also renders a wide collection of technical documents available on the Internet including technical reports and AMS bulletins.

- For entertainment: At present about 200 electronic texts are available on the Internet, in addition to the complete works of Shakespeare. The majority of these documents are in plain ASCII, but the quality of audio renderings produced by AsTeR based on the minimal document structure that can be recognized still surpasses conventional reading machines. Increased availability of electronic texts marked up in La)TeX, SGML and HTML will enable better recognition of document structure, and as a consequence, better audio renderings.

- In proof-reading: This feature is especially useful when typesetting complex mathematical formulae. AsTeR can render both partial and complete documents. Thus, although designed as a system for reading documents, the flexible design, combined with the power afforded by the Emacs editor, turns AsTeR into a very useful document preparation aid.

4. EXTENDING ASTER

As explained in the previous section, the quality of audio renderings produced by AsTeR is dependent on how much of the document logical structure is recognized. Authors of La)TeX documents often use their own macros (9) to encapsulate specific structures. AsTeR of course does not know of these extensions to start with. Occurrences of user-defined La)TeX macros are initially rendered in a canonical way; typically, the user-defined macros are read aloud as they appear in the running text.

Thus, given a document containing

$A \kronecker B$

AsTeR would produce

cap a kronecker cap b

In this case, this canonical rendering is quite acceptable. In general, how AsTeR renders such user-defined structures is fully customizable. The first step is to extend the recognizer to handle the new construct, in this case \kronecker. Here, we give the reader a brief example of how this mechanism is used in practice.

The recognizer is extended by calling Lisp macro define-text-object. In the case of the \kronecker macro, this call takes the form:

(define-text-object :macro-name "kronecker" :number- args 0 :processing-function kronecker-expand :object- name kronecker :supers (binary-operator) :precedence multiplication)

This extends the recognizer to represent instances of macro "kronecker" as instances of object kronecker-product. The user can now define any number of ways in which an instance of object kronecker-product should be rendered.

AFL, our language for audio formatting, is used to define rendering rules. Here, we give a rendering rule for object kronecker-product.

(def-reading-rule (kronecker-product simple)
"Simple rendering rule for object kronecker-product."
(read-aloud (first (children kronecker-product)))
(read-aloud "kronecker product") (read-aloud (second (children kronecker-product))))

which produces

cap a kronecker product cap b

for the input text shown earlier.

Notice, however, that the rendering rule is free to render the use of the kronecker product in more complex ways; in particular, the order in which the expression is spoken can be completely independent of how it appears on paper. Thus, it is straightforward to write a rendering rule that produces

"The kronecker product of A and B "

AsTeR derives its power from representing document content internally as objects and by allowing several user-defined rendering rules for individual object types. Such rendering rules can cause any number of audio events, ranging from speaking a simple phrase to playing a digitized sound, when an instance of a particular object type is rendered. The mechanism for extending the recognizer affords this same power when rendering user- defined constructs. Once the recognizer has been extended by an appropriate call to define-text-object, such constructs can be handled just as well as any standard La)TeX construct.

5. PRODUCING DIFFERENT RENDERINGS OF THE SAME OBJECT

AsTeR can produce more than one kind of rendering for a given object. When perusing printed information, a reader has the luxury of viewing a complex piece of mathematics from different perspectives, and AsTeR provides this same functionality. The listener can switch between any of several pre-defined renderings for a given object, or add to these by defining new rendering rules. Switching between different rendering rules produces different audio views of a given object.

Activating a rendering rule is the simplest way of changing how a given object is rendered. Statement

(activate-rule)

activates rule for object . Thus, executing (activate-rule 'paragraph 'summarize) results in paragraphs being summarized.

Suppose we wish to skip all instances of verbatim text in a LaTeX document. We could define the following quiet rendering rule:

(def-reading-rule (verbatim quiet) nil)

and activate it by executing

(activate-rule 'verbatim 'quiet)

To later hear the verbatim text in a document, rule quiet is deactivated by executing

(deactivate-rule 'verbatim)

Notice that at any given time, only one rendering rule is active for any object. Hence, we only need specify the object when deactivating a rendering rule. AsTeR provides an Emacs interface to activating and deactivating rendering rules.

Activating a single rendering rule is a convenient way of changing how a specific object is rendered. Rendering styles allow making more global changes to the renderings. Activating style style-1 by executing

(activate-style 'style-1)

makes the rendering rule named style-1 active for all objects for which this rendering rule is defined. All other objects continue to be rendered as before. This is also true when a sequence of rendering styles is successively activated.

Thus, activating rendering styles is a convenient way of progressively customizing the rendering of a complex document. The effect of activating a style can be undone at any time by executing

(deactivate-style)

AsTeR provides the following rendering styles:

- Variable-substitution: Use variable substitution when rendering complex mathematical expressions.

- Use-special-pattern: Recognize special patterns in mathematical expressions to produce context-specific renderings.

- Descriptive: Produce descriptive, context-specific renderings for mathematical expressions.

- Simple: Produce a base-level audio notation for mathematical expressions.

- Default: Produce default renderings.

- Summarize: Provide a short summary.

- Quiet: Skip objects.

When AsTeR is initialized, the following styles are active:

(use-special-pattern descriptive simple default)

with the leftmost style the most recently activated style. Defining a new rendering style amounts to defining a collection of rendering rules having the same name. Note that a rendering style need not provide rendering rules for all objects in the document logical structure. As explained earlier, activating a rendering style only affects the renderings of those objects for which the style provides a rule.

6. USING THE FULL POWER OF AsTeR

This section demonstrates some advanced features of AsTeR that are useful when rendering complex documents. AsTeR recognizes cross-references and allows the listener to traverse these as hypertext links. Cross-referenceable objects can be labelled interactively and these labels used when referring to such objects within renderings. The ability to switch between rendering rules allows the listener to quickly locate portions of interest in a document. By activating rendering rules, all instances of a particular object can be floated to the end of the containing hierarchical unit, or entirely skipped. This is convenient when getting a quick overview of a document. AsTeR also provides a simple bookmark facility for marking positions of interest to be returned to later. Finally, AsTeR can be interfaced with sources of structured information other than electronic documents. We demonstrate this by interfacing AsTeR to the Emacs calculator.

6.1 Cross-References

Cross-reference tags occurring in the body of a document are represented internally as instances of object cross-reference and contain a link to the object being referenced. How such cross- reference tags are rendered of course depends on the currently active rule for object cross-reference . The default rendering rule for cross-references presents the user with a summary of the object being cross-referenced, e.g., the number and title of a sectional unit. This is followed by a non-speech audio prompt. Pressing a key at this prompt results in the entire cross-referenced object being rendered at this point. Reading continues if no key is pressed within a certain time interval. In addition, the listener can interrupt the rendering and move through the cross-reference tags. This is useful in cases where many such tags occur within the same sentence.

6.2 Labelling a cross-referenceable object

Consider a proof that reads:

By theorem 2.1 and lemma 3.5 we get equation 8 and hence the result.

If the above looks abstruse in print, it sounds meaningless in audio. This is in fact a serious drawback when listening to mathematical books on cassette where it is practically impossible to locate the cross-reference. AsTeR is more effective since these cross-reference links can be traversed; but traversing each link while listening to the above proof can be distracting. Typically, we only glance back at the cross-references to get sufficient information about what theorem 2.1 is about. AsTeR provides a convenient mechanism for building in such information into the renderings. When a cross-referenceable object such as an equation is rendered, the system verbalizes an automatically generated label, i.e., the equation number, and then generates an audible prompt. If the user presses a key at this prompt, he can specify a more meaningful label which will be used in preference to the system-generated label when rendering cross-reference tags.

To continue the current example, when listening to theorem 2.1, the user could have specified the label "Fermat's theorem". Then the proof shown earlier would be read as:

By Fermat's theorem and lemma3 .5 we get equation 8 and hence the result.

Of course, the user could have specified labels for the other cross-referenced objects as well, in which case the rendering produced almost obviates the need to look back at the cross- referenced objects.

6.3 Locating portions of interest

Printed books allow the reader to skim through the text and quickly locate portions of interest. Experienced readers use several different techniques to achieve this. One of these is to locate an equation or table of interest, and then read the text surrounding this object. AsTeR provides this functionality to some extent.

We explained in Section 4 that different rules can be activated to change the type of renderings produced. Using this mechanism, we can activate a rendering rule that only reads the equations occurring in a document. Once an equation of interest is located, rendering can be interrupted and the rendering rule changed. Using the browser, the listener can now move the current selection to the enclosing hierarchical unit and then read the surrounding text.

6.4 Getting an overview of a document

Rendering rules can be activated to obtain different views of a document. For instance, activating rendering rule quiet for object paragraph provides a thumb-nail view of a document. Activating rendering rule quiet is a convenient way of temporarily skipping over all occurrences of a specific object. We often do this when perusing printed documents; we skip over complex material at the first reading and return to these later. We may skip instances of some objects entirely e.g., source code; in other cases we may merely defer the reading. This notion of delaying the reading of an object is aptly captured by the concept of floating an object to the end of the enclosing unit. Typesetting systems like La)TeX permit the author to float all figures and tables to the end of the containing section or chapter. However, only specific objects can be floated, and this is exclusively under the control of the author, not the consumer of the document.

AsTeR provides a much more general framework for floating objects. Any object can be floated to the end of any enclosing hierarchical unit, e.g., instances of object footnote can be floated to the end of the containing paragraph. The ability to float objects is very useful when producing audio renderings. This is because audio takes time, and it is advantageous to delay the rendering of some objects when obtaining an overview. Printed documents use footnotes and floating figures for precisely this reason. The interactive nature of AsTeR allows us to extend this functionality.

6.5 Bookmarks

The browser provides a simple bookmark facility for marking positions of interest to be returned to later. Browser command mark-read-pointer bound to C-b m prompts for a bookmark name and marks the current selection. The listener can later read the object at this marked position, or move the current selection to the marked position by executing browser command follow-bookmark and specifying the appropriate bookmark name.

6.6 Reading using variable substitution

When reading complex mathematics in print, we often get a high- level view of an equation first, and read the leaves of an expression once we have understood the top-level structure. Thus, when presented with a complex equation, an experienced reader of mathematics might view it as an equation with a double summation on the left-hand-side and a double integral on the right-hand- side, and only then attempt to read the equation in full detail. In an audio rendering that simply produces a linear rendering, the temporal nature of audio prevents a listener from getting such high-level views. We compensate by providing a variable substitution rendering style. When active, this results in AsTeR replacing sub-expressions in complex mathematics with meaningful phrases. Having thus provided a top-level view, AsTeR then reads the sub-expressions that were substituted for earlier upon request.

6.7 Interfacing AsTeR with other information sources

AsTeR has been presented as a system for reading documents. More generally, AsTeR is a system for presenting structured information in audio. This fact is amply demonstrated by the following example where we interface AsTeR to the Emacs calculator, a full-fledged symbolic algebra system.

The Emacs calculator is a public domain symbolic algebra system available under the terms of the GNU license. It provided an excellent source of examples for trying out the variable substitution rendering style for mathematical expressions. Providing an audio interface to a symbolic algebra system is challenging since the expressions produced are quite complex. The flexible design of AsTeR and the power of Emacs makes this interface easy. AsTeR can render any information present in an Emacs buffer. The output of the Emacs calculator satisfies this requirement. A collection of Emacs Lisp functions arranges for the output from the calculator to be sent to AsTeR.

A user of the Emacs calculator can now perform a computation and execute command read-previous-calc-answer to have the output rendered by AsTeR. The expression can be browsed, summarized, transformed by applying variable substitution, and the rendering manipulated in any of the ways described so far in the context of documents.

NOTES

(1) Standard Generalized Markup Language (SGML) captures information in a layout independent form; LaTeX, designed by Leslie Lamport, is a document preparation system based on the TeX typesetting system developed by Donald Knuth.

(2) In real life, AsTeR is the name of the author's guide-dog, a big friendly black Labrador.

(3) To most people, "markup" means an increase in the price of an article. Here, "markup" is a term from the publishing and printing business, where it means the instructions for the typesetter, written on a typescript or manuscript copy by an editor. Typesetting systems like LaTeX have these commands embedded in the electronic source. A markup language is a set of means (constructs) to express how text (i.e., that which is not markup) should be processed, or handled in other ways.

(4) clos (Common Lisp Object System) is an object oriented extension of Common Lisp.

(5) In this article, the notation La)TeX represents the entire "family" of markup languages including TeX, LaTeX, and AMSTex.

(6) This is an Emacs Lisp command, and in the author's setup, it is bound to C-z d.

(7) reader-quit-reading Bound to C-b q.

(8) ANGE-FTP, an Emacs utility written by Andy Norman, allows seamless access to such files. In addition, Emacs clients are available for networked information retrieval systems like GOPHER, WWW and WAIS.

(9) Macros permit an author to define new language constructs in TeX and specify how these constructs should be rendered on paper.

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A GRAPHICAL CALCULUS COURSE FOR BLIND STUDENTS

Albert A. Blank, Professor
Computer Science Department, 1N215
College of Staten Island, CUNY
2800 Victory Boulevard
Staten Island, NY 10314-6600
Tel. 914 738-7678
email: u1555@f.nersc.gov

Karen Luxton Gourgey, Director
Computer Center for the Visually Impaired
Baruch College, CUNY
17 Lexington Avenue, Box 515
New, York, NY 10010
Tel. 212 802-2146
email: klgbb@cunyvm.cuny.edu

Michael E. Kress, Professor
Computer Science Department, 1N215
College of Staten Island, CUNY
2800 Victory Boulevard
Staten Island, NY 10314-6600
Tel. 718 982-2850
FAX: 718 982-2856
email: u1551@f.nersc.gov

For blind students seeking education and a career in science, engineering and mathematics, the calculus has presented a formidable barrier. This is not simply due to the intrinsic difficulty of the subject, which is obstacle enough for most students. The additional hurdle for blind students is the substantial graphical component of the typical calculus course. There are two major aspects of that graphical component: primarily, there is the representation of geometrical objects, especially the graphs of functions; then, there is the presentation of mathematical formulas as a graphic display.

Under a grant from the National Science Foundation, the Computer Science Department (CSD) of the College of Staten Island and the Computer Center for the Visually Impaired (CCVI) of Baruch College are developing text materials and providing an environment to offer blind and visually impaired students technologically assisted access to the graphical content of the calculus. The goal of the project is to equal or exceed the quality of courses for students with unimpaired vision. We are installing facilities for reading mathematical text and graphics directly without the help of sighted readers. It is only quite recently that any such technology has become practical and affordable for institutions. We can expect that it will become so for individuals before long.

We wish to bring such a course into being for the students who need it right now. For that reason, we are trying to base our system, insofar as possible, on "off-the-shelf" technology and courseware, rather than try to invent much of it.

For basic course content, we are using the successful self-paced mastery course in calculus developed at Carnegie-Mellon University for students of science, engineering and mathematics, developed by Albert Blank assisted by Raymond E. Artz. (1) This is being supplemented by essential prerequisite materials that visually impaired students may lack. The original text was oblivious to the special needs of these students and many small adaptations will be made. For example, the original text stated in its second paragraph, "The axes divide the coordinate plane into four quadrants which are traditionally labeled with Roman numerals as shown in Figure 1-1." No further clarification was given.

The use of a course designed for self-pacing is basic to the program. Our students will work with new multisensory media that present the course materials and will augment their skills with new language and new techniques of expression for presenting their own work. They will generally need extra time, effort and training. Furthermore, thorough mastery is vital because the calculus is fundamental to most of science and engineering. Moreover, mastery is important to give the students confidence that they can become proficient in areas that were hitherto largely inaccessible to them.

Many of the problems of presentation to students with visual impairments can now be addressed with existing technology in a multimedia multisensory environment:

-- audio-tactile tablets can be prepared and programmed beforehand to present graphics.

-- scanners with optical character recognition (OCR) software can be used to read conventional printed text into ASCII files. Braille printers with appropriate translation software can render those files in Braille.

-- for those who do not read Braille or even those who do, screen reading systems provide access to ASCII encoded text files.

-- enlarged display screens are available for those with lesser degrees of impairment.

-- Hypermedia techniques can be used to provide easy access at will to information in the courseware.

1. Presentation of graphics.

We are using the touch-sensitive NOMAD audiotactile tablet(2) to present graphic images. Consider, as an example, the problem cited above as Figure 1.1 in the calculus textbook. The graphical version of this purely verbal and visual statement is embossed on a soft plastic sheet 16.5 inches wide by 11.75 inches high. (3) A tactile grid, each cell measuring 1 inch by 1 inch, is displayed in relief on this sheet. The more important details of the figure are presented on the graphic as heavier and in higher relief than the less important ones in order to give tactile expression to their varying importance. At the bottom margin of the graphic, at the base of each vertical grid line, there is a round button. When any of these buttons is pressed, NOMAD voices the x-coordinate of that line. Similarly, along the left margin, there is a row of buttons that voice the y-coordinate of the horizontal gridlines attached to them. Heavier lines or double lines mark the x-axis attached to the button, "y=0," and the y-axis, attached to, "x=0." Pressure at the intersection of the axes will voice, "origin". Pressure at any other point of the x-axis will voice "x-axis," etc. Along the upper right margin of the graphic there is a row of diamond-shaped buttons. A press of one of these will voice an associated keyword from the text. (3)

Any feature of the graphic can be programmed to voice three levels of information in succession. This is especially useful when applied to the rectangle on the lower right. At that location, the first level of information gives the figure number and name. The next level lists features of the graphic that can then be located through NOMAD's search capabilities. The third level can give any information about the graphic or the lesson that the instructor desires. NOMAD lacks high level editing capabilities but it is easy, though sometimes tedious, to program.

The grid spacing and button placement of the figure shown here will be maintained for all the graphs the student will use in the course. The keywords will differ depending on the lesson. The origin and axes may lie anywhere or even be located outside the picture frame. The coordinates of successive grid points on the axes can differ by some other constant than one. At the same time, the constant structure of the graphics will offer a consistent, familiar environment in which the student can operate securely.

The hope for the future is that the process of making a graphic will be automated so that a blind person can operate interactively at a work station to create and analyze such a graphic without requiring the assistance of a sighted person.

2. Presentation of formulas.

Formulas introduce special problems that technology has not resolved in simple ways:

a. Optical character recognition. OCR programs offer great promise. However, they are not yet completely reliable readers even of straightforward literary text. Moreover, technical print containing formulas is still far beyond their capabilities.

b. Braille. Braille systems for rendering formulas exist and others are in development. The Nemeth code was developed specifically for the purpose of rendering mathematical expressions in Braille. It uses standard six dot Braille and, by virtue of adroitly constructed combinations of Braille characters, is able to represent very complex expressions. The Nemeth system needs to use compound characters to represent many of the symbols that are single characters on a keyboard. A more significant difficulty is that the code lacks the graphical elements of complex mathematical expressions that enable the learner to develop an intuitive grasp of the material.

Computer Braille is a six dot system which represents letters, numerals and punctuation (including parentheses, brackets and braces). It is most useful for communicating between ASCII based and Braille based devices without the need for a great deal of translation. Computer Braille can be used for mathematical formulas but its use doesn't make it easier or faster to understand them.

A hybrid system is being developed by Prof. John A. Gardner at Oregon State University under an NSF grant. This is the DotsPlus system which combines eight dot Braille with tactile display of some of the graphical elements in technical formulas. With eight dots per Braille cell, a true one-to-one match could be made between Braille cells and ASCII's eight bit bytes. For blind programmers, this would be even more useful than computer Braille. We plan to test the DotsPlus system in the course of our program. DotsPlus, in common with other Braille systems, requires preliminary training of our volunteers and cannot be deployed immediately. Anything but the limited use of Grade 1 Braille will have to be postponed.

c. Voice presentation. Until we are able to install more advanced methods of presenting technical text, we are simply using the time-honored method of preparing audio cassettes made by a trained reader.

The application of voice synthesis to read ASCII encoded text files appears to be the most promising method in sight. In our multimedia laboratory, we shall soon install AsTeR, T.V. Raman's program described earlier in this issue of _ITD_. AsTeR has great parsing and expressive capabilities. It can auditorily render the structure and content of a mathematical formula in ways analogous to a graphical display. AsTeR has excellent hypertext facilities that permit sophisticated random search for information. These capabilities exceed those of a trained mathematical reader, as demonstrated by cassette tapes prepared by Recording for the Blind, Princeton, NJ. AsTeR reads technical ASCII files written with the LaTeX macro package for the mathematical typesetting language, TeX. The combination of LaTeX and AsTeR has a special advantage: it is possible to use a command set that expresses the semantic content of a symbol as well as its typographical form. For example, the symbol (a,b) for an ordered pair of entities is used in mathematics in many different contexts and interpretations. If it were used to represent the coordinates of a point in a plane, say, it would be possible to use a special LaTeX macro that would cause the symbol to be printed as usual but cause AsTeR to speak, "point a click b".

As yet, AsTeR requires substantial hardware and software resources that would usually be available only in an institutional setting. Until AsTeR is installed, mathematical formulas can be written out in English for synthesis by screen reading programs. For example, the formula

(a+b)/(c+d)

could be voiced as "fraction a plus b over c plus d", where the extra spacing is to be read as brief pauses.

3. Presentation of student work.

The LaTeX macro package is a comprehensive word processing program for literary text enhanced by special facilities for processing technical formulas. It is already the most common form for the computer processing of mathematical text and extensions of LaTeX are being developed for other sciences. LaTeX offers a special benefit to our students, who generally have keyboarding skills: they can present their work in LaTeX. A LaTeX source file uses only keyboard symbols. Since LaTeX expresses the semantic content of a formula through simple macros that can be interpreted either by print graphics, Braille, or voice synthesis, it can be used as a common basis for all computer assisted presentation of technical text. The effort to learn the few LaTeX commands appropriate to a particular course of study is about the same that any student would devote to earning the symbolism of the subject. It would be unnecessary for a student to learn many, if any, of LaTeX's visual typesetting commands.

Work executed in LaTeX could be printed in typeset form by the student for submission to the instructor or the LaTeX source file could be viewed in that form on the instructor's screen. With appropriate software and a Braille printer, the student's work could be saved in hard copy for future use. Wherever AsTeR is installed, the student could review his work in audible form with the assistance of AsTeR's search facilities. Without AsTeR, we would expect that audible review could be done by standard screen reading systems "trained" to render the LaTeX commands. For example, "$ \sin (x) $," would be voiced as, "sine of x."

Conclusion.

It is our hope that others will act along the lines explored by us. The technology for education and training for careers in science, engineering and mathematics of people with visual disabilities is already here. As an added bonus, much of that same technology can do double duty and serve people with certain kinds of learning disabilities. We need not and should not wait for the technology to reach a higher state of perfection as, surely, it will. We can upgrade component-by-component as the technology improves. For now, we can enjoy the marvelous advances that permit us to do what would have been impossible a scant two years ago when our group first contemplated instituting such a program.

Acknowledgments

We are grateful to Julio C. Perez for reviewing the section on Braille and contributing his knowledge. This work was supported in part by the National Science Foundation, Experimental Projects in Human Resources and Education, Grant No. HRD 9450166, "Multisensory Calculus for Teaching Students with Visual Impairments," 1994.

NOTES

1. Supported in part by a grant from the Carnegie Foundation.

2. Available from The American Printing House for the Blind (APH), Louisville, Kentucky.

3. On request, print copies of this graphic on letter-sized paper (reduced about 50%) are available. For our visually impaired readers, we can provide copies on swell paper. We regret that we can distribute swell paper copies only to those readers who are visually impaired because of the associated costs. Please write Prof. Blank at the above address for a copy, one per reader.

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ENSURING USABILITY IN INTERFACE DESIGN: A WORKSTATION TO PROVIDE USABLE ACCESS TO MATHEMATICS FOR VISUALLY DISABLED USERS

Helen Cahill and John McCarthy
Department of Applied Psychology
University College CorkIreland

ABSTRACT

This paper presents an account of the formative evaluation of a multi-media "MATHS" workstation which is being developed to provide usable access for blind and partially sighted students reading and manipulating mathematical expressions. We argue that there is a crucial difference between notions of accessibility and usability in interface design.

Traditionally, assistive technology has been concerned with providing access to disabled users. However, unless such access embraces usability, it does not necessarily overcome the access limitations imposed by the user's disability and provide usable access. Therefore, it is essential that interface designers recognize the difference between the traditional design concept of accessibility and the more user-centered design concept of usability. The MATHS workstation is being designed with a concern for usability. In this paper, the broad context of usability is introduced. The processes of measuring usability according to ISO9241 (CD) and the development of the MATHS workstation usability requirements specification according to ISO9241 (CD) are presented. (Ed. note: These code numbers refer to a draft software usability standard prepared by the European Commission Technology Initiative for Disabled and Elderly People. They are defined more fully in the text of this article.)

We hope that this account of the application of a usability standard to the development of the MATHS workstation will be valuable to other assistive technology designers.

THE BROAD CONTEXT OF USABILITY

Accessibility is a central concept in the literature concerning technology for disabled people. One of the overriding occupational problems faced by wheelchair-users is gaining access to buildings. Many companies have attempted to ameliorate such problems by providing wheelchair ramps. Wheelchair ramps literally afford access. But, they are only a start. There are many examples of buildings with ramps (often tacked on after design, rather than included in the building specification) which are too steep for a person in a wheelchair to use with any ease at all. Other examples of "access" include buildings with relatively shallow ramps that lead to heavily resistant double swinging doors that cannot be opened by the wheelchair-user without the assistance of an attendant or passerby.

Designed to provide access? Perhaps. But hardly usable.

This distinction between accessibility and usability was acknowledged by Stig Becker of Sweden's Handikapp Institut at the First International Workshop on Access to Mathematics (IWAM -1993) when he urged designers to "make accessibility, usability". This call was echoed by John Gardner of Oregon State University, who argued that while Braille may provide access to documents for some, the need for precise, finger-tip tactile sensitivity which declines with age and the need for a considerable initial learning investment (especially for Braille mathematics notation) means that Braille can be completely unusable for many. Gardner's "DotsPlus" system of presenting tactile mathematical symbols as they appear in the printed form was designed with usability as a prime concern.

At this point it is important to make the accessibility/usability distinction clear. According to dictionary definitions, something is accessible if it can be reached. A word processing package might be accessible if the user can perform the functions contained in it. Usability encompasses much more than that. It implies consideration of the ease with which the user can perform those functions; how effectively and efficiently the user can write a paper with the package; and even the satisfaction the user derives from using it. Many writers intend to include some sense of the technology being usable when they write about it providing access. However, in line with Becker, we would suggest that usability should subsume accessibility in design discourse.

Following Whiteside et al. (1987) it can be argued that "usability" is an engineering concern. "Usability engineering" follows in the tradition of established engineering disciplines, in that its methodology is geared toward delivering useful, working artifacts. Engineering involves building things, most of which are used by people. Engineering is not carried out in avoid, but within a social and historical context. Often "the engineer" is not a person, but a multi-disciplinary team. Engineering-- delivering useful, working artifacts--is characterized by commitment to action in the world (Winograd and Flores, 1986) against a background of shared understandings. The users and the engineers must understand the requirements, including the usability requirements in much the same way. However, because of their intrinsically different backgrounds and motivations, each is capable of interpreting the requirements differently. Therefore requirement specifications must be driven by a process of negotiation involving all interested parties. Usability specifications must result in operationally defined and publicly stated criteria for satisfaction of agreed upon requirements. This is the case whether building bridges or computer systems.

So what, exactly, is usability?

In operational terms, usability is a measure of the extent to which intended users of a product achieve specified goals within a specified context of use. From the point of view of the user, usability means products that are easy-to-learn and easy-to-use. Usability means that products meet the users' needs within an overall work system, and result in greater productivity for users.

ISO9241 (CD) - A USABILITY STANDARD

The MATHS (Mathematical Access to TecHnology and Science) project is being carried out as part of the European Commission (EC) TIDE (Technology Initiative for Disabled and Elderly People) program which aims to develop a Single European rehabilitation technology market. The MATHS project is specifically concerned with addressing the mathematical access difficulties that blind and partially sighted people experience. It is intended to develop a multi-media, interactive computer workstation which enables blind and partially sighted users to read, write and manipulate algebraic expressions in a similar way to that which an exercise book allows sighted students to perform these tasks.A central focus in this project is to incorporate a concern for usability at all stages in the design and evaluation.

ISO9241 (CD) is a draft software usability standard that reflects the usability concern outlined above. It offers a framework for defining criteria for the satisfaction of specified requirements, and insists that the requirements specification process is put into context by the intended use ofthe system. ISO9241 (CD) insists that this requirements specification process is public and auditable. Finally it suggests that even if one construes usability as a set of characteristics of the end product, achieving usability entails aprocess of attending to user characteristics and needs from the very start of any software development project.

Let us consider the framework for measuring usability specified in ISO9241 (CD).

According to ISO9241 (CD), usability is a measure of the extent to which intended users of a product achieve specified goals in an effective, efficient and satisfactory manner within a specified context of use.

Effectiveness may be defined as the accuracy and completeness with which intended goals are achieved. For instance, effectiveness can be measured using the percent or number of errors, a ratio of successes to failures, or the percentage of task completed. Depending on the nature of the task, some measure of human error may need to be taken into account when measuring accuracy and completeness of task performance.

Efficiency is a measure of the amount of human, economic and temporal resources that are expended in attaining a required level of product effectiveness. Measures of efficiency include time taken to complete the task, time spent using help or documentation and subjective workload (mental effort) estimations.

Satisfaction refers to the immediate (ease-of-learning) and long-term (ease-of-use) comfort and acceptability of the overall system. Useful satisfaction measurements include the number of times the interface misleads the user or the user loses control of the system, the percent of favorable/unfavorable comments and ratings on a post-test Likert scale.

According to ISO9241 (CD) the three aspects or measures of usability (effectiveness, efficiency and satisfaction) are only meaningful within a clearly defined context of product use and are very much inter-related. Precise and accurate information about each aspect of the intended context(s) of product use must be collected before a usability requirements specification can be drawn up. The context of product use covers everything from user attributes, the equipment available for use, environmental constraints and the task goals which the product is intended to support.

User attributes include: age range, mechanical and cognitive capacities and limitations, general ability, attitude, motivation, skill, product experience, task experience, training and general knowledge. Equipment available for use relates to existing hardware and software specifications for compatibility assessment. Environmental constraints can be anything from the social environment (organizational structure, attitudes, cultureand work practices), the technical environment (or configuration) to the physical/ambient environment (workplace design and conditions). Task goals are the set of tasks that the product is intended to support, enhance or transform, and the specific goals that the product as a tool to aid the user in performing the tasks, is expected to achieve. It is important that task goals should not merely be identified. They must be clearly defined, prioritized and assigned target values.

In a usability requirements specification, a measure or a number of measures of effectiveness, efficiency and satisfaction (where relevant) for each task and in relation to each user group should be identified. This involves listing the set of tasks and types of user contexts and deciding whether effectiveness, efficiency and satisfaction should be measured by asking the user to perform that specific task (as in bench marking), by monitoring the user during free use as in logging and observation, by giving the user a questionnaire to complete, or more directly by interviewing the user.

UNDERSTANDING THE MATHS WORKSTATION CONTEXT OF USE AND USER NEEDS

The major objective of ISO9241 (CD) is to specify a usability requirements specification to guide design and evaluation throughout the duration of the development process. In order to collect the context of use and user needs data required to formulate a usability requirements specification, it is necessary to carry out some formative evaluation research.

In the MATHS project, contextual inquiry was used to analyze the overall context of use and a user survey was carried out to gather user needs. Some interview and task analysis research was also carried out to extend the contextual inquiry and user survey findings.

Contextual inquiry is a useful research tool for understanding and describing a potential user environment. It involves designers visiting potential end-user's workplace (or learning places in the case of educational products) and focusing attention on the user's needs and problems within this dynamic context. The advantage of contextual analysis is that it provides the design team with an opportunity to gain an in-depth understanding of the nature of the user's work and to consider how a product could support or even transform this work. It also helpsdevelop a sense of partnership between the designers and the users, which can be beneficial in later evaluation stages. Contextual inquiry in the MATHS project involved visiting special schools, integrated schools, mainstream schools and university disability support centers.

The results of this contextual inquiry research led to the concept of the MATHS workstation as operating in a layered context of use (Cahill & McCarthy, 1994). The MATHS workstation is intended to help blind and partially sighted students read and do mathematics. In principle it could be used in educational settings, occupational settings and for personal and home use. However, as the primary focus of the MATHS project is access to reading and doing mathematics for blind and partially sighted secondary school and third level students, from this point on,"context-of-use" refers specifically to educational settings.

The MATHS workstation context-of-use includes educational aspects, individual aspects, and interactions between the two. As each of these aspects is in itself complex, and interactions increase this complexity, there is a sense in which it can be construed as multi-layered, involving four layers: a distributed layer; a cognitive layer; a perceptual layer; and a mechanical layer.

The distributed layer concerns the social nature of the MATHS workstation in educational settings and the need for it to support student-teacher interactions and communication and cooperation between blind and partially sighted and sighted students. The cognitive layer represents the cognitive processes involved in reading and manipulating mathematics and the requirements for distribution of knowledge in the world (use of external memory) and knowledge in the head (use of internal memory). The perceptual layer concerns how visual, auditory and tactile perceptual processes differ and the resulting implications for the presentation of mathematical notation. For instance, it is necessary to insert prosodic cues in auditory presentations of mathematical expressions to compensate for the lack of spatial information available through a visual presentation. Lastly, the mechanical layer concerns the diversity of input/output needs and preferences among potential MATHS workstation end-users.

A significant finding that emerged from this research concerned the heterogeneity of the MATHS workstation potential end-user group. The different visual capabilities and limitations, input and output device preferences and mathematical abilities, etc. across blind and partially sighted users must be reflected in the design of the MATHS workstation in order to make it truly usable to a wide range of potential users.

In order to gather data about potential MATHS workstation end-users needs, a user survey was carried out (Bormans et al. 1994).The user survey or questionnaire is a list of questions that is administered to a representative group of potential users about their background, the nature of their work, the difficulties experienced in doing this work, and any feedback that they may be willing to give about their use of a product. In designing a user survey it is important to ensure that all of the questions are relevant, unambiguously stated and unobtrusive to the respondent. While multi-choice questions can be a useful way of gathering general statistical information from a large group of people, open-ended questions are often answered in a vague or meaningless manner. For this reason, contextual analysis involving some interviewing was used to obtain qualitative information about the MATHS workstation context-of-use, and a user survey was used to generate qualitative data about potential MATHS workstation end-user backgrounds, experience of mathematics and experience of computer hardware and software.

The user needs survey was administered to a large sample of blind and partially sighted students and their teachers from special schools, integrated schools, mainstream schools and third level colleges in both Ireland and Belgium. In addition to surveying blind and partially sighted students from these groups, an adapted form of the questionnaire was administered to a control group of sighted students from mainstream schools in both countries in order to determine whether specific areas of difficulty in mathematics were common to all students, or specific to those with a visual impairment.

Brief results from these surveys and the resulting implications for the design of the MATHS workstation are presented here.

First, blind and partially sighted students in Ireland and Belgium attend a range of special, integrated and mainstream schools depending on the degree of their impairments, wherethey are living in their country, and school boarding facilities.

In comparison to their sighted colleagues, only a small proportion ofblind and partially sighted students take higher level mathematics papers in formal school examinations, and in general, blind and partially sighted students find mathematics less interesting and more difficult than their other school subjects. Blind and partially sighted students report great difficulty with the mechanical (manipulation) side of mathematics, which contrasts with sighted students who have more difficulty with the conceptual (understanding) than mechanical aspect of mathematics. The implication of these general findings was that the MATHS workstation should tackle the mechanical difficulty that blind and partially sighted students experience with reading and manipulating mathematical expressions with the long-term goal of increasing visually impaired students'interest in mathematics, and in increasing the number of visually impaired students taking higher level mathematics papers in formal school examinations.

The sample of blind and partially sighted students surveyed reported finding set notation, trigonometry and logarithms as causing the most difficulty, super-and subscripts (powers and bases), tables and graphs as causing average difficulty and punctuation (brackets and commas) and algebra as causing the least difficulty. Obviously it would be ideal if the MATHS workstation could cover all of these aspects of mathematics, however in its early development stages it is only feasible for it to tackle a small subject area. While algebra is not rated as causing the most difficulty, it was felt that it presented a worthwhile area as its associated problems were mechanical rather than conceptual in nature and solutions could be provided in terms of "access" to rather than "assistance" with mathematics, which corresponds with the philosophy of the MATHS project.

In terms of specific difficulties with algebraic expressions, the students reported accuracy and speed of manipulation and memory overload as causing most difficulty with control over their navigation through an expression and confusion from linear layout of otherwise spatial representations (such as fractions) as causing some difficulty. Understanding the meaning of expressions was reported as causing least difficulty. These findings clearly support the assertion of mechanical rather than conceptual difficulties (and needs) associated with algebraic expressions, in other words "access" rather than "assistance" needs.

It was found that blind and partially sighted students tend to experience more or less the same mathematical problems as their sighted peers, except to a greater degree due to the added mechanical difficulties. This finding also supports the need for a MATHS workstation which overcomes mechanical difficulties by providing access to (rather than assistance with) reading and writing mathematical expressions.

While some of the blind and partially sighted students reported having used Apple Macintosh computers, most of the students were most familiar with IBM compatible PC's. Thus, it was recommended that the MATHS workstation be developed using an IBM PC, adapted for use by blind and partially sighted students with screen readers, speech synthesizers, Braille display devices and large character display modifications. Most of the students reported having used word-processing applications, with a small number also having experience with database and spreadsheet applications. This was interpreted as an encouraging finding from the point of view of teachers' and students' attitudes towards computer applications in the classroom and their potential interest in the MATHS workstation.

When asked about a computer-based workstation that would provide them with greater access to reading and manipulating mathematical expressions, preferences were divided between menu and command (both keyboard and voice) input. Due to the need to cater to both partially sighted and blind students and novice and expert computer users, it was recommended that the MATHS workstation provide users with access to both options. It was suggested that as with many commercial software packages, commands could be issued by choosing menu options or keyboard input of the first letter of menu options.

Most of the blind and partially sighted students said that they would be willing to invest as much learning time as required into a workstation that would overcome their mathematical access problems. This also was interpreted as an encouraging finding for the development of the MATHS workstation.

In order to extend these context-of-use and user needs findings, some interview and task analysis research was carried out as part of the MATHS workstation formative evaluation usability process.

Interviews were aimed at collecting information about the user-context, tasks to be supported and feedback on use of existing technology. An interview usually involves a one-to-one structured discussion between an interviewer (a member of the design team) and an interviewee (a potential end-user). Areas of interest can be probed in some detail and questions can be tailored to suit the interviewee.

Task analysis is a user-oriented research tool that involves collecting, analyzing and reporting information about how a task is carried out. The focus of analysis can be either in terms of the objective behaviors involved in attaining each sub-task goal, the objects and action sequences involved in performing the task, and/or the cognitive processes involved in executing the task. Information required for task analysis can be obtained from a range of sources including formal observation, informal observation, existing task documentation such as textbooks and post-task, walk-through discussion. In the MATHS project, task analysis was found to be very useful in describing how sighted, blind and partially sighted students read and manipulate algebraic expressions and how they use internal (knowledge in the head) and external (knowledge in the world) memory in performing reading and manipulation tasks.

Task analysis was also carried out as part of the development and refinement of the user-model for the MATHS workstation. This included a detailed description of the user's mathematical vocabulary, preferred cognitive strategies, goals, etc., and the kinds of functions that would be required to support them.

THE MATHS WORKSTATION USABILITY REQUIREMENTS SPECIFICATION

From the descriptions of the layered nature of the context-of-use and details of the mechanical aspects of the user's mathematical needs, it was possible to assemble a usability requirements specification according to that specified by ISO9241 (CD).

A draft version of the usability requirements specification was distributed among the inter-disciplinary project design group forr eview. This review process not only developed and refined the usability requirements specification by taking into account the ideas of a range of researchers from diverse disciplines (Psychology, Computer Science and Electronic Engineering), but it also provided a forum from which the philosophy and goals of the workstation could be finalized. Thus, it could be argued that ISO9241 (CD) is a useful inter-project group communication and decision-making tool, in addition to being a standardized process for ensuring a focus on usability in the design and evaluation stages.

As described, a usability requirements specification presents clear, detailed information about the intended users under four broad headings.First--the user attributes (general background), second--the supporting equipment (existing hardware devices and software applications and their potential compatibility), third--the user environment (the social, technical and physical aspects of the working or learning context of use) and fourth--usability measurement tasks (tasks to be supported and details of how these may be measured). Each of these, including all potential variations, were carefully and thoroughly described for the MATHS workstation intended contexts-of-use.

In terms of measurement tasks for the usability of the workstation in supporting blind and partially sighted students in reading and manipulating mathematics, a set of six representative tasks were formulated: recognition; syntactic discrimination; interpretation; glancing and browsing; manipulation; and editing. Each of these was designed to examine the individual aspects of reading and manipulation processes and to allow for specific identification of usability problems should they arise. Two further tasks were formulated to measure users' overall use of the MATHS workstation in reading and manipulating simple and complex mathematical expressions. The following list presents a summary of this set of test-tasks.

Task 1: Recognition

Definition: Identification of stimuli in the environment

Rationale: Demonstrate ability to recognize presence of algebraic notation using the workstation

Test: Read algebraic expression from workstation output/display

Task 2: Syntactic Discrimination

Definition: Ability to distinguish differences within stimuli based on their physical characteristics

Rationale: Demonstrate ability to distinguish super and sub-scripts from normal integers using the workstation

Test: Differentiate between terms such as: x^(n) +1 and x^(n+1)

Task 3: Interpretation

Definition: Accurate initial understanding of the meaning of algebraic expressions

Rationale: Demonstrate ability to classify algebraic expressions from workstation display/output

Test: Classify an algebraic expression of the form: ax^2 + bx +c = 0 (as a quadratic equation)

Task 4: Glancing and Browsing

Definition: Ability to move around a long algebraic expression, counting the number of terms and returning to specific terms

Rationale: To demonstrate ability using the workstation to glance at an algebraic expression, gain an overall impression, and also read or browse through it in a feature-discriminating manner picking out or returning to terms of interest

Test: Count the number of terms in an algebraic expression from workstation display/output and orient by reading back to a specific term

Task 5: Manipulation

Definition: Ability to move terms around in an algebraic expression in order to make it more manageable

Rationale: To demonstrate ability to move terms around within an algebraic expression

Test: Rearrange an algebraic expression so that all like terms are on one side of the equal sign

Task 6: Editing

Definition: Ability to solve an algebraic expression by adding terms, etc.

Rationale: To demonstrate ability using the workstation to move terms around in an expression and substitute new values when required

Test: Rewrite an algebraic expression by adding like terms

Task 7: Complete use of the workstation to solve a basic algebraic problem

Definition: Ability to read, interpret, manipulate and edit the solution to an unseen simple algebraic problem

Rationale: To demonstrate competence in using the full range of workstation functions to solve a simple algebraic problem

Test: Solve a simple unseen algebraic problem

Task 8: Complete use of the workstation to solve a complex algebraic problem

Definition: Ability to read, interpret, manipulate and edit the solution to an unseen complex algebraic problem

Rationale: To demonstrate competence in using the full range of workstation functions to solve a complex algebraic problem

Test: Solve a complex unseen algebraic problem

(Note: The word 'read' is used throughout the measurement task listing. It refers to reading through visual (enhanced/enlarged and standard visual display/output), tactile (Braille display/output) and auditory (speech and non-speech output) media. Steps involved in solving the tasks have not been included as the MATHS workstation does not intend to proscribe how mathematical tasks should be performed by individual users.)

It is intended that MATHS workstation evaluation will involve the collection of objective (quantitative) and subjective (qualitative) data for users' performance on each of these tasks. In accordance with ISO9241 (CD), in some cases minimum or target performance levels will be set and in other cases actual levels will be reported. In some cases, target levels will be in comparison to the use of traditional mathematical access media (such as audio cassettes) and in other cases target and actual levels will be measured in absolute terms. Thus, in addition to the set of test-tasks, it will be necessary to observe free use of the system during training and general use in order to complete the evaluation.

In order to illustrate this usability evaluation process in greater detail, the test and usability metrics for the second task: syntactic discrimination (discrimination of different syntactic types in an expression) have been presented below.

Test: If x = 2, find the value of y in the following equations:

(i) 3^(x+1) = y(ii) 4^(x) + 2 = y

Syntactic Discrimination Usability Measures:

1 Syntactic Discrimination Effectiveness
1.1 Accuracy - correct distinction of +1 as part of thes uperscript in equation (i) and the + 2 as a constant to be addedto the 4^(x) in equation (ii)
1.2 Completeness - correct distinctions in both tests

2 Syntactic Discrimination Efficiency
2.1 Time - time taken to perform task
2.2 Effort - workload estimation - using task load inventory

3 Syntactic Discrimination Satisfaction
3.1 Ease of use - using Likert scale

3.2 Workstation acceptability - using Likert scale

For each of these six syntactic discrimination usability metrics, for each user group (blind, partially sighted, sighted, etc.) using each component or combination of components of the workstation (Braille, speech, non-speech, etc.) and at each stage of the evaluation process (prototypes to final evaluation), measures of users' performance using the workstation to support the above syntactic discrimination task will be obtained. The levels to be reported include users' worst case, current level, best case and planned levels of performance.

Finally, it should be pointed out that the MATHS workstation usability requirements specification is intended to be a flexible technical document. As the MATHS workstation is developed, it may be necessary to add or modify the set of tasks. Additional effectiveness, efficiency and satisfaction measures for each task may also be formulated.

DISCUSSION/CONCLUSIONS

In this paper the crucial difference between the traditional and the user-centered design concepts of accessibility and usability were presented. We argued that while access involves providing a basic, but not necessarily useful, means for participation in an activity, usability ensures that this means is effective, efficient and satisfying for the potential user within the intended context of use. The emerging draft usability standard ISO9241 (CD) provides a framework and process for implementing this conception of usability at each of the three crucial stages of the design cycle. In the first stage, it involves formative evaluation and development of a usability requirements specification based on an understanding of users' needs and the intended context-of-use. In the second stage it leads to development of design recommendations and the application of the usability requirements specification to the prototype design, ongoing evaluation, and re-design. In the third stage, it involves application of the usability requirements specification to the formal final end-user evaluation. In addition to providing a usability standard and specifying a usability process, ISO9241 (CD) is a useful interdisciplinary communications tool.

ISO9241 (CD) was implemented as the usability standard for the design ofthe MATHS workstation. As ISO9241 (CD) specifies a formative evaluation of user needs and context-of-use, the first task in the MATHS project was to carry out contextual inquiry and user survey work. The results ofthese tasks were incorporated into a draft usability requirements specification which was reviewed and developed by the general interdisciplinary MATHS project group. An adopted usability requirements specification for the MATHS workstation was formulated. That will be used to design the MATHS workstation to support the users within the contexts-of-use described in this specification, and it is intended to carry out on-going and final end-user evaluation of the MATHS workstation using the tasks and metrics presented in this specification.

To conclude, the purpose of this article has been to present a discussion of the difference between accessibility and usability and to demonstrate why a concern for usability is so important ininterface design. The emerging draft software usability standard ISO9241 (CD) specifies a process that addresses usability by specifying an understanding of user needs within a defined context-of-use from the start of software development. This standard was implemented in the early stages of the on-going MATHS project in formulating the usability requirements specification, and it is expected to guide the design and evaluation of the MATHS workstation. It has also been valuable in instrumenting a sense of general commitment to the development of the one workstation within the MATHS project group. We hope that other researchers and software developers, especially those concerned with developing products for disabled users, will benefit from this broad introduction to usability and discussion of the application of ISO9241 (CD) to the design and evaluation of the MATHS workstation.

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MATHTALK: USABLE ACCESS TO MATHEMATICS

Robert D. Stevens and Alistair D. N. Edwards

Department of Computer Science
The University of York
Heslington York UK YO1 5DD
email: robert@minster.york.ac.uk

ABSTRACT

This paper describes the design of the user interface to the Mathtalk program, which aims to give visually disabled readers an active reading of standard algebra notation. The paper introduces the themes of enhancing external memory and control of information flow as the guiding principles behind the design of the user interface. Fast and accurate control of the information flow is vital for active reading. Mathtalk uses structured browsing functions and a specially developed command language to achieve this active reading. Finally, an audio glance called algebra earcons is introduced that enables readers to get a high-level view of an expression and plan the reading process.

INTRODUCTION

This paper describes the design of a user interface that aims to enable a visually disabled reader to gain an active reading of standard algebra notation using synthetic speech and non-speech audio. Two concepts are central to this paper,"external memory" and "information flow control." The aim is to relieve the reader's mental demands and to make them active in reading complex material, in this case algebra. The paper describes the Mathtalk program, which uses prosodic cues in synthetic speech to improve the usability of the auditory presentation and browsing to make the reading process active. Two facilities are important in making the reading process active: browsing and planning. Mathtalk includes browsing functions that are powerful but easy to use and an "audio glance" that facilitates the planning of the reading process. It is hoped that the design principles used in the design of the Mathtalk program can be extended to interfaces that facilitate reading many types of complex information.

The following section describes the problem in more detail. The next two sections then describe in some detail two of the most important elements of the solution as embodied by the Mathtalk program: control of the reading process through "browsing" and planning of the reading process through the provision of an "auditory glance." Finally there is a summary and some conclusions are drawn.

THE PROBLEM

There is a significant need to make access to mathematics easier for visually disabled people. It is a compulsory subject in all school systems. Though many children may find it hard, many blind students do not have a fair chance to develop mathematical skills simply because the notations used are inaccessible to them (Rapp and Rapp, 1992; Kim and Servais, 1985; Cahill and Boormans, 1994). The mathematical abilities of visually disabled people are not doubted; there is no reason to believe that they do not (potentially) have the same range of mathematical skills as the rest of the population; they simply do not have the means to use and develop those skills. This is the reason that visually disabled people are so poorly represented in mathematical, scientific and technical subjects at all levels in education and employment.

There is a need to improve access to mathematics in the area of reading, writing and manipulation. However, merely giving access is not enough. The way in which access is provided has to be usable. Several computer systems have been built that can transform an unambiguous representation of algebraic grouping such as LaTeX (Lamdport, 1985) into an accessible form such as Braille (Arrabito, 1990) and synthetic speech (Stevens and Edwards, 1993; Raman, 1992). There is now a need to take such access systems a stage further and create usable, interactive systems for reading, writing and manipulating algebra that have been fully tested for their usability. The basis for the design of the Mathtalk process comes from an examination of the high-level processes involved in visual reading. This is not an examination of the cognitive processes of reading, but the external, physical processes that enable visually based reading to take place in an active manner. Printed algebra notation, and all other print, acts as an "external memory" for a reader (Larkin, 1989). The printed expression is a permanent representation that relieves the reader from the onerous task of remembering a large amount of complex information. A mathematician will write down intermediate steps in a calculation because there is too much to be remembered, or held in the head, between steps. This is particularly true in the case of algebra notation (Larkin, 1989), where a large amount of often complex information is present and the omission of any single item of that information will lead to miscomprehension.

An important feature of printed algebra is the two-dimensional nature of the notation, and this is one of the features that is difficult to reproduce in non-visual forms. For example, the grouping of one or more characters as a superscript may denote exponentiation. Kirshner, (1989) showed that these spatial cues acted as implicit parsing marks that aided the parsing process for many readers. The visual system allows the reader to have very fast and accurate control over the reading process, with little cognitive overhead. The eyes can move from any part of an expression, to any other, aided by the print cues with very little conscious thought. This control also allows different views of the expression to be obtained by the reader; a high-level view of an expression that allows overall shape and complexity to be gauged and a low-level view, where attention is focused upon the detail of an expression (Ernest, 1987; Ranney, 1987). Such different views allow a visual reader to plan his or her reading of an equation, thus making the whole process more effective and efficient.

For the sighted reader the availability of an external memory together with fast and accurate control of the information flow from that external memory to the reader's internal cognitive processes are the twin processes that make reading active. For a visually disabled reader, working in the auditory modality, there is often an inadequate external memory and poor control over the flow of information from that source. A classic example of this is recorded speech.

Listening is essentially a passive process (Rayner and Pollatsek, 1989) and users of taped books often complain of lapses in concentration and an overwhelming amount of information to try to remember (Aldrich and Parkin, 1988b; Aldrich and Parkin, 1988a). Taped speech is an external memory in that it is a permanent record of information external to the reader, but it is ineffective because of the poor control over the flow of information from that external source. The controls afforded by a tape recorder do not allow fast and accurate control over which part of the external source is currently being used. Reading (or more accurately listening) often defaults to a passive reception of information at a pace dictated by the speech. This lack of control also means the listener has no overall view of what is to be read until it has been read. This important part of the reading interaction is completely missing for the listening reader.

This section has described the main problems of making written mathematical notations accessible in non-visual forms. The next section describes some of the facilities that have been developed within Mathtalk to address the problems.

CONTROLLING THE INFORMATION FLOW

A compensation for the poor external memory and provision of fast and accurate control over information flow are the two main issues addressed in the design of the Mathtalk program. Prosody (varied pitch, timing and rhythm of speech) is used to enhance the speech based presentation of algebra using a synthetic voice (Stevens and Edwards, 1993; Edwards and Stevens, 1993; Stevens et.al., 1994b). The use of prosody replaces some of the visual parsing cues present in print and makes an expression easier to remember and generally increases its usability.

To take advantage of this enhanced speech presentation, the reading is made active by adding browsing functions. Browsing enables the reader to visit any part of the expression quickly and accurately, at a pace dictated by the reader, not the external device. By making it possible to visit any part of the expression quickly, some effects of the transience of speech maybe overcome. If it is easy to access information, the burden of remembering that information does not fall on the reader.

The browsing is based on the structural components of an expression. This is meant to mimic the type of browsing a sighted reader may undertake based on the spatial features of a printed expression. The explicit and implicit parsing marks within an expression described by Kirshner, (1989) provide prominent features by which the reader can direct his or her gaze through an expression. For instance the use of a distinctive typeface signals to the reader the beginning and end of an expression; white space divides an expression into terms; horizontal juxtaposition implies multiplication and vertical juxtaposition and the fraction line indicate division while diagonal juxtaposition indicates exponentiation.

Providing this type of structure-based browsing would give a visually disabled user very accurate control of the information flow that is based upon the sorts of reading/mathematical tasks a reader would have to undertake. For example, to evaluate a polynomial for a given value, a reader will probably want to move term-by-term through an expression evaluating each term in turn. For this reason a basic set of browsing moves would be to move forward and backward through an expression term-by-term. Another example would be the requirement to move straight to a parenthesized sub-expression in order to evaluate its contents prior to the rest of the expression. All the Mathtalk browsing functions are based on moving to structural features within an expression.

These browsing functions have the potential to make the reading active. Here a difficult point is encountered. The control used by the sighted reader is essentially subconscious. Moving the gaze from one expression to another or within an expression itself seemingly requires no mental effort or explicit issuing of a command. In this case the control process can be said to be internal. For a visually disabled reader any means of control is, by necessity, external. This means that the control of information flow will itself intrude into the reading process, disrupting the flow of information and imposing a further cognitive load on the reader. In addition, the interaction via browsing is necessarily complex in order to be effective.

The structural nature of the browsing gives accurate control suitable for the tasks involved, but does require the reader to use a set of labels that describe the structure of an expression.

Mathtalk covers the core of algebra notation and already has nine labels or syntactic targets that are used to direct browsing. As the algebra covered by the Mathtalk program increases so will this pool of labels that must be learned. A further problem with the external nature of such browsing is that the labels have to be consistent with those used by the reader and those used in the reader's environment. Whether such a system is usable by a reader can only be found by evaluation of the system.

Given that there will be some cognitive burden placed on the reader by using an external means of control, this burden must be made as small as possible. The command language used within Mathtalk to control the browsing and therefore the reading process has been designed to be issued quickly, to be easily learnable and readily extended to other tasks within and without the algebraic domain. A basic principle of the design is to keep the reading process of primary importance. The control process is itself essentially the reading process and how this control is manipulated by the reader must be transparent or the reading will be disrupted.

An important feature of Mathtalk that makes the reading task easier is the folding of syntactically complex items. A complex item has more than one term grouped by explicit parsing marks or spatial location. A term is a group of one or more operands separated by a least precedence operator. During browsing Mathtalk speaks all simple items in full, but only reveals complex items by referring to their type. So instead of speaking all the contents of a fraction, Mathtalk simply states that the current item is "a fraction" and allows the reader to control when and how the contents of such items are spoken. Such a mechanism greatly reduces the amount of speech that may be spoken as the result of a single browsing move.

This folding of complex items influences how a listening reader views an expression. This hiding of complex items is the first stage in the creation of an overview or glance, allowing the reader to see the overall structure without necessarily having to deal with all the detail.

The folding of complex items also proves useful in the default reading style provided by Mathtalk. This strategy allows the reader to move term-by-term through an expression at a pace determined by the reader. If any one term holds a complex item, the speech stops at that item and utters its type. The next stage takes the reader into the complex item and unfolds it term-by- term, reducing the whole expression to its constituent simple parts. For instance, the formula for solution of a quadratic equation would be described as follows (with a pause between each item during which the user would press the space-bar to signal that he or she wants to hear the next component):

- x;

- equals a fraction;

- numerator negative b;

- plus or minus the square root of a quantity;

- the quantity b squared;

- minus four a c;

- denominator 2a.

The Mathtalk command language is based upon a command consisting of an action word and a target word. The action words used are "speak," "current," "next," "previous," "into" "out-of," "beginning" and "end." The target words used are "expression," "term," "item," "superscript," "quantity," "fraction," "numerator level" and "denominator." For example, the command "next expression" is used to move to the next expression in the list of expressions. "Current term" causes the current term to be spoken and "end expression" allows attention to be moved to the last item in the expression. A reader can move "into quantity" to explore the contents of a complex item or use "speak quantity" to reveal the contents without moving inside the sub-expression.

This command language was designed to be easy to learn and extendible by the user. All commands can be generate from a relatively small set of command words. The commands fall naturally into a spoken form that should be easy to both learn and teach. Within the algebra domain the user should be able to generate appropriate commands simply by knowing the actions and targets. For example, knowing that "end expression" works, then "end fraction" should also work in a similar manner. The mnemonic keyboard mapping implementation of this language should be quick to use, and combined with the accuracy of the browsing, gives the reader good control over the information flow.

In addition to these speech facilities, Mathtalk also uses non-speech sounds. The use of algebra earcons is discussed in the next section, but simple sound cues are also used to indicate when the user has moved to the end of an expression or of one of the internal complex structures.

Like all other components of the Mathtalk interface, the browsing functions and associated command language have been evaluated. The techniques used for this evaluation is co-operative evaluation (Monk et al., 1993). In this sort of study a small number of subjects are used to elicit basic usability problems with the interface. The design recommendations are then implemented and retested. At this stage answers to some quite narrow questions were required:

- Is the language both teachable and learnable?

- Do the browsing functions cover all the reading moves a user may want to make?

- How well were navigation and orientation maintained by the reader?

Generally the results from the experiment were positive. Users were able to learn the core of the command language very quickly and use their knowledge of the actions and targets to generate new appropriate commands. Even after a short period of time readers developed strategies for reading expressions that were more effective than simply listening to the whole expression. The default browsing strategy was particularly popular.

The evaluation was useful in revealing several usability problems and software bugs that have now been resolved. The only usability issue discussed here is that of navigation and orientation. If interrupted during a task or when reading a complex expression, users would often become unsure of their orientation within an expression. There is obviously a need for reorientation facility that acts like a map. The glance - which is discussed below - might be one component of such a facility.

The browsing functions and associated command language offer the reader the opportunity to become the active agent in the reading process. All parts of an expression can be reached with speed and accuracy. This component of Mathtalk has been evaluated to ensure the browsing functions allow the reader to perform reading tasks and that the command language fulfills basic usability requirements.

In the evaluation, the non-speech sounds marking the ends of equations and structures proved useful, but users could not discriminate between types of complex item and in particular whether an end sound was the end of an expression or not. These cues have been redesigned, taking advantage of the environmental information used in the audio glance described below, to aid orientation within an expression. We believe that well designed non-speech sounds can be a useful supplement to speech. The next section discusses the main use of such sounds: algebra earcons, to provide an auditory glance.

PLANNING THE CONTROL OF INFORMATION FLOW

In order to use the browsing functions effectively and efficiently a planning facility is needed. Some idea of the syntactic complexity of an expression is required so that the reader can choose strategies for using the browsing functions available. Mathtalk uses earcons to provide an audio glance, allowing the reader the possibility of viewing an expression quickly and efficiently without being overwhelmed by detail.

Ernest, (1987) proposes planning and decision-making as the first stage in the process of reading an expression visually. Ernest suggests that part of this planning is to scan the expression to judge complexity and length and observe any features unfamiliar to the reader. This scanning or glancing is a vital stage in the reading process. Even a simple notion of the size of an expression would prove enormously useful to a visually disabled reader. A very simple expression such as a + b needs no special treatment and could be apprehended by a simple full utterance, but a long expression would simply overwhelm a listener if spoken all at once in that way. The listener has no notion of even the length of an expression without hearing the whole expression. The situation can be summed up as a "catch 22" of not knowing how to read an expression until the expression has been read. In such a situation it would be difficult to develop effective and efficient strategies for reading an expression.

A blind reader needs a glance to make the best use of the browsing functions available. Even the ability to choose between a full utterance and a term-by-term strategy would make the reading more usable. This is demonstrated by subjects in the evaluation of the command language who developed a strategy that began the reading of an expression with the current level command. This speaks the whole expression, but folds complex items and refers to them only by their type. For example, at the top level, the formula for the solutions to a quadratic equation would be described as "x equals a fraction." In a syntactically complex expression this approach can greatly reduce the amount of speech and was the only way in which the readers could get even a partial overview of an expression. The use of this strategy shows that there is the need for a glance. A glance is a high-level view of the expression to be read. A glance shows the general shape, length and complexity of an expression. To choose an appropriate browsing or reading strategy the nature of the structure needs to be known. Simply being able to quickly assess the length of an expression would enable a reader to choose between a full utterance and a term-by-term unfolding. A more detailed impression of structure would enable the need for other tactics to be anticipated and grouping ambiguities to be resolved.

Finally, a detailed glance could provide a cognitive framework into which detail gained from reading an expression could be slotted as it was read. The glance does not need to show any of the detail of the expression, for example, the exact nature of the letters, numbers and operators contained within the expression. It is only required to know that a fraction is present and gain a rough idea of its size, in order to plan the reading. Such detail is only of real importance when the expression is read in full. These are the basic requirements fora glance: it needs to be quick and at least indicate length and complexity of an expression.

The need to remove the detail from the glance led to the use of non-speech audio. The number and syntactic types of the content must be preserved in the glance if all the criteria described above are to be fulfilled. If speeded-up speech is used, some of the prosodic form, and therefore the structure, is preserved, but too much information about the type of structure can be lost. Speech was also rejected as a means of providing this glance because a description would often be longer than the expression itself. One of the principles of Mathtalk is that the interface should perform no mathematical interpretation, as is the case with a printed expression. This rules out a high-level mathematical description as a glance. Instead, non-speech sound was explored as an option for an audio glance. Non-speech sounds have the potential for communicating complex messages to a listener quickly, in a form that does not interfere with speech. Also non-speech audio gives an abstract presentation of an expression, which is non-interpretive and hides the expression's content, both necessary components of a glance.

Blattner et al., (1989) define earcons as non-verbal audio messages that are used in the computer/user interface to provide information to the user about some computer object, operation or interaction. Earcons are composed of motives that are short, rhythmic sequences of pitches with variable intensity, timbre and register (Brewster, 1992a). An adapted form of earcons was developed as the technique to provide a glance. The rules which had already been devised for the prosody of spoken algebra were reapplied as the basis for structuring earcons. Some interesting similarities emerged between the guidelines for earcon design (Brewster et al., 1992) and those for algebraic prosody. Both earcons and prosody are described by the same parameters of rhythm, pitch, intensity, duration, register and dynamics.

The principle construction within an earcon is the "motive." In algebraic prosody a tone unit carries one basic unit of information (Halliday, 1970), which is the term, the equivalent of a motive. To improve recognition of earcons, a pause is used to separate motives. The tone unit or term in speech is separated from the next by a pause, improving the parsing into terms and retention of information.

The first note of a motive is usually emphasized, as is the first item in a spoken term. It is recommended to lengthen the final note of a motive, and this also happens in the spoken term. Finally, pitch is used in earcons to discriminate between different elements in the message, the same is true of the role of prosody in speech. An ordinary earcon is abstract, the structure bears no relation to the information.

In an algebra earcon the rules for construction are indirectly related to the prosodic rules, and directly related to the syntactic structure. Algebra earcons work by representing only the syntactic type and not the instance of an item in an expression. Different musical timbres were used to represent the basic syntactic types within an expression. The sounds used are shown in the table below. The timing, pitch and amplitude characteristics of these sounds were then manipulated according to the rules below. A priority was to establish a rhythm by which a listener could group items together, enabling algebraic structure to be presented. Pitch and amplitude cues also helped in this task.

"Item"
"Timbre"

Base-level operands Acoustic Piano Binary Operators Silence Relational operators Rim-shot Superscripts Violin Fractions Pan pipes Sub-expressions Cello

The rules for constructing algebra earcons are too complex for discussion here, but the following example demonstrates the process. As discussed above an algebraic term is the equivalent of a tone-unit in speech and a motive in an earcon. So the basic unit of an algebra earcon is the term and the bar length of the algebra earcon is determined by the term length.

Details of the term-length calculation can be found in Stevens et al.,(1994a). The expression $3x + 4 = 7$ has three terms making a three bar algebra earcon. The first term '3x' has a length of four beats: a note of one beat for the '3', two beats for the'x' and one silent beat for the '+' which separates it from the following term. The second term '4' has a length of three beats and the final term '= 7' has a length of four beats. Therefore, the bar length of this earcon is four beats. The first and third terms already fit into this bar length. The second has an extra silent beat added to make it fit this length. This bar length determines the rhythm of the algebra earcon, an important part of the earcon's usability (Deutsch, 1982; Brewster et al., 1992).

The next stage is to assign pitch and timbre to each item in the algebra earcon. A piano note at C3 is used for the '3' and one at B4 for the 'x'. For the start of the new term, the note representing '4' is again played at C3 . The rim-shot timbre used for `=' is played at A4 . To emphasize the pitch fall at the end of the expression, the piano note for '7' is played two notes below this at F4 .

The example $3(x + 4) = 7$ has the same lexical content as the previous expression, but a different syntax and therefore a different earcon. Now there are two terms, '$3(x + 4)$' and '$= 7$'. The sub-expression '$(x + 4)$' has a length representing the two internal terms but with no separation for the '+', giving a length of four beats. The coefficient '3' adds a further beat and a silent beat is added to separate this term from the next. As before the '= 7' has a bar length of four beats. No adjustment for bar length is needed as there are only two terms. The piano timbre used for '3' is played at C3 . The sub-expression is played as a single note at A6 with a cello timbre. Finally the '= 7' is played as before.

The two algebra earcons sound very different, despite the same lexical content. The first $3x + 4 = 7$ has a group of two piano notes, a single piano note, a rim-shot sound for the equals and a final single piano note. In contrast $3(x + 4) = 7$ has a single piano note for the coefficient, a long cello note at a low pitch for the sub-expression and a space followed by the same rim-shot and piano note.

Two experiments were performed to evaluate the ability of algebra earcons to present high-level syntactic information to a listener. These experiments are reported in full in Stevens et.al.(1994a). The first experiment used a multiple choice paradigm to probe the basic ability of listeners to recover syntactic information from an algebra earcon and use that information to recognize an expression. The multiple choice design allowed all aspects of the rules for algebra earcons to be tested and the experiment revealed several errors. Despite the errors the algebra earcons seemed to be successful in enabling listeners to recognize syntactic structure.

A second experiment was performed to test the redesigned rules. However before the recognition part of the experiment, the listener was asked to recall what he or she could about the expression just presented. This technique was used to investigate the type of representation a listener could derive from an audio glance. Evaluation of the data from the recall part of the experiment suggested that the following types of representation were derived from the audio glance:

- Idea of complexity or length.

- Low-level knowledge of complexity: equation or expression, balance of left and right and sides. Some knowledge of syntactic items.

- Knowledge of major syntactic features, some detail and knowledge of their order.

- Detailed representation of structure. A framework into which detail could accurately be placed during reading.

All of these representations could be useful as a glance because they would indicate the syntactic complexity of an equation. However, a strong, but inaccurate framework has the potential to mislead a reader. As algebra earcons were only designed to provide a glance, such inaccuracies would not be too great a problem because any glance is not supposed to be entirely accurate. A good representation of the equation would be a bonus for the reader. Recovering information from the glance may be a difficult task, as described by many subjects, but this may be exacerbated by the novelty of the audio glance and the artificial nature of the experiment. In addition, the difficulty of using the audio glance has to be balanced against having to use a full utterance to guide the reading process.

These experiments showed that algebra earcons work. However discovering if this audio glance is useful and usable for reading will have to wait for the evaluation of the full Mathtalk program. However there is a need for such a glance and algebra earcons seem to provide a good attempt at such a facility.

SUMMARY This paper has described the design of the Mathtalk interface, which aims to promote the reading of algebra using speech from a passive listening to an active reading process. A simple analysis of why the visual reading process is active results in the key notions of external memory and fast and accurate control of information flow. The permanent print representation is knowledge in the world, which, being quickly accessible by the visual system, does not have to be remembered by the reader. The order of precedence instantiated in the spatial printing of the algebra, combined with the fast and accurate control of the information flow by the reader makes the sighted reading process active. In contrast the listening reader is usually passive. Typically, the pace of the interaction is dictated by the external device, for example a tape recorder. The control of information flow from such a device is slow and inaccurate, making the reading process tedious and frustrating. The taped speech is an external memory, but the frequently poorly spoken versions of algebra expressions, together with the lack of control reduce the quality of the external memory.

The ability to generate an accurate computer-based representation of an algebraic expression gives the opportunity to design a reading interface that avoids the problems of poor external memory and lack of control. The interface of the Mathtalk program compensates for the lack of external memory by enhancing the synthetic speech presentation using prosody. Advantage is taken of the improved auditory display by making the reading active, giving the listening reader control over the information flow using browsing.

Prosody rules have been implemented in the Mathtalk program so that any algebraic expression can be spoken with a voice synthesizer using prosody. The effects of prosody were then evaluated experimentally and shown to promote the recovery of syntactic structure, enhance the retention of lexical content and reduce the mental workload involved. The prosodic cues act in much the same way as the rules governing the printing of algebra, instantiating the order of precedence and thus facilitating parsing. By increasing the usability of the synthetic speech the reading task is made easier.

The external memory only becomes truly effective with the addition of control of the information flow. Unless a reader can access any part of the structure with speed and accuracy, the burden of memory is placed on the reader, rather then the external memory. The browsing functions available in Mathtalk enable any part of an expression's structure to be visited. In contrast to the sighted reader a visually disabled reader has to mediate his or her control of information flow externally. A command language has been developed and evaluated for the Mathtalk program that enables fast and transparent manipulation of the browsing functions.

The key to efficient use of the browsing functions and development of reading strategies to control information is planning. A sighted reader uses a glance to assess the basic nature of an expression and formulate a strategy for reading the expression. An audio glance combining the cues used in speech to indicate structure and the ability of abstract sounds called earcons to present structure non-verbally provide this glance in a form called algebra earcons.

Evaluation of algebra earcons has demonstrated that listeners can derive a considerable amount of structural information from an audio glance. At best the listener gains a detailed structural representation into which he or she could place lexical information as the expression was read. Such a representation should allow the reader to gain a quick overview of an expression and make decisions about how to use the available browsing functions, without having to tediously listen to a potentially long expression, then reread it by browsing.

An issue emphasized in this paper is the evaluation of the interface being developed. Each component of the Mathtalk interface has been evaluated separately to ensure that the task that component performs is achieved. Eventually the whole Mathtalk interface will be evaluated in a task-based manner to ensure its usability. The Mathtalk program only tackles the problem of designing an interface to promote active reading of algebraic notation. A project called "Maths" is being funded by the European Tide (Technology for the Integration of Disabled and Elderly People) Initiative to develop an algebra

workstation. (See a paper on Maths in this issue of "Information Technology and Disabilities.")

This will be a multi-media system that will enable visually disabled school children to read, write and manipulate standard algebraic notation. The workstation will use speech, non-speech audio and Braille as output media. The writing and manipulation of algebra is even more complex than the interactions described here in the Mathtalk program. However the principles outlined for the design of a reading interface form a firm base for this future development.

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THE USE OF LASER STEREOLITHOGRAPHY TO PRODUCE THREE-DIMENSIONAL TACTILE MOLECULAR MODELS FOR BLIND AND VISUALLY IMPAIRED SCIENTISTS AND STUDENTS

William J. Skawinski, Thomas J. Busanic, Ana D. Ofsievich, Victor B. Luzhkov, Carol A. Venanzi, and Thomas J. Venanzi***

Department of Chemical Engineering, Chemistry, and Environmental Science, New Jersey Institute of Technology, 323 King Blvd., Newark, NJ 07102

***Present address: Institute of Chemical Physics, Chernogolovka, Moscow Region, Russia 142432**

**** Department of Chemistry, College of New Rochelle, New Rochelle, NY 10805**

Internet: SKWINSKI@TESLA.NJIT.EDU

ABSTRACT

Laser stereolithography, a rapid prototyping process that produces three-dimensional plastic models from the images created in certain computer aided design (CAD) programs, has been used to fabricate tactile molecular models for blind and visually impaired individuals. The process uses a computer-controlled laser to cure and solidify a light-sensitive, liquid polymer in the shape of the image. The models can be customized and used for educational and research purposes. Several models built using four different scales are described. Surface textures are varied to allow atom types to be distinguished.

INTRODUCTION

Several reports describing the status of disabled individuals with respect to careers in science and engineering have been published (Reddon, Davis, & Welsh-Brown, 1978; U.S. Government Report, 1989). They indicate that disabled individuals are seriously under-represented in both areas.It has been suggested that attitudinal and physical barriers exist that can make pursuit of careers in technically oriented disciplines less attractive for people with physical or learning disabilities. Some of the negative attitudes may arise from a lack of information about the capabilities of people with disabilities, or about the technology available to help disabled individuals meet physical and perceptual requirements. For those who are blind or who have visual impairments (and some people with specific learning disabilities), one major physical barrier is access to the vast amount of information that is part of scientific disciplines. With the growing use of electronically stored data and adaptive technologies, more information is being made accessible to this segment of the population. Textual material can be acquired by use of recorded media, computer files can be read using speech synthesis, display enhancement, or Braille output.

Laboratory instrumentation and classroom demonstrations can similarly be adapted by the use of alternative outputs to visual displays (Crosby, 1981; Flair & Setzer, 1990; Hinchliffe & Skawinski, 1983; Lunney & Morrison, 1981; Morrison, Lunney, Terry, Hassell, & Boswood, 1984; Reese, 1985; Shimizu, 1986; Smith, 1981; Tombaugh, 1981). In some cases simple two-dimensional tactile graphics can be produced and some attempts to represent depth have also been made (Dietrich & Seufert, 1986). One area that is not easily addressed is the presentation of three-dimensional graphics in a form that can be perceived directly by blind and visually impaired individuals.

Sophisticated, three-dimensional computer graphics techniques are now commonly used in all scientific disciplines to produce representations of experimental and calculated data. Images of physical phenomena and mathematical graphs can be displayed in a number of ways to emphasize specific features and enhance scientific communication. Spatial relationships are critical in many areas of chemistry, physics, and biology. Mathematical relationships in three dimensions are utilized in many other disciplines. Blind and visually impaired scientists, students, and teachers of science and mathematics however, encounter serious barriers to acquiring important information that is presented in the form of three-dimensional images, and the use of tactile models can be essential for a full understanding of these concepts.

In recent years several systems for rapid prototyping have been developed which allow engineers and designers to create an image within a computer-aided design (CAD) program and automatically translate that image into an accurate plastic model (Hull, 1988). These systems fabricate the models layer-by-layer from bottom to top, and are capable of accurately producing intricate structures. We describe here, the application of one such rapid prototyping system, laser stereolithography, to the preparation of tactile models of molecular structures. Since these models can be designed to represent any of a variety of images, they are also useful to sighted researchers and students. Models can be made by this method which cannot be made using standard molecular model techniques and can thus be designed to fit the specific needs of researchers, students and teachers. The specific aspects of this work applied to chemical research problems are described elsewhere (Skawinski, Busanic, Ofsievich, Venanzi, Luzhkov & Venanzi, 1994). We emphasize the aspects of this work particularly interesting to blind and visually impaired individuals.

The first models to be fabricated were molecular models to assist one of us (WJS), a blind chemist, to perceive the detailed structures of several molecules. Standard molecular model kits were inadequate for this purpose since they are limited in the range of diameters and angles they can represent. Stereolithography is virtually unlimited in this respect and is highly accurate. A brief description of the stereolithography process is presented, followed by a detailed description and evaluation of the tactile models.

METHODS

The stereolithography apparatus (SLA) used was the model SLA-250 from 3-D Systems, Valencia, California. The system consists of a cubic tank approximately ten inches on a side, which is filled with a liquid resin. Within the tank is a table that can be positioned vertically. At the start of the process the table is elevated to a level that allows a thin layer of the resin to lie above the table surface. The computer-controlled laser then traces out the shape of the first, (lowest), slice of the object being built. The interaction of the laser with the resin converts the liquid into a solid plastic. The table then moves downward until another thin layer of liquid lies above the first solidified slice. The laser then traces out the shape of the second slice of the object in the liquid simultaneously solidifying it and bonding it to the first slice. This process is repeated until the entire object is built slice-by-slice from the bottom up.

In order to control the SLA process data files defining the object to be built, it must first be prepared within a CAD program that supports rapid prototyping. Several CAD systems are capable of preparing files for use by the SLA. I-DEAS, a CAD software package produced by SDRC Inc., Milford, Ohio, was used for this work.

A short program was written to input the molecular structure data (i.e., positions and radii of atoms and atom type) into I-DEAS. This allowed the CAD program to automatically assemble the image of the molecule. Once the image was obtained, several processing steps are carried out in order to produce the data files which are then used to control the SLA. The data files containing the information describing the CAD image were processed into a format which represents that image as a series of horizontal slices. Thus, when these slices are stacked, they form an exact model of the original screen image. In some cases temporary support structures are required during the building process to attach parts that are disconnected temporarily while the slices are being fabricated. These supports can either be designed manually from within the CAD program or designed automatically with appropriate software. After the model is completed these supports can be readily removed. A program called Bridgeworks, from Solid

Concepts, Valencia, California, was used to automatically design these supports for several of the models described here.

Atoms would normally be depicted as colored spheres in video displays or physical models, with different colors being assigned to each atom type to allow identification. For the purpose of these tactile models we used faceted rather than smooth surfaces for each atom. These facets are essentially planar faces which form a polyhedron rather than a perfectly smooth sphere. The number of facets used to define an atom, horizontally and vertically, can be specified. The number of facets for each atom type were: hydrogen -- 8 x 8; carbon -- 8 x 8; oxygen -- 12 x 12; nitrogen -- 16 x 16; chlorine -- 20 x 20. Since the hydrogen and carbon atoms differed significantly in size, the number of facets used for each could be the same without confusing the atom types. Models of 12 molecular structures were built using four different scales. These scales produced carbon atoms that were approximately 0.3 inch, 1.0 inch, 1.2 inch, or 1.4 inch in diameter. The dimensions of all the atoms were obtained by taking the vander Waals radii and setting the model radius to that value in inches in the CAD program and multiplying the result by factors of 0.08, 0.25, 0.30, or 0.35, respectively, for each scale.

The molecular structures modeled were the natural amino acids glycine, L-alanine, and L-serine; two amino acid derivatives; the drug amiloride in several forms; two derivatives of amiloride in non-planar conformations; the carbohydrate macrocycle beta-cyclodextrin; and the transition state complex of beta-cyclodextrin and phenyl acetate. These were selected because of their importance in several investigations being carried out in this laboratory. The results, however, will be described in general terms so that no knowledge of their structures will be required for an understanding of the method and results. These relatively complex molecular models should be considered as examples of the range of shapes that can be fabricated and the power and flexibility of this method.

RESULTS AND DISCUSSION

The time required for the SLA to build the five amino acid models simultaneously was eight hours, three amiloride models were built in 12 hours and the beta-cyclodextrin and beta-cyclodextrin-phenyl acetate models required 24 and 31 hours respectively. Normally the models require an additional one to two hours in an ultraviolet oven to complete the curing process.

The models of amiloride and its derivatives were built using the second smallest scale. They were approximately three inches long and two and a half inches wide. Amiloride is planar while two of the derivatives are twisted slightly out of planarity and this distinction was easily perceived tactually using the models. At this scale it was possible to tactually locate and identify all 23 to 26 atoms in these structures. It is possible to probe the entire surface of the model and detect the different textures produced by the varying number of facets for each atom type.

The amino acids and their derivatives were built on a slightly larger scale, approximately 20% larger in linear dimensions. These models were approximately two inches across. As expected, the features of these models were more easily recognized. These structures are not planar but consist of a central carbon atom with four other groups of atoms projecting from it at various angles. The spatial relationships of these projecting groups, which are important for understanding their nature, are easily perceived in these models.

The beta-cyclodextrin models were built on the largest scale, approximately 40% greater in linear dimensions than the amiloride models. This model can best be described as being funnel shaped. The large end was approximately six inches in diameter compared with five inches for the smaller end. The model was three inches high. The sides are composed of seven sugar molecules, consisting of 147 atoms, linked together to form a ring. Thus the molecule has a large internal cavity. This was built on the larger scale in order to allow easy examination of the atoms within that cavity. The groups of atoms along each opening of the cavity were easily identified. Another model of this molecule was made with a molecule of phenyl acetate within the cavity. This was done to represent a transition state structure which occurs during a reaction involving these two molecules. The important aspect of this second model was the positioning of the smaller molecule within the cavity and this was clearly depicted in the model. Tactual examination of the smaller molecule within the cavity was facilitated by the larger scale.

A second model of beta-cyclodextrin was made using the smallest scale yet attempted. It was approximately one and a half inches in diameter and three-quarters of an inch high. Even at this scale many of the atoms along the openings of the cavities were still distinguishable.

Since the same number of facets was used for each atom type in all these models, it was noted that as the scale decreases the atoms would feel more spherical because the facets would be smaller. Even in a given model that contains both hydrogen and carbon atoms the hydrogen atoms would feel more spherical because the facets on their surfaces were smaller. Also as the number of facets increased to as many as 20 x 20 in the chlorine atoms, these most nearly approached a spherical structure. The model of the beta-cyclodextrin made using the smallest scale contained the most spherical atoms. As a result this technique allowed facile discrimination between atom types even to some extent in the very small model.

Since these models were constructed for specific research purposes the radius of each atom was chosen to model selected properties. As a result the spheres representing the atoms overlapped to a large extent yielding models that appear as spheres with bumps protruding from their surfaces. Though these were well-suited for the investigations being carried out, they might not be appropriate for educational purposes at an elementary level. In those cases it might be desirable to make the individual atoms more distinct. This is readily done by decreasing the radii of the spheres while maintaining their locations in space. This would result in less overlap and more distinct atoms.

It is also possible to produce shapes based on mathematical equations using stereolithography (Peterson, 1991). We are currently working on methods of building plastic models of physical phenomena which have specific spatial distributions. For example, it is often useful to know the way in which electrical charge is distributed in the space surrounding a molecule. Using data on this property we are attempting to build a useful model which would allow blind and visually impaired individuals to perceive this information. In a similar manner any property that can be described by a mathematical function in three dimensions could conceivably be modeled in this way.

We are also planning the fabrication of an entire protein molecule on a small scale to allow examination of the general topology of the molecule. Though the size of any single model fabricated is limited by the ten-inch cube of this particular system, if the image can be created in the CAD program it can then be cut into several pieces which can be fabricated separately and assembled afterward. Additionally, the model SLA-500 is available which has a tank approximately 24 inches on a side.

Fabrication of models using SLA can become expensive as the size and intricacy of the models increases. The primary component of the cost is the resin. As a result we have made several models that are hollow in order to consume less material. They have proven to be sturdy and have been dropped on a hard floor without being damaged. Fabricating hollow models when possible also utilizes significantly less laser time which is another consideration when determining the cost. Since the models are made of uncolored translucent plastic, they may be painted to allow persons with some vision to perceive important features. This is readily done using common paints appropriate for plastics.

Methods have been developed to produce castings from these models (Imamura, Meng, & Nakagawa, 1993) which might be used for mass production. Several other rapid prototyping methods have been developed (Wohlers, 1991), including laser sintering and fused deposition modeling, which could also extend the use of such systems for producing custom tactile models, and as these methods are refined the cost of models should decrease.

Though simple models might be more easily obtained for educational purposes that adequately convey the desired information, this method extends the range of models that can be made in a reasonable time and for a reasonable cost for blind and visually impaired students and professionals. The most important aspect is that they can be custom-made to suit the application for which they are required. Images from chemistry, physics, biology or any other discipline could be modeled in this way. Virtually any image that can be produced in a CAD program can be translated into plastic.

The process of stereolithography can be applied to the fabrication of accurate three-dimensional tactile models for use by blind and visually impaired individuals. Models can be made of virtually any CAD image that can be custom-designed to suit the requirements of the user. Currently, sighted operators are still required to carry out the complete model-building process, but procedures are generally straightforward once the CAD image has been produced. Though the equipment and materials used in this process might be prohibitively expensive for most institutions to purchase, some commercial enterprises exist which will produce models for clients. The most effective use for this process is the production of models that can not be readily made by any other method. As the use of these systems become more widespread, costs may decrease allowing more extensive use by institutions with limited resources.

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COMPUTER BASED SCIENCE ASSESSMENT: IMPLICATIONS FOR STUDENTS WITH LEARNING DISABILITIES

David D. Kumar

College of Education
Florida Atlantic University
2912 College of Education
Davie, Florida 33314

ABSTRACT

Computer technology can be invaluable for assessing learning disabled students in science since it opens up opportunities for developing innovative assessment tools in science education. The nature of computers as information processing tools, the role of computer technology in user-friendly interactive learning environments, and the possibility of designing instructional tools to meet individual needs of students, make computers potentially powerful tools for assessment. Computer-based assessment applications used in science, such as Computerized Adaptive Testing, Figural Response Item Testing, Computer Simulations, and Anchored Assessment can be appropriated for assessing students with learning disabilities.

INTRODUCTION

Science education has been one of the major topics of reform in the United States, leading to national curriculum and assessment standards currently being developed for science education. Meanwhile, _The Americans with Disabilities Act (ADA)_ along with the _Individuals with Disabilities Act (IDEA),_ is mandating academic access is all areas of education for students with learning disabilities (Stinson, 1993).

As Bybee and DeBoer (1994) suggested, pre-college science education must help all students to develop thinking and problem-solving skills essential for survival in the 21st century, and science assessment should evaluate student-ability to apply these skills in problem situations (Helgeson, 1992). Nevertheless, science education often fails to address the needs of students with learning disabilities (Holahan, McFarland, & Piccillo,1994). For example, among high school students, disabled students scored significantly lower grades on science tests. Donahoe and Zigmond (1990) reported that 69% of students with learning disabilities earned a grade of D or below in ninth-grade science. In this respect, an argument could be made that science education as a field, is failing to provide learning disabled students with suitable assessment technology in order to meet their testing needs. Therefore, how to develop suitable assessment technologies for students with learning disabilities is a question of great concern to science educators and researchers.

While exploring avenues for improving science assessment for the learning disabled students, one should not overlook the emerging role of computer technology in assessment. The following discussion will address how computer technology might be a promising tool for designing assessment environments for such students.

COMPUTERS FOR SCIENCE ASSESSMENT: IMPLICATIONS

Research and development of innovative computer environments for science assessment is a field that is slowly but steadily growing. A comprehensive review of computer applications in science assessment is reported in Helgeson and Kumar (1993). It should be noted here that this review did not find any computer-based assessment tools specifically designed for individuals with learning disabilities.

This paper will attempt to fill this void in the area of assessment of students with learning disabilities, by deriving information from computer-based science assessment studies in regular classrooms.In order to fully understand what computers are and how they can play a vital role in the assessment of students with learning disabilities, it is important to see computer technology from a cognitive science perspective. According to cognitive science, computers are information-processing tools with a capability to be developed into thinking tools (Rowe, 1993; De Mey,1992). Computer technology environments such as hypermedia and multimedia are known to resemble human knowledge structure and hence are increasingly gaining recognition in educational applications (Kumar, Smith, Helgeson, & White, in press). Additionally, computers are found to have a positive impact on student attitudes in learning (Knight & Dunkleberger, 1977). Therefore, considering the cognitive and affective significance of computers in education, computer-based tools ought to be developed for the assessment of learning-disabled students in science.

Some of the cognitive and affective ways computer technology can be used for assessing students with learning disabilities in science include: Computer Adaptive Testing; Figural Response Item Testing; Computer Simulations; and Anchored Assessment.

COMPUTERIZED ADAPTIVE TESTING

In computerized adaptive testing (CAT) the computer continuously reevaluates the ability of the student resulting in a test that is tailored to each individual student (Jacobson, 1993). This fine tuning is achieved by statistically tailoring the test to the achievement level of each student while avoiding extremely easy or difficult questions (Welch & Frick, 1993). Some of the potential benefits of CAT for students with learning disabilities are summarized below. First, according to Welch and Frick (1993), questions used in a particular computer adaptive test should have one objective of measurement at a time. This simplifies the focus of the test taker, and helps him or her avoid worrying about multiple objectives. Second, in a computerized adaptive test, the order of presenting questions does not determine the success or failure in answering that question. If informed in advance about this characteristic of CAT the student's frustration over failure in an early question will not interfere with his or her attempt to solve the another question. Third, in CAT, questions are administered by a computer, and the student enters an answer using a key board or computer mouse. The computer platform also allows the use of colorful graphics and illustrations to make the questions clear and understandable to the test-taker with a learning disability. Such a format over the traditional paper and pencil test may tend to reduce any impediment in comprehending the information on the test at the student-media interface. (See Schneiderman, 1987 for more information on computer-user interfaces). Fourth, the number of questions required to reach a pass/fail decision in a CAT is considerably fewer and the test time is considerably shorter than in traditional written tests (Herb, 1992). In the case of learning-disabled students with short attention spans, fewer test questions and shorter test time can be motivating factors to complete the test.

FIGURAL RESPONSE ITEM TESTING

Figural response item testing is a novel approach to science assessment using computers. According to Martinez (1993), figural response items are suitable for assessing science proficiency in graphic-oriented science disciplines such as biology. Often graphic information is more comprehensible than textual information, especially when dealing with students with learning disabilities. In figural response item testing, students respond to each question by manipulating the appropriate figures on a computer screen. For example, in a biology assessment, students can be asked to assemble a plant cell from a menu of cell components, or transform stereo isomers of biological molecules using on-screen computer tools. According to Martinez (1993), figural response item testing scores correlated positively with students' verbal and figural aptitudes, and it is suitable for a making reasonable appraisal of student performance in science.

COMPUTER SIMULATIONS

Traditional assessment methods are often criticized for testing end results or products and not assessing processes of science learning and problem solving (Helgeson, 1992). While dealing with students with learning disabilities, it is always to their advantage that more manipulatives are used for both science instruction and assessment. On the other hand, assessing science processes of large groups of students via hands-on tasks is a particularly strenuous task. In this respect, computer simulations play a key role in science assessment. Simulations of hands-on science tasks are found useful for assessment on a large scale basis (Pine, Baxter, & Shavelson, 1991). The computer keeps a record of every move made by the student in solving a task to provide a detailed profile of his or her performance for assessment. Using computer simulations of simple science experiments might be a more meaningful way of assessing the understanding of science processes of students with learning disabilities than using traditional multiple choice tests.

ANCHORED ASSESSMENT

In anchored assessment, videos are used as anchors, and an interactive software is used to trace and record student performance (Young & Kulickowich, 1992). The videos provide students with a broader context of the problem, enable them to revisit the problem context any number of times, and help them gain a meaningful understanding of the nature of the data involved.

These features should give students with learning disabilities a flexible visual environment for exploring and understanding a problem before attempting to solve it, rather than trying to guess its meaning when it is presented textually on a paper. Anchored assessment also enables students to be evaluated qualitatively, an advantage seldom available with multiple choice tests.

DISCUSSION AND CONCLUSION

This paper attempts to present innovative ways of science assessment using computer technology and to assess the implications for students with learning disabilities. As pointed out earlier, computer technology is a viable tool for performance assessment in science, and a potentially powerful tool for replacing traditional product-oriented paper and pencil tests. However, most of the performance assessment research in science education to date is focused on the normal/regular student population. If students with learning disabilities need to be properly assessed in science and their participation in science education encouraged, then more innovative approaches to testing ought to be researched and developed.

The computer-based science assessment methods addressed in this paper are potentially useful methods for meeting the needs of students with learning disabilities. Researchers and educators must pay special attention to, first, testing and validating the use of computer technology-based testing tools, and second, developing newer tools or redesigning existing tools for assessing learning-disabled students in science education. If the goal of science education in the United States is to make science available for all people, and it is not rhetoric, then the rights of students with learning disabilities must be honored and their science educational needs given due consideration.

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BOOKS FOR BLIND SCIENTISTS: THE TECHNOLOGICAL REQUIREMENTS OF ACCESSIBILITY

William A. Barry, John A. Gardner, and Randy Lundquist
Department of Physics, Oregon State University
Weniger Hall 301, Corvallis, Oregon 97331

ABSTRACT

This paper describes three new developments that hold great promise for improving the accessibility of scientific literature for people who are visually impaired or who have significant vision-related learning disabilities. All rely on the availability of information in high-level electronic form. A brief review of methods for storing high-level information and an example of their use in printing Dotsplus documents are given.

INTRODUCTION

Computer technology is revolutionizing information accessibility, and few people have benefitted more than those with severe visual impairments. Voice synthesizers and computer Braille displays allow blind people to read computer text as easily as sighted people do. Computer Braille translators allow Braille documents of a large amount standard literature to be printed directly from word processor files. Computerized reader services provide news, weather, sports, stock reports, and other information by telephone.

Unfortunately easy access to computerized information has been largely restricted to words. The information revolution has barely touched the problem of access by blind people to math and science, fields whose literature cannot be represented adequately by words alone.

Blind people presently have only three realistic options for reading literature containing scientific notation - human readers, tape recordings, or Braille. Because human readers are expensive and seldom reliable, high quality tape recordings are generally preferable. Recording for the Blind, a nonprofit company based in Princeton, New Jersey, maintains a large library of textbook tape recordings. For many years RFB has been a critically important source of accessible textbooks for many blind students. RFB will record any book on request, but a lead time of many months is required. Tape books are most useful for materials that can be read from beginning to end. For science and math books in which the reader must frequently refer to equations, tables, appendices, etc., tape recordings are a poor substitute for a book.

Standard Braille is inadequate for science and math. It does not even have symbols for "plus" or "equals." A special "math Braille code" is used for math, but it is not really adequate for such subjects as chemistry, physics, or engineering. Unlike printed mathematical and scientific notation, which is more or less internationally standardized, the Braille math codes used in the United States and the United Kingdom are different, and both differ substantially from math codes used in non-English-speaking countries. Most blind people do not read Braille, and only a very small percentage of those people read math Braille. Blind children find it particularly difficult to learn math because they must first learn a separate math Braille language.

Another problem is that almost all literature involving scientific notation must be Brailled by hand, and very few Braillists know the math code. Only the most common K-12 math and science texts are routinely translated. Other texts can often be obtained only by contracting with a Braille transcriber. This is expensive and requires along lead time.

NEW TECHNOLOGIES

Three new developments can potentially revolutionize accessibility to math and science literature by people with severe visual and learning disabilities. None of these technologies can provide ready access to printed books, but information that is available in high-level computer files can be readily accessed.

One of these new technologies is the AsTeR computer program (Raman 1992, Barry 1994) (described in this journal by its developer, Dr. T. V. Raman. A World Wide Web (WWW) demo of AsTeR is available at:
http://www.cs.cornell.edu/Info/People/raman/aster/demo.html.

Dotsplus, a method for producing hard copy scientific literature, is another important development. Developed at Oregon State University, Dotsplus is described briefly later in this article. Visual examples of Dotsplus documents are given in Gardner (1993), and are available to Internet users at a World Wide Web site:
http://dots.physics.orst.edu/dotsplus.html.

Tactile examples are available from the authors on request.

Finally, the utility of Braille for scientific literature should be greatly enhanced by a fundamental Braille reform being considered by the International Committee on English Braille (ICEB). A committee appointed by ICEB is presently developing a proposal for a single unified Braille code based on an expansion of the present Standard English Braille literary code.

The unified Braille code project chair is Ms. Darleen Bogart. The Braille Research Center, which is directed by Ms. Hilda Caton, chair of the Braille Authority of North America, has a list server, , that reports on unified Braille research developments. The list moderator is Dr. Emerson Foulke, .

The authors' Dotsplus research group is developing practical methods for making these three new possibilities into realities. Future technological developments should make it possible for people to have Braille as well as voice output from AsTeR, or simultaneous Braille and audio. Many sighted people may find it useful to have both audio and visual information presented simultaneously. In the longer term, it is possible that high resolution tactile output devices will permit blind readers to "see" graphs, line drawings, etc. Specialized portable computers with full-page, high-resolution tactile display and voice output could finally give blind people both the accessibility and portability of print books. A number of innovative research efforts are underway to develop such tactile displays (Leeb, 1994, and Fricke, 1994).

None of these developments will provide easy accessibility unless the written material is available in a high-level electronic form. It is possible that electronic publishing will someday make all materials available in such a form, but today most authors and publishers regard computer files as little more than a convenient intermediate step in the process of publishing a book on paper.

HIGH LEVEL ELECTRONIC INFORMATION

All printed books are, in essence, picture books because they are visual illustrations of something. A math book, for example, commonly contains printed letters, numbers, other scientific characters, flow diagrams, line drawings, and occasionally pictures with varying shades of gray or color. The reader's eyes and brain translate the pictures of characters into meaningful words, sentences, tabulated information, equations, etc. Line drawings, graphs, flow diagrams, etc. also are visually interpreted as information. Almost everything appearing in a scientific book or article is intended to convey quantitative information to the reader.

A book can be introduced into a computer by scanning it with an optical scanner and storing its pages as bit-mapped images. Information in such a "low-level" file can be accessed visually by displaying it on a computer screen, but this information is no more useful to a blind person than the original book. Artificial intelligence computer programs can often recognize letters and numbers in such files and make that information available in other ways. For example, a number of commercially available reading machines scan pages and use a voice synthesizer to read the pages aloud to blind users. Many can also make computer files that can be printed in Braille or read on other computers using either a voice synthesizer or a Braille display. Unfortunately these reading machines are slow and work well only for the simplest kind of printed material. The computer recognition routines can be confused easily if the print quality is poor, if several font types are used, if the page contains columns, tables, figures, or other complications that are common in much literature. In addition, there are presently no commercially available programs capable of recognizing any but the most common scientific symbols, and all are incapable of reconstructing a scientific equation. It is far better for a blind reader to have a high-level file in which the information, not a picture of the information, is stored in the computer in an easily retrievable format.

One such high-level language is The Standard Generalized Markup Language (SGML)--actually a family of high-level markup languages--which is used by a number of publishers. SGML files contain tags identifying the function of the file elements. These tags are described by document type definitions (DTD's) written in the SGML meta-language. Hyper-Text Mark-up Language (HTML) is a DTD developed for the WWW electronic information network. A DTD developed independently by the International Committee on Accessible Document Design (ICADD) is almost completely included in HTML, and future HTML releases will include the ICADD DTD as a subset. HTML does not presently store mathematical, scientific, or tabulated information at a high level, but new or improved extensions are being developed to include these. When these extensions are completed, HTML files or files using other DTD's that have math tags could provide the blind reader as much information as WWW or a book printed from these files provides to the sighted reader.

At present, the family of mark-up languages based on TeX which are used for publishing many higher level scientific books and articles, can provide excellent high-level files that are in principle easily accessible by AsTeR, Dotsplus, and Braille users.

Unfortunately, the majority of today's publications are still being printed from low-level files such as PostScript, which discards the information inherent in equations, tables, etc. and presents them as pictures. People with severe visual impairments and many people with learning disabilities are effectively excluded.

PRINTING DOCUMENTS IN DOTSPLUS

Dotsplus provides a particularly straightforward example of how high-level information can be reformulated to be accessible to blind people. A Dotsplus document is laid out much like the corresponding print document. Dotsplus symbols are larger by a factor of approximately 2.5, but most scientific symbols (plus, minus, equals, parentheses, brackets, summation sign, integral sign, etc.) are raised images similar in appearance to their print equivalents. Some are emphasized to make tactile recognition easier, but all are instantly recognizable by sighted readers. Letters, numbers, and a few symbols that are difficult to recognize actually are reproduced in an eight-dot Braille code. Symbol position is the same as it would be in an ink-print version. Thus the Dotsplus Braille code must be one in which the cell shape without reference to position is sufficient to identify the symbol. The lower case Dotsplus letters are standard Braille. Upper case letters are those used in most eight-dot codes. Numbers have previously been represented by the European computer code convention but will be represented in future versions by symbols that are more consistent with the unified Braille code.

Dotsplus documents can presently be printed from LaTeX files and from some graphics-based word processor files. Original files maybe viewed and edited on a graphics screen or printed for sighted viewers. Sighted editors can view the document using non-Braille fonts of the appropriate size. Except for the font size, such documents look like any other scientific document. A straightforward global font change converts these into pictures in which the letters, numbers, etc. are Braille dots. This document is then printed by a modified wax-jet printer that produces tactile images, or it can be printed on a special "swell" paper using almost any standard printer. The swell paper is then fed through a machine that heats the paper causing the black portions to swell. In either case, the output is tactile and has proven to be easily readable by good Braille readers after a minimum of instruction and practice. Widespread use of Dotsplus awaits introduction of good quality, commercial wax-jet printers and/or lower priced swell paper.

Dotsplus transforms the visual layout of a document to a tactile layout. This has the advantage that the information conveyed by the spatial layout (eg. a raised symbol is a superscript/power) is the same in a Dotsplus representation as in the visual one. The only high-level requirement for Dotsplus is that fonts must be easily alterable.

Dotsplus translation is not possible from files made by every word processor or mark-up program because not all such programs allow fonts to be changed globally. Programs that retain equations as bit-mapped pictures are inadequate. The equation editor in Word for Windows, for example, does not permit character fonts within equations to be altered without rewriting the equation in the desired (Braille) font. However if the equations are written using"field codes", Word fonts can be changed. The Dotsplus group has made a number of Dotsplus documents from Word files written using field codes.

CONCLUDING OBSERVATIONS

Braille and AsTeR cannot use spatial representation to convey information and consequently require higher level files than does Dotsplus. Most modern word processors do not presently store information at a high enough level, but future versions are likely to include options for transforming files to TeX and/or SGML. Several shareware and commercial products that allow easy authoring of TeX and SGML are either presently available or have been announced for future release.

Widespread use of software-producing, high-level files and procedures for making such files available to individuals with disabilities are required before math and science can be made truly accessible. Even then, more research on non-visual representation through sonification, virtual reality, and various tactile/audio methods are needed in order to make graphs, figures, line drawings, flow diagrams, and more complicated non-textual information readily understandable by people with visual disabilities. Such techniques will, of course, be useful in practice only if the information, not just pictures of that information, are stored in the computer files.

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Word for Windows is a trademark of Microsoft Corporation.
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INCREASING THE REPRESENTATION OF PEOPLE WITH DISABILITIES IN SCIENCE, ENGINEERING AND MATHEMATICS

Sheryl Burgstahler
Assistant Director-Information Systems, Computing & Communications

University of Washington
JE-25 Seattle, WA 98195
(206) 543-0622

Internet: sherylb@cac.washington.edu

ABSTRACT

There are three main factors that cause individuals with disabilities to be under-represented in science, engineering, and mathematics fields: preparation of students with disabilities; access to facilities, programs, and equipment; and acceptance by educators, employers and co-workers. Technology can have a positive affect on all of these factors and help open doors to new areas of study and employment. This paper explores the role of information technology, describes a campus program designed to positively influence each of the factors, and makes a series of recommendations for action.

INTRODUCTION

Access to higher education can enhance the employability and vocational success of individuals with disabilities (DeLoach, 1992; Sampson, 1984). Although the number of individuals with disabilities who attend post-secondary institutions is increasing, few pursue academic careers in science and engineering and, for those who do, the attrition rate is high. Individuals with disabilities are also under-represented in science and engineering professions, and scientists and engineers with disabilities experience higher unemployment rates than do other scientists and engineers (Malcom & Matyas, 1991). Nevertheless, the employment rate for scientists and engineers with physical disabilities is much higher than the estimate for the overall U.S. population with physical disabilities. These facts suggest that students with disabilities can find success in the science, engineering, and mathematics fields.

Recent advancements in adaptive technology provide efficient,relatively inexpensive access to computers and networks for people with a variety of disabilities (Brown, 1992; Burgstahler,1992a). As a result, careers that exploit technology are particularly accessible to individuals with disabilities. The increased use of technology in science, engineering and mathematics combined with the increased availability of access technologies strongly suggest that the time is right to promote the inclusion of disabled people into the science, engineering and mathematics fields.

DISCUSSION OF THE PROBLEM

Individuals with disabilities are under-represented in science, engineering, and mathematics educational programs and professions. There are three areas that cause this under-representation: preparation of students with disabilities; access to facilities, programs, and equipment; and acceptance by educators, employers, and co-workers.

PREPARATION

For an individual with a disability to experience life to the fullest, independent-living and self-advocacy skills must be developed (Transition summary, 1988). As the end of high school approaches, so does the termination of a structured environment and pre-college support systems (Burns, Armistead, & Keys, 1990). Adolescents with disabilities who wish to attend college are often faced with responsibilities that they are unprepared to meet because they are conditioned to depend on others (Transition summary, 1988). Once enrolled, students with disabilities often hesitate to request the specific accommodations they need (Amsel & Fichten, 1990). The levels and types of resources available to students with disabilities in pre-college programs, on post-secondary campuses, and in employment situations differ from one another and programs to help bridge the gaps between these critical stages are rare.

Students with disabilities are rarely encouraged to prepare for science, engineering and mathematics fields. Since they do not consider a career in science, engineering, or mathematics an achievable goal, they do not take the courses necessary to prepare for post-secondary studies in these areas. High school and college students with disabilities, counselors, social service agency staff, and special education teachers often lack an understanding of the content and requirements of science, engineering, and mathematics programs in higher education and of the technology and other resources that make it possible for students with disabilities to pursue these fields.

Students with disabilities lack access to role models with similar disabilities who are successful in careers that they might otherwise have thought impossible for themselves (Aksamit, Leuenberger, & Morris, 1987; Fonosch & Schwab, 1981). Potential role models are often separated by great distances, leaving individuals with disabilities isolated from those facing similar obstacles in school and work (Brown & Foster, 1990; Moore & Nye, 1986).

To prepare for science, engineering, and mathematics studies, students need to be able to use the powerful tools of the trade at an early age. Although network technology can reduce social isolation and allow independent access to information resources (D'Sousa, 1991), these tools are not often readily available to pre-college students with disabilities.

ACCESS

Computers, adaptive technology, and network resources can bridge the communication and accessibility gaps for people with disabilities. Electronic communications provide new options for independent access to people and resources. Computer and network access can increase levels of independence and have a positive impact on the academic progress and career success of individuals with disabilities (Coombs, 1991; Burgstahler, 1992a; Burgstahler, 1992b; Horn, Severs, & Shell, 1988). Unfortunately, many individuals with disabilities and people in their primary support systems are unaware of the tremendous contributions technological innovations can make to the lives of individuals with disabilities. Students with disabilities are not guaranteed access to computing and networking technology in pre-college and college programs (Burgstahler, 1992a; Horn & Shell, 1990). Likewise, lab facilities are often inaccessible to students with disabilities.

Those who wish to pursue science and mathematics fields need access to publications in these fields. Scientific and mathematics publications are not readily available in alternative formats for the print-impaired. Making them available in electronic format can assist those who have adaptive technology to produce materials in alternative format--such as large print--however some barriers still exist in making mathematics and scientific symbols accessible to those who are blind. A number of approaches being explored for making materials accessible to individuals with disabilities are reported in other articles in this issue.

Universal access to publications will require the creation of new products as well promotion of the use of existing methods.

ACCEPTANCE

A National Science Foundation Task Force (Changing America, 1989) stated that negative attitudes are the single most significant barrier faced by individuals with disabilities pursuing careers in science and engineering. Faculty and employers lack information about the rights and needs of students with disabilities and their potential contributions to society; they often have negative attitudes about including disabled students in academic programs and employment. Professors are particularly reluctant to include students with learning disabilities (Leyser, 1990) and have little knowledge of the characteristics and needs of students with this type of disability (Akamit et al.; Dodd, Fischer, Hermanson, & Nelson,1990). Faculty in science, engineering, and mathematics are less accepting than those in social sciences and education (Fonosch & Schwab, 1981). However, faculty attitudes have been found to be more positive when faculty members have previous contact and more information about students with disabilities (Aksamit et al., 1987; Fonosch & Schwab, 1981; Sedlacek & Stovall, 1983).

THE ROLE OF INFORMATION TECHNOLOGY

Information technology plays a key role in the three areas addressed in this paper. In order for students with disabilities to prepare for careers in science, engineering, and mathematics fields they must begin to use computing and networking tools at a young age. These tools can help them access resources, communicate with others, and perform academic tasks independently. The importance of the availability of adaptive technologies for individuals with disabilities cannot be over-estimated. Such tools are required if individuals with disabilities are to compete with their non-disabled peers. For all students and employees, the ability to perform tasks efficiently and professionally can earn the respect of educators, employers, and peers alike. The ability to control powerful technological tools can contribute to the acceptance of a person with a disability as an equal partner in learning and working situations.

ONE UNIVERSITY'S EFFORTS

At the University of Washington (UW), a project is working to increase the participation of disabled individuals in science, engineering, and mathematics programs and careers. DO-IT (Disabilities, Opportunities, Internetworking, and Technology) began in 1992 and is primarily funded by the National Science Foundation. Below, some of the DO-IT activities that address the areas of preparation, access, and acceptance are discussed.

PREPARATION

The DO-IT Scholars program offers students with disabilities, beginning in their sophomore or junior year of high school, opportunities to study science, engineering, and mathematics; experience campus living; develop self-advocacy skills; interact with mentors; and use technology to pursue academic interests.

Internetworking DO-IT Scholars learn to use computers and the Internet to explore academic and career interests. Computer and adaptive technologies are selected for each participant; local Internet connections are established; and in-home training is provided.

One scholar who is blind reports, "getting access to the Internet was the best thing that ever happened to me. In a way, my computer and access to the net have become my eyes to the world."

A DO-IT industry partner reports, "network communication is a liberating experience for many of these kids, since their disabilities aren't visible in their e-mail. They have been quick to exploit the technology, both to communicate among themselves and also to explore worlds that were previously inaccessible to them."

A parent points out that too often, without a special program like DO-IT, students with disabilities have "inferior and inadequate equipment and if they can get the right technology there is nothing that can stop them in what they want to do with their lives."

MENTORING--Through electronic communications and personal meetings, DO-IT Scholars are brought together with post-secondary student and career mentors to facilitate academic, career, and personal achievements. DO-IT mentors study and/or work in a variety of fields including computer programming, post-secondary education, statistics, physics, engineering, computer science, computer consulting, and biology. One scholar describes mentors as people who "provide us with useful contacts in academics, career, and personal areas. They help participants find their talents, interests, and confirm their goals."

Experienced scholars practice communication and leadership skills as peer mentors for new scholars.

Scholars and mentors are encouraged to reach out and help others. For example, they communicate with patients at a children's hospital through an electronic mail account established at the hospital through DO-IT. A mother reports that her son, a scholar with attention deficit disorder, "has already passed on some of what he got to another ADD child, by taking a boy to register for high school and showing him around so he will know where things are the first day of class."

SUMMER STUDY--At live-in programs held during two consecutive summers at the University of Washington, each scholar studies science, engineering, and mathematics by participating in lectures and labs and using computer applications and the Internet. Subjects include oceanography; heart surgery; chemistry; virtual reality; geophysics; material sciences, civil, mechanical and electrical engineering; mathematics; biology; physics, and astronomy. Accommodations are made in each activity to ensure that all participants remain as active as possible.

In the words of one scholar who attended a summer program, "I'm excited about many different careers I could go into. I learned what college life is all about."

A mother of one of the scholars pointed out how the summer study program boosted her son's "belief in himself and his abilities," she said. This experience has changed the course of his life."

Scholars learn self-advocacy skills as part of the summer curriculum. One parent reported her son's plans to talk to the math department head about challenging the math class he has been put into. "He says it's too easy and he wants a more difficult class where he can learn something new. He is not asking for me to help. He has the courage to go and work on this on his own. His being his own advocate has been coming, but this jump in ability is a direct result of the DO-IT experience," she said.

After observing two summer programs, a corporate partner noted, "We repeatedly hear the comment that these kids have never experienced a situation like this before--where the focus is on their abilities (rather than their disabilities)--and yet everyone else has their own challenges to overcome. The combination seems to produce an almost immediate sense of community and an extremely supportive intellectual environment."

SPECIAL PROJECTS AND EVENTS--Throughout their involvement in DO-IT, scholars have opportunities to pursue projects of special interest, using mentors and staff as resources. Options include collecting scientific resources, administrating systems, editing the newsletter, teaching in the summer program, and helping with other DO-IT events. DO-IT scholars as well as other pre-college and college students with disabilities and their families, teachers, counselors, and service providers are invited to participate in special events, including the UW Computer Fair booth, presentation and reception; the UW Engineering Open House; and the UW Health Sciences Open House. Events generate a lot of interest and often attract children with disabilities and their parents who, after meeting DO-IT scholars and mentors, are encouraged to use technology and to pursue science, engineering, and mathematics interests.

It is too early to measure the ultimate impact of the DO-IT project, but evidence has begun to appear in the many successes of the DO-IT scholars so far. Four DO-IT Scholars graduated from high school in 1994 and are pursuing college programs in genetics, computer programming, electrical engineering, and general studies, in preparation for more advanced studies in science. One scholar won a NASA Space Grant four-year scholarship to the University of Washington; she became aware of the scholarship program during a DO-IT summer study session. ADO-IT Scholar won an honor for his essay about the Internet in a national contest sponsored by the National Science Foundation, National Center for Education Statistics, and NASA. He was invited to speak at the Washington State Governor's Technology Conference. Two participants worked with a mentor to organize afield trip for scholars and other students with disabilities to Battelle Pacific Northwest Laboratories in Richland, Washington. One participant earned a paid summer internship at the Labs. DO-IT scholars have appeared on local television and radio shows and in conference presentations. One Scholar is working part-time at Microsoft and in the Adaptive Technology Lab at the University of Washington. A DO-IT scholar is now the editor of DO-IT News, the project newsletter. DO-IT scholars and mentors have formed the nucleus of an electronic community of people who share both a love of science, engineering, and nathematics, and the challenges of a disability.

DO-IT sponsors one-day college transition workshops and adaptive technology seminars open to on-and off-campus individuals with disabilities, families, service providers and educators. These programs extend the impact of the DO-IT project to a large audience, helping more students with disabilities make the transition and adjustment to college life and make effective use of information technologies. Plans are underway to teach day camps on the use of computers and the Internet to young children. Most of the instruction will be done by experienced scholars.

Involvement of corporate sponsors in DO-IT scholar activities is expected to pay off in terms of more accessible workplaces for individuals with disabilities. A Microsoft representative said, "I sincerely hope and expect to someday count DO-IT graduates among my colleagues at Microsoft."

For Battelle Pacific Northwest Laboratories, involvement in the DO-IT project has "provided a way for our staff scientists and educators to learn first-hand what we can do to ensure that our working environment welcomes students of diversity, including those with disabilities. The overarching goal of our participation is to enrich science and technology by opening the door to a diverse, highly talented work force. We consider ourselves a partner with the University of Washington in the DO-IT program. Through DO-IT, we have been able to link students to our scientists via Internet, provide opportunities for scientists to interact in person with disabled students including hosting DO-IT students for a tour of our laboratories, and provide a summer internship for a selected DO-IT student."

ACCESS AND ACCEPTANCE

DO-IT works to create a barrier-free campus for students with disabilities, particularly in the academic areas of science, engineering, and mathematics. The latest adaptive technologies are available in convenient locations. Students with disabilities were surveyed about access the barriers they have faced and plans are underway to survey computer and science labs to pinpoint accessibility problems, recommend solutions, and implement recommendations.

The most effective way DO-IT improves access and attitudes toward students with disabilities is to invite University faculty to teach in the summer study program for DO-IT scholars. Staff provide assistance in making presentations and labs accessible to all scholars. Without exception, instructors come away with a positive impression of the capabilities of students with disabilities and a better understanding of access requirements.

Disability awareness presentations are delivered regularly to faculty. These programs reach a wide audience and increase awareness of the potential of students with disabilities, improve attitudes toward students with disabilities, and provide creative and practical approaches for ensuring access to educational opportunities. A short videotape, funded by U.S.West Communications, introduces viewers to faculty and post-secondary students with disabilities who demonstrate successful techniques that allow full participation in academic programs and careers. NEC Foundation of America has assisted with nation-wide distribution of the videotape and accompanying presentation materials. Plans are underway to adapt the model used for faculty to similar presentations for pre-college educators and employers.

Electronic tools on the Internet allow DO-IT participants, mentors and staff to reach a large and growing audience of thousands of people world-wide. Electronic discussion lists and a gopher server deliver program and disability-related information and facilitate communication on issues related to participation of disabled individuals in science, engineering, and mathematics. Printed materials also promote the inclusion of disabled individuals in the science, engineering, and mathematics fields and promote the use of technologies to give disabled individuals equal access to information.

In summary, DO-IT helps students with disabilities make the transition to post-secondary studies and careers in science, engineering, and mathematics, and it creates a positive and accessible learning environment for disabled students programs. The long-term outcome of projects like DO-IT will be to increase the number of disabled individuals in science, engineering, and mathematics professions.

RECOMMENDATIONS AND CONCLUSIONS

A review of the literature and of the experiences at the University of Washington lead to several recommendations to promote the inclusion of disabled people in science, engineering, and mathematics academic programs and careers.

PREPARATION

To help students with disabilities become prepared to pursue these fields efforts should be undertaken to:

Help people with disabilities develop independent-living and self-advocacy skills and facilitate transitions to college and employment.

Encourage students with disabilities to take mathematics and science classes in high school and college so that they can pursue careers in science, engineering, and mathematics.

Establish positive, motivational, and lasting interactions between disabled high school and college students and practicing engineers and scientists who have disabilities.

Make sure students with disabilities begin to use computers, electronic communications, and network resources to increase their independence in pursuing academic studies at an early age.

ACCESS

To improve access to science, engineering and mathematics fields we must:

Make facilities, computers, science equipment, and programs accessible to people with a variety of disabilities.

Assure that scientific and mathematics publications are readily available in appropriate alternative formats.

ACCEPTANCE

In order to create a positive environment for learning and working, efforts should be undertaken to:

Increase the awareness of pre-college and college educators regarding the potential contributions and accommodation needs of people with disabilities.

Help employers and co-workers appreciate the potential contributions of people with disabilities and create a flexible work environment where productivity can be maximized.

In all of these efforts successful individuals with disabilities should be given opportunities to share the specialized expertise they have developed through their own personal experiences. Individuals with disabilities can be empowered with opportunities to apply their skills in efforts to promote the participation of other disabled individuals in science, engineering, and mathematics academic programs and careers.

We must continue to increase the understanding of factors affecting the under-representation of individuals with disabilities, implement creative programs to address problems,and share successful practices. Many small steps taken locally can, together, create a substantial impact and move us closer to a shared vision where people with disabilities have equal access to opportunities in science, engineering, and mathematics.

For more information about DO-IT contact:

DO-IT University of Washington, JE-25/Room 206 Seattle, WA 98195 (206) 685-DOIT doit@u.washington.edu

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*INTRODUCING _INFORMATION TECHNOLOGY AND DISABILITIES_*

Tom McNulty
mcnulty@acfcluster.nyu.edu
Editor-in-Chief
*_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.

Tom McNulty
*Editor, _ITD_*
mcnulty@acfcluster.nyu.edu
Bobst Library
70 Washington Square South
New York, NY 10012
phone: 212/998-2519
TDD: 212/998-4980

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Signature: Tom McNulty	Printed Name/Position/Title: Tom McNulty/Editor-in-Chief	
Organization/Address: EASI	Telephone: 212 998-2519	FAX: 212 995 4583
	E-Mail Address: ~~mcnult~~ tom.mcnulty@nyu.edu	Date: 10/17/98

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