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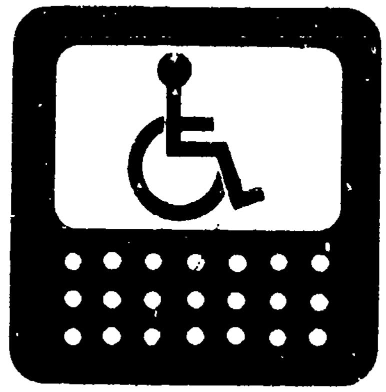
ABSTRACT

Thirty presentations are included from a 1983 conference on computers for the disabled. The conference blended viewpoints from vocational rehabilitation and special education. The first section presents three keynote addresses: "High Tech/High Touch: Making Good on the Promise" (D. A. Fenderson); "Curbcuts and Computers: Providing Access to Computers and Information Systems for Disabled Individuals" (G. C. Vanderheiden); "The Person with Disability and the Benefits of the Microcomputer Revolution" (T. Shworles). The second section is composed of papers on such topics as the use of computers in rehabilitation facilities, adaptation of computer equipment for handicapped children, the lip-reader trainer, an electronic blackboard for a blind teacher, a computerized system at an independent living center, a voiced personal computer system with word processing capabilities for the severely physically handicapped, and use of LOGO by learning disabled students. (CL)



Discovery '83:
COMPUTERS FOR THE DISABLED

CONFERENCE PAPERS

Edited by
Janet E. Roehl, Ph.D.
University of Wisconsin-Stout

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Discovery '83

September 12-14, 1983
Minneapolis, Minnesota

Sponsored by
University of Wisconsin-Stout:
Office of Continuing Education
Stout Vocational Rehabilitation Institute
School of Education and Human Services

The papers appearing in this book comprise the proceedings of Discovery '83: Computers for the Disabled. They reflect the authors opinions and are published as presented without change. Their inclusion in this publication does not necessarily constitute endorsement of the Office of Continuing Education, Stout Vocational Rehabilitation Institute, or the Materials Development Center of the University of Wisconsin-Stout.

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Editor's Note

A conference of this complexity is not easily coordinated. Special recognition and appreciation are given to Ms. Debbie Hass, Ms. Kathy Mork, and Ms. Jean Price, of the Office of Continuing Education. Assistance was also given by Ms. Linda Smith and Dr. Fred Menz. And finally, a heartfelt thanks is offered to all the participants who were patient while we learned by trial and error, and who were complimentary of our efforts. See you next year.

J.E.R.

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Introduction

Twenty million Americans suffer from some sort of disabling physical handicap, 10% of the world's population. There are over two million blind individuals, 13 million hearing impaired, and 100,000 quadriplegics. Ten to twenty percent of the school-age population suffer from a perceptual handicap, minimal brain dysfunction or dyslexia.

The advent of microcomputers has provided a new and potentially powerful tool for the persons with disabilities and those working with them. The purpose of this conference was to provide an overview of the many areas in which computers can serve the needs of the disabled and some specific applications of this new medium.

Discovery is an annual conference designed to highlight frontier areas in serving the disabled. This year's topic, Computers for the Disabled, was a unique blending of two disciplines, vocational rehabilitation and special education. The field of vocational rehabilitation has produced much of the design hardware; special education has developed control oftware. A wealth of new ideas, energy, and enthusiasm have been the products of these innovations.

This conference provided teachers, administrators, counselors, government personnel, researchers, purveyors of computer technology, and persons with disabilities with an excellent opportunity to learn about the advances made in computer technology that are impacting special education and vocational rehabilitation today.

The conference was held September 12-14, 1983 in Minneapolis, Minnesota. There were over 500 participants, 60 presentations, 40 exhibitors, and three eynote addresses.

The Conference Papers offer an abundance of new ideas, research findings, and innovations that were presented at Discovery '83. Part I includes the three keynote addresses. They were given by Dr. Douglas A. Fenderson, Director, National Institute of Handicapped Research, United States Department of Education; Dr. Gregg Vanderhoiden, Director, Trace Research and Development Center for the Severely Communicatively Handicapped, University of Wisconsin-Madison; and Mr. Thomas Shworles, Chairperson, Committee on Personal Computers and the Handicapped (COPH-2), Illinois Council of Organizations of Physically Handicapped. These addresses are printed in order of appearance.

Part II is the papers presented during the three day conference. These include reports of research activity in computer useage, papers detailing the modification of hardware and software, as well as designing of new products. The general interest areas were: deaf and hearing impaired, blind and vision impaired, physically handicapped, learning disabled, and EMH-TMH. Not included in these proceedings are presentations that were demonstrative in nature. Papers are published alphabetically by authors' names.

Secretary of the United States Department of Education, T. H. Bell, commended Discovery '83: Computers for the Disabled for providing a platform for the sharing of knowledge and exploration of "new ways to help disabled citizens pursue better lives and live more independently." He concluded, "I wish you success in the interest of innovation in education and rehabilitation, and most importantly, on behalf of the handicapped persons who benefit from your dedication and talent."

Part One

Keynote Addresses

High Tech/High Touch: Making Good on the Promise

D.A. Fenderson

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Washington, D.C.

Some 31.5 million Americans—14.6% of the non-institutionalized population—have a limitation of function caused by a chronic health condition (DeJong, Note 1). Of this number, some 7.9 million are classified as severely disabled. Moreover, both the number and incidence of disability is increasing. For example, the incidence of severe disability has increased more than 70% from 1966 to 1979, from 213 per 10,000 population to 365 (Note 2). This increase is in some important sense a credit to improved primary and secondary preventive measures in a humane and caring society. Improved perinatal care, trauma and rehabilitative care, surgical and antibiotic treatment, and geriatric care, all contribute.

As you might expect, the likelihood of disability increases with age and decreases with level of education (Note 3). Disabled persons are less likely to be married or white and much more likely to live in the east south central part of the United States. How will this "High Tech Information revolution affect the one of seven of our citizens who have a disability?

A related trend involves institutional care. Although I do not have current data, fewer retarded or mentally ill persons are being placed in large public institutions and many there are being released to other less restrictive environments. In fact, a major priority of the new Assistant Secretary for the Office of Special Education and Rehabilitative Services (OSERS), Mrs. Madeleine Will, is to increase this trend both through financial incentives and improved access to necessary community services.

The subject of this conference is Computers and the Disabled. The implications are many, diverse, and of varying consequences. On the one hand, this technology, in relation to a confluence of social streams is pervasive and profound in its opportunities and impact. On the other hand, it will, in some instances present new obstacles to the inclusion of disabled persons in the mainstream of American society. Let's take a closer look at these trends.

In his recent best-selling book, Megatrends, John Naisbitt (Note 4) tries to characterize the current global social and economic revolution as a movement from industrial society to information society. His data is persuasive. Although the traditional service sector has remained quite stable since 1950 at about 11 to 12 percent, the "information occupations" have exploded from about 17 to 60 per cent. In add tion, the manufacturing firms which have increased the : work force d ing the 1970s by only about 5 per cent, also employ a large and increasing number of information workers. To emphasize this rapid shift from a goods versus service knowledge economy, he points out that the largest single employment category by 1979 was clerical, followed by professional—with information jobs comprising some 16 per cent of the overall work force.

About 90 per cent of job growth since 1970 has been in the non-goods area, and much of it in small businesses and state and local government. Naisbitt cites a 1967 U. S. Department of Commerce study of the size of the "information worker" work force, which makes a distinction between the primary and secondary information sectors. Adding them, the study shows that 46 per cent of the gross national product (GNP) and 53 per cent of earned income was accounted for in the information sector. The study's author. Dr. Marc Porat, says simply that the information economy has grown "by leaps and bounds" since then.

Literacy—to say nothing of computer literacy—is now a major political issue, and both are of importance to the full inclusion of the disabled in our society. Secretary Bell (Note 5) estimates that 23 million Americans are functionally illiterate.*

And if by one estimate (see Note 4) some 75 per cent of the jobs in our economy by 1985 will involve computers in some way, many who do not know how to use them may well be disadvantaged. Although these trends may be of limited importance to the increasing population of older and/or poorly educated disabled persons, surely the crisis in education in the United States will have a profound effect on our younger disabled citizens. Those of us who direct our energies into means for including disabled citizens in all aspects of social and civic life have a special concern for their education, and where possible, computer literacy. Or, it may well be, that lacking such opportunities and possibly special speed-enhancing adaptive interfaces, disabled students may again fall behind.

USA Today, Tuesday, August 30, 1983, featured a front page story, "Computer gap grows in school." Citing a recent National Science Foundation (NSF) study, it reports that computer instruction in schools is strongly skewed towards boys in suburban and affluent urban areas. Although racial differences are not large, 13 year olds in the west were twice as likely as those in the southeast to have had computer experience in school. But overall, only about one-third of 17 year olds in the large national sample had used a computer in school. The implication is diminished job opportunities for the poor, female and rural students.

Contrast this with recent congressional testimony by Dr. K. R. Jhin, Assistant Superintendent for Instructional Technology, D. C. Public Schools. He notes a general improvement in standardized test scores over the past three years, in part in response to the incorporation of computer assisted learning into the school program. Dr. Jhin reports that all D. C. teachers and administrators are being "retrofitted" for computer literacy to make use of the the 1,450 computers now on hand. All new teachers must demonstrate computer literacy to be employed; all teachers must pass a five-year computer recertification requirement beginning in 1988; and, by that date, every student must demonstrate computer literacy as a requirement of completion for grade 9.

Secretary Bell, quoting President Reagan, says "We're stepping into a new economic era and one of the most challenging and exciting decades in our history. High technology is revolutionizing our industries, renewing our economy, and promising new hope and opportunity in the years ahead." (Feb. 14, 1983). "Yet," the Secretary notes, "A consensus finds American education at the very heart—or at the root, of a society in transition from an old industrial base to a new info-high-tech-service age. And the condition of American education is found to be wanting, to be mediocre and needing a transformation--a revitalization all across the board from preschool to continuing life-long learning." He cites six prestigious blue-ribbon commissions recently arriving at a

*On Wednesday, September 7, 1983, President Reagan announced a national program to combat illiteracy. Computer technology will play a significant role in this effort.

similar conclusion—that our future as a country is at risk because of the serious deterioration of school achievement in the United States, particularly in such vital areas as mathematics and the sciences. These general educational and computer literacy concerns are of basic importance.

The National Institute of Handicapped Research (NIHR) has a special interest in this meeting. Although our $30 million program is small by comparison with most federal agencies, we are the largest single source of support for rehabilitation research. In addition, we are required by law to convene at least quarterly the legally mandated Interagency Committee on Handicapped Research, which includes the 33 federal agencies with identifiable research portfolios relating to disabled persons. We are now assembling the entire catalogue of disability research supported by the federal government in a simple computerized system—Interagency Rehabilitation Research Information System (IRRIS), soon to be accessible through the Bibliographic Retrieval Service (BRS).

It goes without saying that virtually all the 27 Research and Training Centers, 18 Rehabilitation Engineering Centers and 16 Research and Demonstration projects use, develop and apply computer technology in one way or another. Let me illustrate the nature and extent of our investment in computers and the disabled with the following brief summary. It might suffice simply to say that we support the work of your next speaker from the University of Wisconsin, Greg Vanderheiden. Even a casual review of the published literature on this subject provides a clear indication of his extensive and practical contributions. Although this work cannot be captured in a title, it is one of four centers or projects emphasizing computer interface and communication augmentation for severely disabled persons. Research includes tracking of eye movement and gaze via corneal reflection and micro television cameras, use of Morse Code and vibrotactile stimulators for deaf-blind; devices to aid in speed of input, (my colleague, Dr. James Reswick, uses the term "computer-speak" to refer to special commands used to elicit a communication sequence); and other nonvocal communication procedures and devices. Contributing to this area are, in addition to the University of Wisconsin, Tufts University, Smith-Kettlewell and the United Cerebral Palsy Foundation of Kansas (Note 6).

A second major segment of our computer-related portfolio is in the quantification of the performance of disabled persons. We support five projects in this area—at Harvard/MIT, Tufts New England Medical Center, Rancho Los Amigos Hospital, The University of Minnesota, and the Dallas Rehabilitation Foundation. Although each project is unique, they include multiple simultaneous data input on gait, pressure, position, range, energy cost and other factors in 3-D, real time. Results may be too complex for analysis by inspection; pattern analysis is required to tease out the clinically useful findings. These studies promise greater precision in diagnosis and assessment as well as criteria against which to measure improvement in function.

A third major NIHR commitment is in micro technology application to Functional Electrical Stimulation. We support three centers in this work. The grandfather of them all—supported over the past decade through our international program—the Rehabilitation Institute of Ljubljana, Yugoslavia, along with Rancho Los Amigos and Case Western Reserve University. The most applied product coming out of this work is the Scolatron, developed at Rancho. It involves selective electrical stimulation of muscles during sleep, to stop or reverse spinal curvature. Other work includes experiments with standing and limited walking in persons with paralyzed limbs, therapeutic stimulation of denervated muscles and control of incontinence—one of the primary reasons for institutionalization of the elderly.

A fourth area of computer application support relates to studies of brain dysfunction. Four Research and Training Centers are studying various aspects of the use of computers both for diagnosis and treatment of perceptual, cognitive and language dysfunction. Centers applying computer technology to these problems include New York University, Emory University, Northwestern University and the University of Washington.

Other significant work includes: chip technology in the development of a new generation of hearing aids; improving intelligibility of speech by deaf person (Gallaudet), wheelchair controls and related scanning and protective devices for severely handicapped persons (University of Virginia Medical Center, and Northwestern University Prosthetics and Orthotics Center); Robotic prostheses for amputees and upper limb paralysis (MIT, Northwestern University); and the development and maintenance of disability-related data bases on:

- Job Opportunities and Experience of Deaf Person - University of Arkanas
- Rehabilitation Research and Devices for the Disabled (NARIC, ABLEDATA) - Catholic University of America
- Inventory of Reasonable Accommodation in the Work Place-President's Committee on Employment of the Handicapped
- National Spinal Cord Injury Rehabilitation Data System - University of Alabama, Baylor University
- Inventory of Clinical Evaluation of Devices for Handicapped Person—Southwest Research Institute
- Vocational Rehabilitation Data for the United States - University of West Virginia

As part of a Presidential initiative to stimulate small business, NIHR is reviewing some 39 proposals relating to disability. Two-thirds of them are for applications of computer technology. We also receive unsolicited proposals. A couple of them are intriguing. One identifies several problems of profoundly retarded persons and suggests a series of robotic type solutions ranging from memory prompting for personal hygiene through the creation of artificial environments which provide education and function enhancing entertainment.

Another proposal describes progress in the entry of detailed anatomic data into computer storage and suggests that surgeons may be able to "try out" various procedures by simulation, having visual access to the site of intervention from any angle. A rehabilitation related application, for example, would be repositioning of the head of the femur (in preference to a metal prosthetic insert) by removing a wedge of bone to change the angle of the articulation. Computer "surgery" would permit detailed scrutiny of the location and angle of the wedge cut and the resultant change in repositioning of the asatabulum.

Currently, NIHR has no authority for supporting unsolicited proposals. However, regulations have been drafted to correct this deficiency and will be published in the Federal Register for public comment January 1. Also, by January 1, 1984, we expect to announce the availability of small (up to $50,000) and medium (up to $150,000) field-initiated grants. We will also announce the second "class" of rehabilitation research fellowships which will provide a one-year stipend to individual investigators of from $25,000 to $30,000 plus a small expense allowance. Through these means, we expect to consider a whole new range of application of computer-related solutions to the personal, domestic, medical, social, and vocational goals of disabled persons.

Under our authority for international programs, a guest from Australia visited some 30—primarily NIHR-supported—Rehabilitation Engineering and Research and Training Centers throughout the United States. His trip was a backdrop for plans in Australia to develop a rehabilitation engineering program. His report to us was disturbing. He said we went about it backwards. Our work, he contended, was driven by the often esoteric needs and interests of engineers and their students. It lacks the real life experience of large numbers of disabled persons. He also contends that highly vaunted concepts of interdisciplinary teams are seldom to be seen in practice. Typically, the physicians are too busy with the business of medicine to engage in genuinely collaborative work with technicians and engineers. He also says our technology programs tend to function in relative isolation from each other.

In a similar vein, Henry Blaszczyk, principal of the Widener Memorial School (Note 7) says, "We serve over 400 physically handicapped children with a wide range of physical abilities; an age range of 4½ to 21 years, an I.Q. range of 22 to 140, and yet no other research agencies, computer companies, book publishers, or game makers have attempted to utilize the tremendous resource of our pupils or staff in product development.

In another critique of our technology program, the author says that the number of resulting products now in use by disabled persons is pitifully small—some six, he estimates, in ten years of REC support.

Our Australian friend said that their approach will be to establish centers where the technology-related needs of disabled persons may be assessed using, to the greatest extent possible, adaptations of existing technology. The identification of problems which require evaluative study, standard setting and the engineering of new products, would be driven by the needs of disabled persons and therefore would be more functional and efficient than our top-down approach. I take these criticisms of our work in technology very seriously and will be considering several approaches to the increasing collaboration of our Research and Training Centers and Rehabilitation Engineering Centers—and possibly, through professional societies and community facilities, to more realistically and productively engage the needs and goals of disabled persons themselves.

Another major problem we see in the adaptation of computer technology to the life goals of disabled persons is cost. Several rehabilitation engineers have told me that this is the single most distressing aspect of rehabilitation engineering today. Not only are rehabilitation engineers able to design and fabricate adaptive devices, but most are able to perform consultations for vocational counselors (Project IMPART, for example) that can make a significant contribution to the rehabilitation outcome. Through education, counselors are becoming more aware of the potential for technological consultation. But the problem of payment for unique or adaptive devices remains.

In seeking an answer to the cost question, I discovered from Dr. Justus Lehmann, University of Washington, Seattle, that they have solved the problem in their setting. They have on staff a person skilled at securing needed resources. This person tries every conceivable source—public and private—insurance, voluntary health organizations, service clubs, community organizations, churches. Dr. Lehmann reports that no truly needed device has been denied for lack of a sponsor. If you think this sounds too good to be true, some of you with this problem may want to write to Dr. Lehmann for advice.

I introduced my paper with reference to Megatrends and will conclude with it, as well. Naisbitt forecasts that during the 1980s, the international electronics business will top $400 billion—the largest business ever created on this planet. Can anyone, including skeptics and critics, deny this reality?

The twin cities is one of the major high tech centers in the United States, surely, in part, a credit to far sighted corporate leadership, a strong base of public and private education and the cultural and recreational richness this environment affords.

In the early years of Control Data, I read a speech by its president, William Norris,—which set out a "strategic vision" of the future of computer technology. He used an analogy to Edison's light bulb. The Scottish scientist, Lord Kelvin, found Edison's work ridiculous—what foolishness to envision a system of shared light—to have light wherever, whenever, and at whatever intensity desired! The vision was not only a bulb, but a generating and distributing system. Norris' analogy is obvious. A particularly current example of the progress toward the strategic vision is a two-page advertisement in the September 1983 "Smithsonian" by GTE. The ad shows a physician checking the indications and cautions for the use of erythromycin on his terminal. The ad then states that the first nationwide computerized medical information system, a collaborative project of GTE and AMA, is now in service. It can provide immediate access to participating physicians of the "latest knowledge and information on drugs and diseases." Local terminals are connected to the GTE telenet and central computer. The ad concludes that the system is expected to save physicians an enormous amount of time—and "quite possibly, something a lot more valuable."

The title of this paper is from Naisbitt, who says flatly—"The technology of the new information age is not absolute. It will succeed or fail according to the principles of high tech high touch." He explains that as our work tasks move inexorably in the direction of the manipulation of abstract symbols—data mediated process for the production of desired goods and services, the human need for personal relationships, values, beliefs may be increased. Unless the high tech environment of the future finds a strong counterpart in, for example, the human potential movement, the great and potentially liberating achievements of technology will be blighted.

One of the great pioneers of the computer age was MIT mathematician, Norbert Wiener. You recall, he coined the term cybernetics in 1943 and co-authored the book, The Human Use of Human Beings. Toward the end of his career, he became increasingly concerned with this humanizing theme. He wrote a little science fiction piece, a modern version of the Faust plot of selling one's soul to the Devil. The ultimate evil, in this story, was for humans to lose control of their creations.

Although based on more than 20 years of research support through RSA, NIHR as a distinct research institute is only five years old. The chief architect of NIHR was Dr. William Spencer, Director, TIRR. I told him last spring of my concern for an organizing theme, a strategic vision, for the long range plan of NIHR. He gave me a little monograph (Note 8) resulting from an international conference. He said the emerging concept was fundamentally different from the traditional rehabilitation program. It was, "Include the Disabled." That doesn't sound very profound, does it? In the old rehabilitation mode, we begin with an impairment, which limits function (disability), which in relationship to personal goals and environment, constitute a handicap. The emphasis is, of necessity, on difference, defect, gap. The new concept, Spencer says, goes further. Not all impairments repaired, not all functions restored, not all personal goals achieved. The new concept is simply to include the disabled. The old paternalism is gone. We share the basic promise and plight of all humanity--and we seek to achieve a barrier-free society for all citizens—a universal value of including all our citizens in all aspects of society. COMPUTERS AND THE DISABLED—INCLUDE THE DISABLED!

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Curbcuts and Computers: Providing Access to Computers and Information System for Disabled Individuals

G.C. Vanderheiden

Trace Research and Development on
Communication, Control, and Computer Access
for Handicapped Individuals

University of Wisconsin - Madison

This morning I'd like to talk to you about some of the potential for microcomputers, but, more importantly, I'd like to talk to you about how computers can become the greatest new handicap that disabled people will ever face. I'd also like to talk about a few approaches we can take to see to it that it doesn't happen, or to turn this trend around early.

Many such special instruction sets or programs for individuals experiencing handicaps have been written. These include programs to allow blind individuals to auditorily process text, translate text into Braille, and translate Braille back into text; programs to help deaf individuals learn sign language or better understand how to move their vocal mechanisms in speech (by displaying cut-away views of the mouth during speech); and programs to allow physicallly handicapped individuals to write, speak, and control items in their environment. I won't dwell on the many special applications for computers, since you will be spending the next few days reviewing them. But it is clear that with these programs we can use the computer to do all sorts of wonderful things which can assist individuals who have various disabilities. At this point, the computer still looks like a "good guy".

But that's only half of the story. Let's look at the other half — where computers have the very great potential of creating new barriers and widening the gap between disabled and able-bodied people rather than helping the disabled individual overcome these gaps.

How does a computer become a barrier? Well, first of all, we have to realize that the computer was not invented for the individual with a disability. We get so excited about all of the potentials and potential uses of the computer to carry out special activities for individuals who have disabilities that we forget that the reason they were developed and the reason the technology is racing ahead and the prices are dropping is that they are very rapidly being applied and incorporated into the lives of non-handicapped individuals. As they are incorporated into our lives, they are extending the capabilities of able-bodied individuals, increasing their efficiency and effectiveness, and providing them with new capabilities. Computers are now beginning to show up and will show up at an ever-increasing rate in our educational system. Soon there will be computers in all classrooms, and they will be used as routinely as blackboards and pencils and paper are today. Similarly, in the job site employers are making more and more extensive use of computers in all aspects of employment. Even in daily life, we may soon be doing most of our ordering and bill-paying using computer terminals and the like from our homes. In all of these cases, however, the software being written is being written to be operated by individuals who have use of all senses and fingers. As such, they are for the most part unusable by individuals who have various types of physical disabilities. Thus while we are busy providing handicapped individuals with ways of using a computer to act like a typewriter, pencil and paper, or environment control system, to parallel the manual activities of non-handicapped individuals, the rest of society is busy moving on to the next generation, where many of these activities will be carried out much more efficiently and effectively in totally different ways using computer technology. Moreover, these new ways are designed to make maximum use of all of the senses and movement patterns of able-bodied individuals, and will thus exclude the handicapped individuals.

Thus, while the computer is advancing handicapped individuals two steps through the use of special programs designed for handicapped individuals, the computer is advancing everyone else in society five steps. Moreover, the five steps are being designed in such a way that the handicapped individual can not take advantage of them, thus leaving them actually three steps behind in the net result.

For example, we will now find bright physically handicapped individuals being placed in the classroom, where half of the classwork is being done on computers. Although these handicapped individuals have the few special programs which have been written for them, and which they can operate with their limited physical abilities, they are unable to use the much larger (on the order of a hundred to a thousand times larger) body of standard software which is being used by the rest of their class, since they are physically unable to operate it. As a result, half of the classwork (and the educational system) will be inaccessible to them.

Other individuals, when moving into the job market, will find that companies are not interested in the fact that these handicapped individuals can use their own computer and their specially adapted programs. The employer is only interested in whether the disabled individual is able to operate the accounting program running on the company's computer. If not, then he can't carry out the job, and is unemployable, despite the fact that he "has a computer and a program he can operate." Care must be to taken to distinguish between having the ability to do something or operate a computer and the ability to operate the programs and computers that are required. This is roughly akin to being able to easily access your bathroom at home, which does you little or no good if you have to go to the bathroom on the job. It's not good enough that you can access a bathroom — you have to be able to access the bathrooms that are in the environments where you need to operate.

Even in the home, however, this problem can arise. As we move toward telecommunication systems where ordering and bill-paying is carried out through specialized communication links, it will become necessary for the handicapped individuals to operate the specific keypads or control panels on these auto-home communication systems. If standard computer terminals were used, then a specially adapted "terminal for the handicapped" might be usable. More likely, however, due to security and other considerations, very specialized systems will be used. Again, what could be a very powerful capability for handicapped individuals (remote ordering and bill-paying) will instead be available only to non-disabled individuals.

Thus, although custom software programs can provide a great number of very useful capabilities to handicapped individuals, custom software is not enough. Access must be provided to the world of standard computers and, most importantly, the world of standard software, if computers are in fact to result in a net gain for handicapped individuals.

The first method that jumps into mind for providing access to standard software is to simply modify the software so that it can also be used by handicapped individuals. However, this is an extremely and difficult proposition, even when support from the original software developers is available. Again, because of security and commercial reasons, most standard software is a carefully guarded and protected commodity, making modification almost impossible. Moreover, the software programs are continuously updated and revised, making it impossible to keep handicapped users supplied with a modified version. It should be remembered that modifying a single program can cost between $8,000 and $20,000 (writing a program from scratch can cost anywhere for $5,000 to $2,000,000 and up per program).

The only real solution to the problem is therefore the ability to provide transparent access to computers. Transparent access refers to the ability of the handicapped individual to access the computer in such a way that the computer program cannot tell in any way that the input is not coming to it in the standard fashion. For example, if a program is written to accept input from the keyboard, the modification must be made in such a way that it is impossible for the program to tell that the input is not coming from the keyboard.

One technique that can be used to do this is the use of a keyboard emulator. The keyboard emulator is a small module which is installed inside a computer between its normal keyboard and the rest of the computer. Once installed, it does not affect the operation of the computer in any way. The keyboard operates in exactly the same fashion as it did before. The emulator, however, provides a small port or plug point where individuals using specialized communication aids can connect. They can then use their specialized communication systems (which they may operate using eye movements, head movements, or sip-and-puff, etc.) to generate their "keystrokes" which are then fed to the keyboard emulator. The keyboard emulator in turn feeds them into the computer in such a way that it looks as if they were actually typed on the computer's keyboard. With a keyboard emulator installed in a computer, a wide range of individuals having very different communication aids and input techniques would be able to use the computer and all of its software without requiring any modifications of any kind to any software.

In a classroom, for example, there might be fifteen computers lined up along one wall on which the students carry out their written assignments, etc. Two of the computers might have keyboard emulators installed in them, and a small "access" sticker similar to that found on restrooms placed on the computers' cases. Any individuals who are unable to use the standard input keyboard could then use these two computers and control them using their specialized communication or writing systems. When not being used by handicapped individuals, these two computers could be used by anyone else. The situation would in fact look very much like a bathroom, where one or two stalls have been modified for use by handicapped individuals. The difference here would be that the non-handicapped individual would not be able to distinguish in any way (except, perhaps on seeing the access sticker) that any type of modifications had been made to the system.

Keyboard emulators are currently available for the Apple II and Apple IIe computers, with emulators for the IBM, Atari, and many other computers following quickly. More information about these and other transparent as well as non-transparent modifications to computers is available in the Software/Hardware Registry distributed by Trace R&D Center.

For visually impaired individuals who cannot use the CRT display, substitute displays using tactile and voice output are under discussion and development. One system uses a pad about the size of paper, which the blind individual touches. Wherever he touches the pad, the contents of the CRT screen corresponding to that portion of the pad are read vocally to him. This system can therefore be used by individuals who are blinded later in life as well as those who are congenitally blind, since it does not require any learning of special skills, such as Braille, etc.

More in-depth discussions of these topics can be found in other papers in this conference, as well as in the September, 1982 issue of BYTE magazine.

The problem, however, is not solved yet. While we are now coming up with solid solution strategies to deal with transparent access to keyboards, the computer designers are busy inventing non-keyboard methods for input to computers. Most of these input methods take increased advantage of the many physical abilities of the non-handicapped individual; as a result, they are even more difficult for handicapped individuals to operate than the keyboard. These include the use of "mice", voice inputs, and body tracking techniques. In addition, more complex video displays are being used, with heavy use of graphics and visual-spatial representation, which will make the task of providing alternate displays for visually impaired individuals even more difficult. The development of new strategies to deal with these problems, as well as the raising of the awareness level of computer designers to these problems, is therefore very important, and needs to be one of our highest priorities.

So, where do the curb cuts come in? Let us imagine for a moment a land where there are only roads, and no sidewalks of any kind. Individuals in wheelchairs (not allowed on the road) are therefore trundling across the grass, pushing their chairs. This of course is a very difficult activity, so they greet with great anticipation and joy discussions about putting little concrete runways along the side of all the roads, on which people can walk. Although it is clear that these walkways are not being put in for specific benefit of handicapped individuals, it appears that it will be a tremendous boon to them. In all the celebration, however, people don't notice that along with the sidewalks also come curbs. Thus, when the whole system is installed, the handicapped individuals find that they are now able to move very swiftly around on their own block, but for the most part are unable to access all of these nice pathways that have been laid throughout the society. Moreover, putting in the paths increased the ability for everybody else to get around, thus making the difference between their mobility that much greater. Now, they can put little ramps or adaptations on the sidewalks near their homes, or in the places that they frequent a lot, but they really need to be able to access all of the little pathways if they are to be able to get around and about.

Today, we find ourselves in exactly the same situation with regard to the area of computers and information systems. Very rapidly, our society is moving toward electronic assisted everything. In the process, electronic pathways are being laid throughout our society, pathways which could tremendously increase the functional mobility and capabilities of individuals with physical and sensory disabilities. All of these electronic information pathways will be of little use, however, if unrestricted access is not available. Patching one or two access points is not sufficient, in the same manner that providing curb ramps or curb cut for some of the sidewalks is not sufficient.

I guess my message to you today is, let's not wait until all of the sidewalks have been laid and the curbs poured before we begin talking about curb cuts. It's incredibly expensive to go back and tear everything back up to install the curb cuts later. Let's identify the problem and move now so that we can pour the curb cut (provide unrestricted transparent access) while we are laying these electronic pathways.

It is certainly a bright, shiny and dynamic field. The potentials are enormous. But as it races ahead—and continues to evolve—it will be a continuing challenge to make sure that we maintain open channels of access—unlimited unhandicapped access—to these systems and all of their software. This applies not just to computers, but to the information systems they are going to generate. As we go through our society developing and creating these wonderful computer systems and information highways, let's make sure we don't forget to build the means to access them at the same time.

For More Information

The Bulletin of Science and Technology for the Handicapped
American Association for the Advancement of Science
1515 Massachusetts Avenue
Washington, DC 20005

Closing the Gap Newsletter on computers and handicapped individuals
Budd Hagen, Editor
Route, 2, Box 39
Henderson, Minnesota 56004

Communication Outlook
Artificial Language Laboratory
Michigan State University
East Lansing, Michigan 48824

COPH Bulletin
Congress on the Physically Handicapped
101 Lincoln Park Blvd.
Rockford, Illinois 61102

International Software/Hardware Registry
Trace Research and Development Center
314 Waisman Center
1500 Highland Avenue
Madison, Wisconsin 53706

Link and Go
(includes COPH Bulletin, above)
2030 Irving Park Road
Chicago, Illinois 60618

The Person with Disability and the Benefits of the Microcomputer Revolution

T. Shworles

Committee on Personal Computers
and the Handicapped (COPH-2)

Evanston, Illinois

After 2½ days of "braindrain," what remains to be said about personal computers and people with disability to the near 500 of you this early morning hour? Up to this moment, you all have partaken of more than 60 papers and presentations, five 2½ hour mini-workshops, two keynote addresses, a large sized room full of exhibitors, and hours of hallway and mealtime information exchanges. What in addition can be said of any importance about personal computers and people with disability? The answer is, a whole lot more! In only these few days, it is unusual to think that we have learned enough of what needs to be known in order to properly understand and use the technologies of the microcomputer revolution—the revolution that has impacts considered to be more far reaching and faster than the effects of the Industrial Revolution (Evans, 1969; Marsh, 1983). But in order to avoid the disabling anxieties of Toffler's (1974) information shock load, we need to acknowledge that our cups are filled for now. It is proper therefore to break camp, to scatter to our works on behalf of people with disability, to evaluate, and then to learn again.

But, it is earnestly recommended that when we take of the filled cup, we flavor it first with perspectives, values, and feelings of consumers. Knowledge and information earned during the days of this conference will be better understood and therefore best utilized when it is all mutually judged by knowledgeable and experienced people with disability. If this is not done, needless and wasteful cultural gaps will emerge. The benefits of the personal computer revolution will remain unavailable to people with disability unless new ways are invented for influding them in the processes of (a) finding out what is new in the area of information technology, (b) judging the usefulness of what is learned, and of (c) determining what additional research and development should be done. The following information, examples, and arguments are offered on behalf of the premise that people with disability must not be approached exclusively as the problem-to-be-solved but instead must be included as the-problem-solvers when it comes to utilizing personal computer technologies.

I accepted to be here as a principle commentator only because the conference planners agreed for me to speak as a consumer representative who would follow the expression of ideas by a person notably representing the federal involvement in rehabilitation engineering as it applies to computer technology and by a person qualified to represent the views of the rehabilitation engineering provider sector. A consumer representative is defined by the Illinois Congress of Organizations of the Physically Handicapped as a person with lifelong experience in successfully coping with disability, who is matured, is knowledgeable regarding the subject at hand, and has been chosen by a constituency to represent their views. Although it is not common, it is yet not a precedent for consumer representatives to be actively involved in technology oriented conferences and meetings. A useful example is the Fourth Annual Conference of the Rehabiliation Engineering Society of North America (RESNA) during which consumer representatives served on the program planning committee, were appointed as fellows and presented major addresses, received discounted conference registration fees, critiqued the majority of presenters' papers at the scientific sessions, and had rent free booths on the exhibit floors (Proceedings, 1981). The impact of consumer representation on this Discovery '83 conference will not be as thorough as the effects of consumers on the RESNA conference, but as a consumer representative I have the opportunity at least to mingle ideas publicly with representatives of the federal and provider networks.

Therefore, as I come to you now, I do not present my personal credentials as a husband and father of two young boys and 52 years as a wheelchair user with almost total quadriplegia, educated in the colleges and universities, employed in both rehabilitation and mainstreamed environments as a tester and counselor, project manager and administrator, recently retired, and now "up-to-my-neck" and "over-my-head" in volunteerism. Rather, I come to you as a representative of the views of the Committee on Personal Computers and the Handicapped. This group (COPH-2), soon described below, is a subcommittee of the Illinois Congress of Organizations of the Physically Handicapped (Illinois COPH) which is an 18 year old umbrella consumer organization encompassing 25 groups and over 3,000 persons with disability (Delutri, 1982). Also, I have been asked to represent both the thinking of the Consumer Involvement Committee of RESNA and the concerns of the Micros and Disability Special Interest Group of the Chicago Area Computer Hobbyst Exchange (CACHE). Thus I am bringing to your attention not my own narrow perspectives. You are having the advantage of a measured consensus—more objective ideas, more representative of more numbers of people—thereby more worthy of earnest attention and serious consideration. And there is one more compelling reason why this conference should announce that it gave at least moderate attention to the combined concerns of consumers—this conference will be designated by rehabilitation historians as the "watermark," the event which signified that personal computer technology should no longer be considered as incidental in the rehabilitation programs of people with significant disability (at no time before this conference have so many persons with such diversity spontaneously met and thoroughly covered so many dimensions of disability and personal computers).

For only a brief moment, I wish to put on my "personal viewpoint hat" and comment on the keynote addresses of Fenderson and Vanderheiden. As director of the National Institute for Handicapped Research, Dr. Fenderson represents the Federal agency which can impact profoundly how the benefits of personal computer technology will be attained by people with disability. In his address, Fenderson pointed the broad scene and convincingly portrayed the reality that information and computer technology developments are impacting our culture in ways as profound as those influences brought by the Industrial Revolution. I wish to thank Dr. Henderson for his final exhortation and advice to include people with disability in the process which affect how they will ultimately benefit from computer technology. I only wish that Dr. Henderson from his advantaged viewpoint had given us information as to how NIHR practices consumer involvement and how knowledgeable consumer representatives can influence industry and the rehabilitation provider network. Dr. Vanderheiden as a rehabiliation engineer with established credibility, also is to be commended. He introduced a note of realism with concern that unsolvable problems may be involved in making some of the fast-changing personal computer technology accessible to people with disability. But the virtue of Vanderheiden's presentation is his optimism; if we are to slay dragons, we need hope, and Vanderheiden gives hope that for those who are willing to submit to a time of struggle, there are inventable alternatives.

And now to turn more specifically to representative views of consumers. We affirm that what has been seen the past two days is wondrous, relevant, and will benefit persons of the entire age range) with severe impairments. We have witnessed how personal computers have made independence achievable, dollars earnable, education feasible, communication possible, and environmental control attainable (Byte, 1982). We implore that efforts like this conference be replicated ten-fold to inform to train, to speed-along and dissemminate useful knowledge. We advocate that dollars and other resources be readily committed to implement what is known and to research what needs to be researched. We understand that it has required from the rehabilitation network much vision, innovation, petitioning, and perseverance to reach this point of that history which deals with the humane applications of computer technology. For all this we extend our kudos, our appreciation to program planners, governments, researchers, industry, clinicians and other service providers.

But in spite of the unquestionable possibilities of personal computer technologies and the measurable achievements on behalf of people with disability utilizing these technologies, there are questions, imperatives, that must be raised—they are the type of questions and issues that consumers would address. And until these questions are asked publicly, there is a kind of existential uneasiness which only consumers can feel. To reiterate, almost anyone notable agrees that people with disabilities are benefitting and will continue to benefit from information era computer technology, but how much benefit will accrue? Will the benefits be substantial or only token? How many people with disability will benefit—great numbers or only small proportions compared to the population of people without disability who will benefit? How fast will the benefits come? At what expense and at whose expense will they occur? Will they come without exploitation? What level of urgency exists and in what sectors of our society is there motivation strong enough to insure that immediate and useful benefits will come? Thoughtful reflection leads consumer representatives to feel skeptical that the answers to these questions could be positive or upbeat. We feel that a cultural gap may soon come about, that large numbers of persons with disability will find themselves in the truly handicapped and disadvantaged computer illiterate caste (Compaine, 1983).

There are enough trends evident to substantiate this pessimistic view. NIHR, among our best allies, already considered to be two-thirds under-funded, grants only proportionally small amounts of dollars to this area of concern. And among the approximate 14 rehabilitation engineering centers of NIHR not one allocates the majority of its resources to the issue of personal computers and disability. In addition, there are only a few rehabilitation engineers knowledgeable about this subject matter, and in such small numbers they are unprepared to handle the explosive upcoming demand for their expertise. There is an anticreative and counterproductive federal policy which regulates that only one recipient of rehabilitation engineering movies may undertake computer and disability related research and development. How is it to the immediate and profound advantage of consumers to promote the idea that only a few practioners from one small part of this vast and talented country will have all the answers (or approaches) to the complex and interdigitating issues involved in personal computer technology? The rehabilitation facilities which are not engineering oriented but which have useful computer related knowledge are not only few but are inaccessible, i.e., they are oftentimes too far from home, too expensive, too medically oriented, or too unknown to many people with disabilities. And, as you all know, much of the rehabilitation provider network is too underinformed to be of much assistance to inquiring consumers. Finally, it is suspected that some (hopefully not many) sectors of the rehabilitation network take on not the finest of American culture, are self-serving, often find themselves competing with each other for limited dollars and resources, "hold their cards against their chests," and as a result do not readily share their splendid methodologies, activities, and results.

In the private non-federal, non-rehabilitation area we do not see national studies, institutes, foundation sponsored blue-ribbon panels acknowledging the profundity of the computer technology revolution and outlining national efforts so that people with disability do not get caught in a cultural gap. Neither do we witness intra-industry collaboration of the kind that assures that people with disability will have access to most of its products and services.

There are exceptions, of course, to what has just been said. Some have already been referred to, and this '83 Discovery Conference is a good one to have at hand. There have been other recent computer related workshops, federal technology assessment report, as well as various publications.

Reports on the incidence and prevalence of disability in the U.S. cannot agree on a common number; but they do agree that there will not be hundreds, but that there will be thousands of U.S. citizens survive trauma and disease. These citizens with lifetime disabilities constitute a large segment of the U.S. population who could benefit from access to personal computers. They vary markedly in the types and functional consequences of disability (7,500 surviveable spinal cord injured persons per year, 750,000 persons with cerebral palsy and 25,000 more born each year, five million people have arthritis and 200,000 have muscular dystrophy). The vast numbers of people with disability, the extreme variability from one disability condition to another, and the complexity and fast-changing nature of the computer industry all when viewed together reminds us that the national challenge of making computers accessible is only beginning to be done and could fall far short of being a job well-done.

A sense of urgency separates the consumer from the persons responsible for the good works listed in this presentation. For the greater part, these people are sincere, intelligent, and persevering. Nevertheless, the rehabilitation provider, researcher, and practioner eventually leave their place of work, return to home (periodically with a paycheck), and rightly pursue another life not filled with concern for personal computers in the lives of people with disability. But we people with disability cannot turn-off—we cannot be distracted from the possibilities of independence and productivity inherent in the promises of personal computer technology. We see our days of technological inequality being ticked-off. We cannot blind ourselves to the opportunities being offered to every other person. The hype for and acceptance of the home computer abounds all around us. Ten years ago we could discover the post-industrial, communication oriented, and telecommunications dependent society only by a trip to the dusty shelves of a library (Bell, 1973). Today, these ideas and notions jump at us from everywhere. We turn on our tvs and NOVA tells us about Logo, Donohue presents a group discussing the personal computer in the classroom, the creator of Dennis the Menace describes his forthcoming book on computers for children, and the public broadcasting stations airs a series of eleven half-hour shows on the development and impact of the personal computer. Simultaneously, the all-news radio station carries an eight-day five minute special about personal computers. Not only does the daily newspaper present ample stories on the marketing and purchasing of personal computers, but in its future oriented "Tomorrow Section" (a sizeable section appearing weekly) a feature appears with colored diagrams and it details how to physically lay out a home personal computer work station. And in this same year, the mails bring us advertisements from a personal computer book-of-the-month club, a notice from the community library regarding a free evening lecture on the selection and purchase of personal computers, an announcement from the originators of Sesame Street that it now has a monthly computer magazine for children, and a notice from the continuing education department of the nearby private university offerings of six courses dealing with the purchase, care, and use of personal computers. In the same ten-month span a visit to the corner newstand on to the neighborhood drug store magazine rack easily brings enticing titles to our vision (articles appearing in popular non-technical magazines): "Powerful Portables-Best Buy in a Personal Computer," "Calling All Computers-A Guide for Shoppers," "Now: World's First $100 Computer," "Your Most Crucial Computer Purchase," and "The New, Incredible, Hand-Held Computers." As we push deeper into the magazine rack towards the more specialized monthlys we uncover "The Dawn of the Portable Computer," "Home Work In the Electronic Cottage," "A Computer In Every Home," and two more magazines with issues devoted to disability and computers. We are sufficiently turned-on although we have not even rummaged through the many computer monthlys. And finally, the all-time favorite high-quality subscription magazine, the National Geographic, beautifully lays it all out for us to carefully ponder. As we turn away from the newstand magazine selections, we glance through the window of the nationally franchised bookstore and see computer coloring books and R2-D2 and 3-CPO on the cover of the book which contains their answers to question about computers! And those willing to admit that they pick-up the National Enquirer at the food check-out counter, will tell us that this tabloid tried to inform their readership also how best to buy a personal computer. The message is clear to us—personal computer technology and its impacts are not idiosyncratic phenomena. The personal computer in the home, at work, and during education, are established cultural realities. We people with disability ordinarily learn about improvements and advances in hearing and visual aids, mobility systems, communication and speech devices, and prosthetics and orthotics by way of the mechanics of the rehabilitation network. This is not so with personal computer technology which, as you can witness, we learn about from many non-rehabilitation sources and which we are beginning to see as potentially very basic to our sense of equality and independence. Being "beseiged on all fronts," we need to respond, to reconcile what this new technology means to us, and to decide what to do before opportunity is lost. And we feel urgent—an urgency not reflected in most other programs and efforts designed to bring the benefits of computer technology to people with disability.

We have acknowledged so far in this presentation that people with disability are benefitting from personal computer technology. We have also declared that these benefits may not be substantial and that widespread inequality is just around the corner. The reasons for this sad possibility have been established. It is at this point that we want to present more explanation as to how the concept of "consumer as problem-solver" can bring some hope to a pessimistic situation.

Almost 15 years ago, John McHale in his The Future of the Future (1969) pointed out that "the 'hardware' to solve many of our physical problems is available for use. The 'software,' or social thinking, through which we may apply our developed capacities in humanely desirable terms, is less than adequate...our highest futures priority lies with social invention—the re-evaluation and re-design of our social forms and possibilities. We need to experiment with innovative social organization with new modes of individual and cooperative relationships."

I can offer you this morning one relatively small, but significant, example of McHale's new form of social relationships which is making more personal computer technology accessible to more people with disability—the Committee on Personal Computers and the Handicapped, COPH-2.

COPH-2 has a consumer origin (it emerged as an activity of the Education Committee of Illinois COPH). It still functions within the operating structure of Illinois COPH and is guided by its consumer character. It is not a "social group of handicapped people" segregated from the mainstream. It truly is unique in the sense of McHale's requirement for innovative social organizations to solve the problem of making technological advances humanely utilizable. Consumers, industry representatives, rehabilitation providers, and advocates are members of COPH-2 and they innovatively interact as peers. There are no referrals by physicians, no comprehensive evaluations by teams, no costly charges by institutions, no hard sells by computer representatives, and no rejections on the grounds of infeasibility as COPH-2 members readily share ideas, leads, information, and assistance. This new form of activity makes more rapid the utilization of information bearing on computer use by people with disability and tends to forestall the culture gap resulting from the computerization of society.

In 1981, three adults with disability (wheelchair users also with upper extremity impairment), a graduate student in the Northwestern University Rehabilitation Engineering Program, and a counselor from the Illinois Department of Rehabilitation Services (all members of Illinois COPH) together conceived of the need for COPH-2. These founders were commonly aware of the under-utilization of the results of research and demonstration projects, the inadequate exchange of information among consumers, the threatening cultural gap, the fact that useful ideas and devices were emerging from other than the rehabilitation network, and the need for a consumer-based group to advocate and to try to influence the forces which determine how much people with disability will benefit from computer technology. COPH-2 was organized (utilizing the structures, philosophical stance, and other resources of Illinois COPH) to address these issues. The timelines and importance of these issues is evidenced by the fact that with no membership recruitment campaign COPH-2 has nevertheless attracted over 300 people from more than 40 states. These members have available to them (for $8.00 a year U.S. and $10 foreign) a variety of services: a four times per year publication, hands-on-experience meetings, low-cost personal computer adaptations, free technical assistance, a process for networking and connecting-up with other members, no-charge computer loans, and a library. These services emerged at first unevenly and were awkwardly dispensed. Today, design and coordination are practiced as more than a few volunteers with significantly varying background work from residences scattered throughout the Chicago area. They share the time and resources of their private lives, interact as peers, and in so doing hope that their innovative behavior will become widespread and normal.

Since its beginning and up through September 1983, COPH-2 has conducted 14 day-long meetings at which attendees exchange information, browse through the library ("Resource boxes"), put hands on personal computers, witness demonstrations, and return or borrow COPH-2 computers. Later in the day more focused two-hour programs are held. Some of the presentations (such as one on young children and another on blindness) generate considerable library materials, special issues of the COPH-2 publication, and the formation of on-going subgroups. Meeting attendance varies from 14 to 42 persons (annual meetings bring 47 to 297 people). Although planned and conducted by COPH-2 members, the meetings are hosted free in educational settings (colleges, universities, and technical institutes) by the Micros and Disability special interest group of Chicagoland's largest computer user group, the Chicago Area Computer Hobbyst Exchange (CACHE). In this mainstreamed setting, COPH-2 members explore the activities of 21 other CACHE special interest groups. They talk with vendors, attend main CACHE meetings, and interact with some of the crowd of usually over 200 people. As a result of these interactions, CACHE members have given technical assistance, have found bargain-priced hardware, and have built adaptations for COPH-2 members. By joining CACHE, running for office, writing for the CACHE newsletter, and otherwise relating to CACHE members and activities, COPH-2 members are demonstrating how to mutually accelerate the process of making computer technology accessible to people with disability.

The COPH-2 annual event held at Chicago's Museum of Science and Industry is an additional example of a public meeting which provides a comfortable setting for people with disability to begin or reclarify the process of determining what personal computer configurations can work for them. Nine COPH-2 members with differing disabilities and varying home-based personal computer systems welcomed persons with disability from the public to interact with them and to understand how PC's are used by them as communication aids, educational and vocational tools, word processors, remote information transmission devices, environmental controllers, and as instruments for pursuing game and hobby interests. The all day meeting of this 1983 July summer was characterized by a new feature—interorganizational co-operation. Four groups lent their resources and co-sponsored the large public event: Illinois COPH, the Northwestern University Rehabilitation Engineering Program, CACHE, and the Museum of Science and Industry. This kind of co-operation is necessary if consumers are to have speedier and more direct access to personal computer technology.

COPH-2's publications, Link-and-Go, began as a two page newsletter and developed to a 20 plus page "magazine" appearing quarterly. It is not slick but the need for the information it contains has motivated numerous professionals and organizations to join COPH-2. Seven regular issues (plus two special issues for the COPH Bulletin, the national publication of Illinois COPH) have produced: updates on the contents of COPH-2's library, letters to and answers from COPH-2's technical assistance group, reports on meetings, newly available software and hardware, advocacy issues, and special themes (young people and computers and computer aids for persons with blindness). The most recent issue contains, in addition to most of the above, descriptions by people with disability of their home-based personal computer systems (why they chose them, what they consist of, how they are used), an outline on how to unfold the process of choosing the "right" PC with disability in mind, a li[illegible] of COPH-2 library materials dealing with personal computer aids for people with blindness (incidentally, Link-and-Go is available on audio-tape for members with visual imp[illegible]irments), a history of how consumers developed personal computer keyguards to meet their needs and at a price they want to pay, position papers regarding consumer involvement in development of technology for people with disability, and there are photos and more. A review of Link-and-Go's evaluation so far leaves no doubt that consumer groups can generate access to timely information.

Before leaving the topic of information, it should be repeated that information generated on behalf of people with impairments often reaches them as the last person in life. Conferences, workshops, institutes seldom see consumer representatives invited to be among the first-in-line to early view new information generated, after all, for their benefit. The same is true for federally-funded "national bases". To consumer groups they are costly, mostly unknown, and because of the routes required to use them they generally are inaccessible. It would be a noteworthy event if the government sponsors of various disability related "data banks" saw to it that consumer groups have direct, immediate, and low cost (or no cost) access to these systems. Disappointment is not the case with Closing the Gap, a new publication devoted exclusively to disability and computers. We like this privately funded source of information because it has a sense of urgency, is easily accessible, low cost, is on target, and is consumer sensitive.

Another feature of COPH-2 is its unique membership directory, Enter-Act, in which important contact information about members is made available to all members (with permission). Although it is time consuming to maintain and produce (the May 1983 version was 15 pages long) and costly to mail, COPH-2 finds it necessary to do this in order to set up the beginnings of a national network useful to people with disability.

The need to interact with a personal computer in the home and before purchase was expressed not only by COPH-2 members, but also by consumers and others at a needs assessment workshop sponsored by the American Association for the Advancement of Science. Prior to the AAAS meeting and in the spring of 1982, Illinois COPH purchased for COPH-2 a nearly new TRS-80, Model I, Level 2 personal computer. Two other identical systems were donated (with the advantage of a tax deduction) by members, and twenty members with differing backgrounds and for different reasons took these computers home (at no cost to them) for one to two month periods. A subcommittee coordinates the maintenance, repair (and raising of money for repairs and replacement of parts), transfer, and recordkeeping involved in this computer loan service. Experience has shown not only the need for more COPH-2 table-top personal computers, but changes have come swift and bring the need for including the smaller, portable computers in the computer loan activity.

A COPH-2 source for technical information, TAG (the technical assistance group), was formed in the fall of 1982. TAG answers question about computer technology and disability by telephone, letter, or in person. Questions and answers with general relevancy have been appearing in the column "Linking Up" of the past three issues of Link-and-Go. The advantage of this process is obvious—efficient sharing of information with larger numbers of people.

It became apparent that some COPH-2 members needed keyguards in order to successfully operate personal computer keyboards. Keyguards (stencil-like plates layed over keyboards) prevent inadvertent hitting of keys. In the original days of COPH-2, keyguards for personal computers were not available as ready-made, off-the-shelf items. In those instances where personal computer keyguards were obtainable, they were custom-made, and thus long in coming, and when they were not gifts, they were expensive ($200 plus). COPH-2 became involved in the testing, redesign, manufacturing, and sale of keyguards. A total of 40 keyguards have been manufactured to fit the TRS-80, Models 1 and 3, and the Apple 2+. Twenty-eight have been purchased by COPH-2 members. The recent issue of Link-and-Go contains an interesting narrative that gives all the background of thought, work, and outside help that went into the keyguard development.

Link-and-Go, TAG, members, and friends have generated a large amount of material for another COPH-2 service, the library. It has grown from a few items to over 500 references on computers and disability, and COPH-2 has the actual source documents for ⅓ of these references. All documents are available on a loan-free basis for members. Where permission has been granted to duplicate materials, members are given these on request for their permanent records for only the cost of duplication. The library is used well. In the first three months of 1983, over 160 items were distributed nationally. A library subcommittee is reviewing now to make the library more efficiently available to more members.

COPH-2 is advocacy oriented also. It wants to directly influence the processes which determine how much people with disability benefit from the outcomes of computer projects conducted on their behalf. COPH-2 feels obligated to share its views and resources when opportunity presents itself for enhancing the outcomes of computer related projects. Such was the case with the "First National Computer Search". Numerous useful ideas and products for people with disabilities appeared to come out of "the National Search". But COPH-2 learned that much of the follow-up contact information for each product and idea was unavailable to public including people with disabilities.

COPH-2 petitioned project officers for amelioration of this frustrating situation. Subsequently, all project reports now contain amendments which make it considerably easier for persons with disability and others to contact authors of original and useful ideas. Advocacy does not necessarily mean confrontation. It means promoting common agreement among consumers and others. It also means promoting and working together on projects with mutually agreeable goals. In this regard, COPH-2 has formally embarked on projects with the Illinois Children's School and Rehabilitation Center and the Trace Center at Madison in Wisconsin.

In summary, consumer representatives acknowledge that people with disability are benefiting from personal computer technology. But there is skepticism—over the long haul, the benefits may be less than substantial. And there is concern—concern that people with disability are on the verge of experiencing a culture gap. Many may find themselves among the have nots without a share of the personal computer revolution. New social forms are required in order to offset the imminent culture gap. It is recommended that consumers and consumer representatives become a part of the problem-solving process.

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Part Two

Conference Papers

Computers: A Touchy Topic for the Handicapped and Nonhandicapped

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Instructional Computer Equipment

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Abstract

Computerized instruction has the potential to utilize selective attention as a positive tool in the educational process of both handicapped and nonhandicapped learners. Industrial Computer Equipment (I.C.E.) has developed a computerized system which places curriculum first, then software and hardware last. The total presentation of instruction is possible via a computerized teaching machine which has the capacity to provide instruction via a touch sensitive screen, video and voice synthesizer. Regardless of the exceptionality area, most anyone can operate the I.C.E. system. By breaking down discriminatory barriers, everyone has a "reason to be" in the computer world with I.C.E.'s "user friendly" computer.

In the classroom of 1983 the gifted child is learning to write a computer program, another child works to become computer literate. Through the efforts of Instructional Computer Equipment Corporation, the special education child, as well as the nonhandicapped, will benefit from computer technology.

The advent of the computer has contributed to the interest in mental processes in today's field of cognitive psychology. The convenience afforded by computer assisted management of experimental data analysis and software instructional programs, a cybernetic approach to information processing has stimulated the minds of cognitive psychologists, Diversity of thoughts among psychologists and educators has created various theoretical models and approaches to the area of cognition and mental processing. Attention, specifically selective attention, has been an area of concentration for researchers and interested writers of cognitive processes. In the recent years investigative efforts in the area of selective attention and the handicapped have been conducted.

The Zeaman-House (1963) model supports the idea that the greater the attention to one dimension causes an inverse relationship with the decreasing of other dimensions observed. In distinguishing between differences in abilities of normal and retarded children, the Zeaman-House (1963) model suggests the importance of the probability of attending to relevant cues rather than in the rate in learning appropriate attentional and choice responses (Medin, 1976).

Whereas Zeaman et al. (1963), considers the subject to be locked into learning about one dimension, Lovejoy's (1968) two-discrimination choice theory, based on simultaneous visual discrimination data of rats, considers the selective mechanisms allow flexibility to respond selectively to one dimension or another and learn selectively about one dimension or another.

Mackintosh (1975) discusses the theories, such as Zeaman et al. (1963) and Lovejoy (1968), presenting selective attention as being "two stage" or "chaining" models: learning about a stimulus depends on attending to that stimulus. Mackintosh (1975) suggests experiences within the environment, i.e., reinforcement, correlates with the subject switching in analyzers as well as learning stimulus-response associations. Subject learns to attend to and ignore relevant and irrelevant stimuli; increasing attention to one stimulus is accompanied by a decrease in others. "The first assumption is used to explain the phenomena of acquired distinctiveness and dimensional transfer, the second those of overshadowing and blocking" (Mackintosh, 1975, p. 276).

Hagen (1967), Maccoby & Hagen (1965) all investigated the question of age differences and development of selective attention. They consistently found between the ages of ten and thirteen years of age marked improvement is shown by children in their ability to select what is relevant from what is irrelevant. Based on Broadbent's (1958) filter theory, Hagen's (1967) experiment concludes the younger children process more information than is necessary to perform the central task adequately because of some deficiency in selective "filtering" ability. Older children are considered to be more efficient than the younger ones in selective attention strategies (Druker & Hagen 1969).

In reference to developmental lags and learning problems, Schworm (1979) hypothesized that by teaching children with these difficulties the strategies of what and where to attend in words would improve decoding abilities. The study revealed a person's ability to decode unfamiliar words may be related to an increase in usable decoding strategies. Many inadequate readers may not attend selectively to the important stimulus properties needed for decoding words.

In another study of poor readers, it was found by Pelham and Ross (1977) that a delay of 2 to 4 years existed in selective attention with these students. With lack of maturity in selective attention which did not begin to develop until fifth grade, the learning disabled students would have fallen academically behind the other children in a normal school setting.

Mercer (1979) states with regard to children with deficits in attention, "Specifically, they are unable to select relevant stimulus dimensions (i.e., they have poor selective attention)" (p. 46). Ross (1976) believes most learning disabled children possess a cognitive problem which affects their maintaining selective attention.

From Keyboard to Touch Sensitive

Though there are numerous advantages to computerized instruction, the design of both hardware and software could be questioned with regard to meeting the various cognitive processing needs and cognitive styles. Knowledge in the area of cognitive psychology coupled with the rapid advancements in simulated information processing via computer learning may, at this point in ti[illegible] in direct conflict in thought and practice. With the knowledge acquired through a collection of literature in the area of selective attention, the remarks of those such as Bennett (1976), who has studied the relationship between teaching style and student achievement may be challenged: regardless of teaching style students who spent more time studying a subject had higher achievement in the subject. The research being reviewed seems to indicate there is something more to instruction than the amount of time spent. An individual's ability to perceive, attend, think, remember, and know needs to be addressed. All of these areas imply an active role on the part of the learner in processing information. Computers offer the individual the "what" is to be processed through repeated tasks and continuous opportunities for stimulus-response associations and reinforcements. Such controlled activities may limit the active participations of the learner engaged in processing the information. Attending to the task, specifically selective attention, may also be difficult for those individuals whose mental processes cannot make the necessary distinctions and integrations of relevant information (attending to the computer keyboard instead of the screen of programmed information) required to complete the stimulus-response associations. This may be due to age or mental capacity. Ross (1976) indicates that as the child gets older and nears adolescence, the capacity to focus on a limited number of stimuli (selective attention), required by the situation, seems to approach a mature level. Given expected individual differences in developmental rates, some children may be slower in attainment of such selective attention.

Can computers provide the "how" component of individualizing instructional programs which will accommodate the learner's unique cognitive processing needs? There appears to be, as indicated by the research presently being reviewed, a relationship between the age or maturity of the learner and the degree of selective attention.

Beyond the area of selective attention are other dimensions which are as important to the learner's ability and ease in computer usage: manual dexterity; arrangement of the letters on the keyboard; usage of all capitals on the keyboard; confusion with typing skills; inability to type, age, maturity, and emotional ability required to type; mental capacity to perform the act of typing; physical disability restricting the use of the keyboard.

The developmentally handicapped may find difficulty using traditional computer keyboards. For this population special input or output devices may be warranted instead of the standard terminal. The physically handicapped are unable to manipulate a normal keyboard and for the partially sighted the standard-size characters are difficult to see (Brebner, Hallworth, and Brown, 1981).

Vanderheiden (1981) is an advocate of using microcomputers for rehabilitation but cautions the need for modifications in the use with the handicapped to remove constraints in the areas of process and control aids. The challenge of the new technology is to breakdown the discriminatory barriers to allow everyone to have a "reason to be" in the computer world.

The father of behavioral psychology, B.F. Skinner (1983), recently told the 91st annual American Psychological Convention participants, "computers allow each individual to go at his or her own pace. A good computer program can interest students in almost anything". Placing more computers into the classroom will aid in straightening out the nations's schools. Skinner (1983) considers "an algebra program can be as motivating as Pac-Man if the student is successful in it...That's what educators don't understand and won't accept". Learning can be enhanced if the computer can keep a student interested.

Though Skinner advocates the usage of computers to save the schools, "A computer system can't dominate or save a school any more than a new plumbing system can" has been stated by Bourque (1982). Depending on how it is used, the computer will be used to educate or not educate. A few concerns for software should be evaluated as to: Is there a sound teaching method? Will teachers have to write programs designed to certain needs? Who teaches the teacher to use the program? The updating of software occurs how often? (Bourque, 1982).

Once limited to use as drill, repetition, or game, the computer is being challenged by I.C.E. Corporation to meet the individual learning styles of both regular and special education students. I.C.E. Corporation has developed computer software and hardware peripherals which, when combined, facilitate learning through individualized programs utilizing a child's unique learning style, needs, and learning strengths.

I.C.E. Corporation stresses curriculum to a greater degree than computer hardware in its evolvement of computer assisted instruction and computer managed instruction. The developers feel the importance of maximizing curricular capabilities has been overlooked because of mechanical limitations of the computer. While other companies are selecting hardware for writing courseware (instructional software), I.C.E. has reversed the process in first creating instructional curriculum which adapts to a child's unique learning needs and styles, operationally defining the curriculum for courseware, then modifying existing hardware to accommodate the instructional format.

I.C.E. developers have found computer-assisted instruction can go far beyond drill, repetition, or simply tutorial reinforcement. The conversion of curriculum through the I.C.E. system to courseware via the touch-sensitive and audio computer provides a teaching machine rather than mere drill and repetition. The computer allows for alterations for various individual student performances as established through criterion-reference assessments and baseline data. Computer managed instruction will also be available for student record keeping and management control.

The I.C.E. system offers the learner the opportunity to selectively attend to the instructional material by providing for individual processing of information which adjusts to individual learning styles of varying degrees of ability areas and levels of sequential skills. Inability to utilize, overall difficulty, or confusion which may occur in the learner's usage of a computer keyboard will be removed and simplified by merely touching the screen for an appropriate response. Should paper/pencil follow-up or additional practice be warranted, the optional usage of a printer will be made available as a peripheral hook-up.

I.C.E.'s computerized system is supported by psychological and educational research. The curriculum is based on fourteen years of applied research within various educational settings: public and private, group and individual instruction, graded and nongraded, handicapped and nonhandicapped. The curriculum has been researched in preschools, elementary and secondary schools, and at the university level. Based on documented research, the curriculum content stresses the need to meet the learner's individualized learning needs through an approach that includes remedial, developmental, and compensational techniques. The student's abilities, strengths, and weaknesses, skill levels, behavioral and motivational needs are given consideration by I.C.E., as well as convenience of usage by both student and teacher. One of the major goals of I.C.E. is to allow ease in interfacing both student and computer and/or teacher and computer. A teaching machine is now "user friendly".

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But It Will Be Obsolete Tomorrow: Evaluating Ultimate Needs of Users vs. The Capabilities of Devices

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Abstract

Recent developments in high technology, particularly in the availability and flexibility of small computers, offer disabled individuals new hopes in achieving independence. The approach commonly taken in these technologies is to purchase a device for an individual or group of individuals based on general goals or needs, then work out the specific uses. This approach is often inadequate resulting in misused, underused and idle devices. The capabilities of technology is changing so rapidly that focussing on specific devices is no longer adequate. There are now a multitude of devices with varied capabilities. The focus therefore must be on the user, the user's goals, and the user's environments. Selection of the technological device should be one of the final steps in the process. The systems development approach, a method used by human factors engineers and systems psychologists, provides a framework for designing systems before the purchase is made, based on user needs rather than available equipment. The adaptation of the systems analysis approach as presented in this paper is intended for small systems with the user being a disabled individual.

Glossary of Terms

equipment system-a group of components a-at least some of which are pieces of equipment-designed to work together for some common purpose (Chapanis, 1965, p.8).

function-a general means or action by which the system fulfills its requirements (DeGreene, 1970a, p.21).

goal (mission)-a statement of what the system is to do to solve a given problem and when and where-an expression of purposes and objectives (DeGreene, 1970a, p.21).

human factors engineering-ways of designing machines, operations, and work environments so that they match capacities and limitations (Chapanis, 1965, p.8).

input-actions required to initiate a function (Meister, 1971, p.60).

man-machine system-an equipment system in which at least one of the components is a human being who interacts with or intervenes in the operation of the machine components of the system from time to time (Chapanis, 1965, p.16).

output-actions resulting from performance of a function (Meister, 1971, p.60).

requirement-a statement of an obligation the system must fulfill to effect the mission (DeGreene, 1970a, p.21).

task-a composite of related (discriminatory-decision-motor) activities performed by an individual, and directed toward accomplishing a specific amount of work within a specific work context (DeGreene, 1970a, p.21).

Recent developments and increased availability of high technology have changed many aspects of our society and will continue to do so as the technology impacts the work and life style of almost everyone. The lives of handicapped individuals will also be impacted by increasing their ability to live and perform more independently.

Specifically, recent developments in the area of micro and mini computers have offered viable alternatives for handicapped individuals, including the nonspeaking or speech impaired and the motorically handicapped, to communicate with people and control their environment as do their nonhandicapped peers. The available technology, however, is not always affordable, especially when individual needs are extremely specific and do not generate "shelf available" demand. Microcomputers and related technologies are often made with the general user in mind. Consequently the potential of these devices to be easily adapted remains out of reach for most handicapped users.

Disabled individuals may not have to wait for added demand or a significant drop in costs of new developments in the technology, if a systematic approach is applied in comparing the user's abilities and goals with available technology. One such approach has been employed in developing large systems for the military and major engineering firms since the end of World War II. This approach is referred to as SYSTEMS DEVELOPMENT. This systems approach is based in the relatively new field of psychology called systems psychology.

The role of the systems developer or "human factors engineer" in this approach is to assure a match between human capabilities and limitations and the development of machines, tasks, and work environments (McCormick & Saunders, 1982, p.4). This role takes on a different meaning when the intended user is a handicapped individual. Available human factors research is seldom appropriate for applications of this nature because it reports the norms of human capabilities. Consequently, the human factors specialist for handicapped users must rely on individual assessment and analysis to assure a match that will make the system successful.

The instrument designed and presented in this paper adapts the systems development approach for use by individuals who are responsible for designing systems for handicapped users. The sole human component in the system is the handicapped individual. The instrument is designed to provide the specialist with a systematic procedure for assessing the user's capabilities and limitations and matching them with existing hardware and software for the production or assembly of a system that meets the needs of that one individual.

This systems development model differs from other models presented by human factors specialists in that it is adapted specifically for a smaller systems development project with one user. The flowchart (Figure 1) illustrates this process of systems development, adapted to small systems and handicapped users. There are five major categories through which the developer must proceed: 1) requirements analysis, 2) functions analysis, 3) task analysis, 4) interface analysis, and 5) field evaluation.

Systems Development

"The most common view of the 'system' emphasizes the equipment, minimizing the role of other system constituents." (DeGreen, 1969, p.1). This echoes a statement by Gagne that the human components of a system are often not integrated into the planning process (1962a, p.2). The users of the system must be part of the system, and their contributions to that system in terms of control, decision-making and utilization of system outputs are important variables to consider in systems design. The total effectiveness of any system must consider individual needs, rewards, expectations, and attitudes of the person interacting with the system (DeGreene, 1969, p.4).

Systems development, as described by DeGreene, is comprised of two stages, systems analysis and systems evaluation. Systems analysis is defined as "the body of techniques applied prior to or during the conceptual or planning phases of the system development . . . to obtain general as opposed to system-specific data, . . . for predicting system and human performance reliability." (1969, p.80). Gagne has a corresponding stage which he refers to as the design stage (1962, pp.3-6). The model presented here (Figure 1) expands the DeGreene and Gagne models for this first stage by breaking it into two separate stages; requirements and functions analysis. DeGreen's second stage, systems evaluation, is defined as "the body of techniques applied to the later development and assessment of a given system or its evolution" (1969, p.80). Gagne breaks this stage into two parts; development and testing (1962, pp.6-9). His development stage is further divided into two stages in Figure 1 to include a task analysis and interface analysis stage. Gagne's final stage, testing, corresponds directly to the final stage shown in Figure 1, field evaluation. The five stages or phases followed in this adapted application, the HUMAN-SD (Handicapped User's Method for Analyzing Needs-Systems Development), then are; 1) requirements analysis, 2) functions analysis, 3) task analysis, 4) interface analysis, and 5) field evaluation. They are represented by the five columns on the flowchart. (See page 23)

Most applications of the systems approach are for systems developed by major engineering firms and the military where any systems are integrated into one and a large number of personnel are usually required to interact with the system. The purpose of the systems development model presented here is to serve the developer of a small system for an individual handicapped user. This developer may be a consultant working privately or with a school district or other human services agency. Consequently, this model will reflect variables that meet the different needs of the smaller system and the individual user.

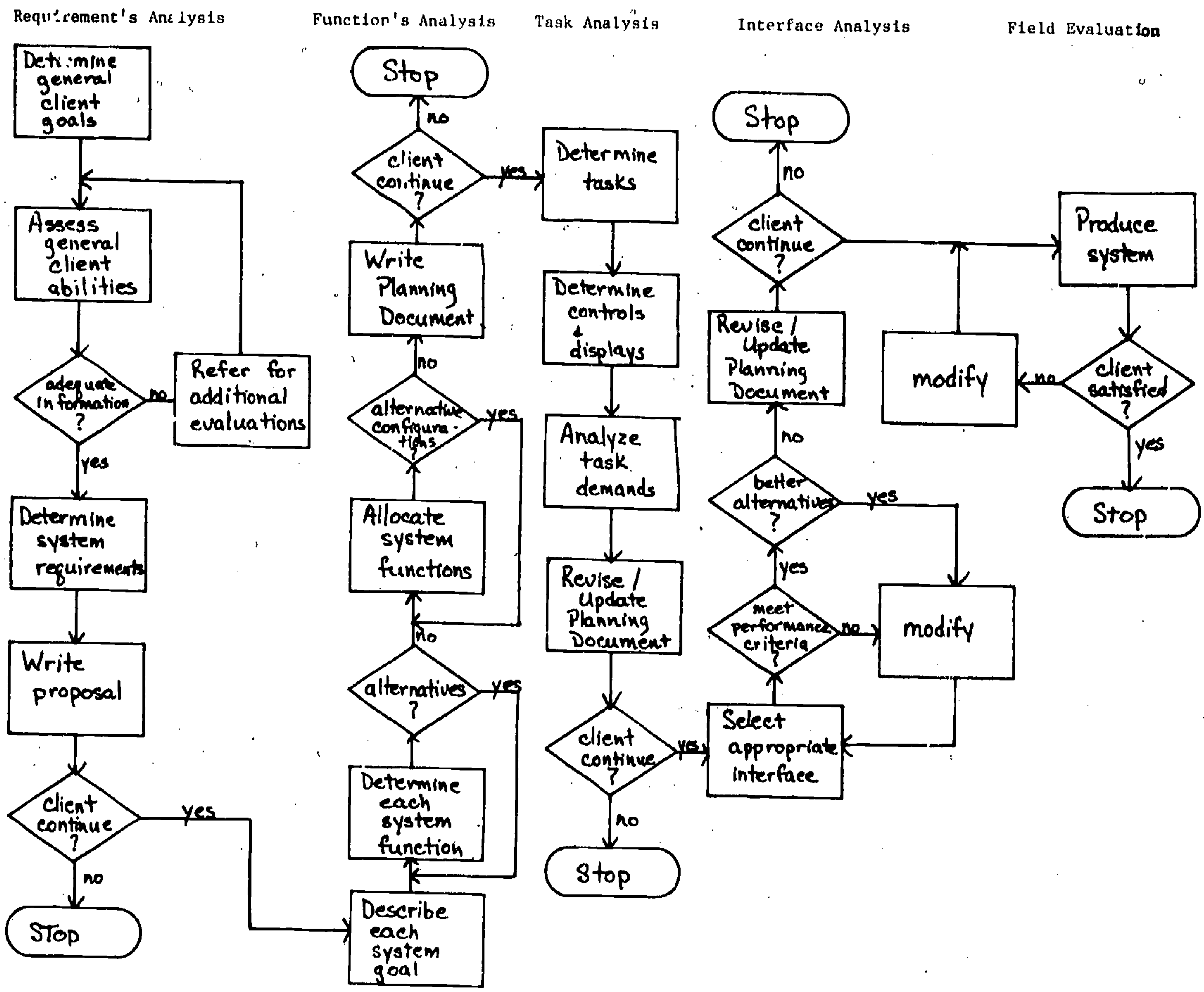

Figure 1. Handicapped user's method for analyzing needs-systems development.

Handicapped User's Method For Analyzing Needs Systems Development

The Planning Document

Each phase of the HUMAN-SD results in a planning document which must be approved by the user before moving to the next phase. The flowchart in Figure 1 shows a decision and stopping point at the end of each phase. This facilitates a consultant designing a system for an individual client. In a smaller systems market, the client may not be willing to initially commit a large sum of money. The decision steps in the model provide logical breaks for asking the client to make a commitment to the next phase of development if the cost-benefits are acceptable. Initially a proposal is written outlining the best estimates of cost and benefits for the client. If the client wishes to continue, the next phase will result in a more detailed planning document. In phase two, functions analysis, this includes the description of the overall system, its input and output requirements, description of the systems functions, its specifications, and at least one method for constructing it.

The planning document is normally a part of a systems approach (Chapanis, 1969, p.57). Due to the nature of the private client/consultant relationship in HUMAN-SD, the planning document appears more frequently. It is periodically revised to include more detail, allowing the client to make a more informed decision for continuation or termination of the planning, evaluation, and testing process of the systems development. (Figure 2)

PLANNING DOCUMENT
Revise the current planning document (more detailed).
Write a report for the client.
- Detail the costs to date.
- Estimate hardware costs.
- Estimate consultant costs up to next report period.
- Estimate consultant costs to completion.
- Estimate total costs to client.
- Estimate maintenance and operation costs of the system.

Figure 2. Planning document.

Requirements Analysis

In the first phase analyzing the basic requirements for the system, there are four major steps. The first, determination of general client goals, corresponds to steps used by DeGreene (1969, p.85), Gagne (1962b, p.369), and Meister (1971, p.59). In larger systems development projects, this information would be derived from an initial request from the consumer and information taken from previously developed systems that may be similar. In the case of the single handicapped user this step includes direct input from the client using an interview or questionnaire format. (Figure 3) The clients' goals are much individualized in this smaller system and cannot be compared to other systems development models in use.

1.1 GENERAL CLIENT GOALS
What are the clients' goals or reasons for seeking a computer system?
Which area(s) are the goals classified in? (eg. communication, home control, adaptive living skills)
What specific environments would the client like the system to function in? (eg. home, school, work)
How portable should the system be?
Will the user mind an equipment intensive system? (ie. how unobtrusive should the equipment be?)
What are the general financial limitations of the client?

Figure 3. Requirements analysis.

Step two, assessing general client abilities, is a continuation of the information gathering process. Relevant documents are consulted to provide detail (DeGreene, 1969, p.88; Meister, 1971, p.59). In this case information may include test results, IEP's and other relevant information. In addition, the client is asked to provide information and insight into his/her own performance capabilities. (Figure 4). The background information in this phase is generally more qualitative in nature to establish a basis for system performance criteria (ie. determine generally what the client can expect of the system) (DeGreene, 1969, p.88). If sufficient information is not available, the client is referred to outside evaluation specialists (ex. private practice psychologists, physical or occupational therapists, and diagnosticians) to obtain the necessary information before continuing.

1.2 ASSESS GENERAL CLIENT ABILITIES
What is the client's mode of communication? (verbal, vocal, gestural, assistive device, interpreter, none)
What pieces of information do the school/work/medical records contain? (motor, language, cognitive, sensory, etc.)
What does the client (or interpreter/parent) report on his/her self? (motor, language, cognitive, sensory, etc.)
If this information is not adequate, refer for an evaluation.

Figure 4. Requirements analysis

The general system requirements (Figure 5) are determined next. These requirements begin to identify a specific system for a specific individual. They are based on client goals and abilities and are modified by client limitations (eg. financial) if any exist, and become expressions of obligation or commitment to the client (DeGreene, 1969, p.88; Kennedy, 1962, p.22; Meister, 1971, p.59).

1.3 DETERMINE SYSTEM REQUIREMENTS
What is the mission (purpose) of the system to be developed? (eg. to control electrical appliances)
Where will the system be used? (home, school, etc.)
How will the client operate it? (hand, foot, voice, etc.)
What are the specific goals of the system? (eg. independent operation, multiple tasks, mutiple or alterable functions, etc.)
What are the performance requirements of these goals? (speed, portability, flexibility, etc.)

Figure 5. Requirements analysis.

The system requirements form the basis for the first proposal for the development of a specific system that will be designed to meet the goals of the client. (Figure 6).

This system is described in as much detail as possible at this time and at least one alternative is suggested (DeGreene, 1969, p.83). Estimations of cost and time (for consultant, equipment and training) are provided for the client (Chapanis, 1969, p.56). The client is then asked to make a decision as to whether they wish to continue with the systems development project.

1.4 WRITE PROPOSAL
Are the client's goals realistic?
Is it feasible to build this system for the client?
If yes:
Describe the potential system and at least one alternative.
Estimate cost of the system (hardware).
Estimate cost of consultant time (to next report period and total time).
Estimate total cost to client.

Figure 6. Requirements analysis.

Functions Analysis

The second phase begins after the client indicates the desire to proceed and ultimately results in the identification of both human and machine functions. (Figure 7). Initially the descriptions of the system goals are detailed to a greater degree (DeGreene, 1969b, p.83). This is followed by the determination of each system function (DeGreene, 1969b, p.88; Meister, 1971, p.60). Functions are the general means or actions that contribute to the system's ability to meet its requirements and are usually expressed in verb or participial form (DeGreene, 1969a, p.21). Examples might be monitoring light levels or controlling voice output. These functions are then sequenced according to their order of operation and examined for the effects of client abilities, environmental factors, and performance requirements on them (Meister, 1971, p.60). The third step then looks at possible alternatives and new functions that are identified and re-examines the sequence and effects of other factors before proceeding.

2.1 DESCRIBE EACH SYSTEM GOAL
For each identified goal: (eg. environmental control)
What is the system output for this goal? (eg.16 combinations of controlling appliances)
What input does the system require for this goal? (eg. reception of vocal commands)
What system capabilities are demanded by this goal? (eg. discrimination of vocal commands)
What performance requirements are demanded by this goal? (eg. acceptance of range of vocal commands)
What environmental factors potentially affect this goal? (eg. proximity of user to the microphone)
Do client limitations (financial, psychological) restrict this goal?

2.2 DETERMINE THE SYSTEM FUNCTIONS
What are the major operations (actions) of the system? (eg. voice recognition, display of available appliances, etc.)
What sequence will these operations follow? (eg. display, recognize voice, operate appliance)
Do client limitations affect the functions? (eg. financial, psychological)
Do environmental factors affect the functions? (eg. acoustics)
Do the performance requirements of the system affect the functions? (eg. portability-placement of microphone)
Were any additional functions identified in the above answers?
If yes:
Include on the list of major functions.
Where do they fit in the sequence?
What limitations, environmental factors, and/or performance requirements affect these new functions?

2.3 DESCRIBE EACH SYSTEM FUNCTION
What information does the user require for this function? (eg. knowledge of system capabilities)
Will it be directly or indirectly sensed? (eg. indirect-display relays the on/off status of each appliance)
Will it require relative or absolute discriminations? (eg. absolute-specific choices of appliances)
Will it be dynamic or static in nature? (eg. static-appliance will stay on until turned off)
What responses are required of the user for this function? (eg. vocal command for selection)
Will some equipment need activation? (eg. microphone on)
Will a discrete setting with a control have to be made? (eg. on/off switches)
Will a quantitative setting have to be made? (eg. volume setting for a stereo)
Will data entry (keyboard or switch) be necessary?
What information processing or decision-making will be required between the receiving of information and the response? (eg. selection of which appliance to activate)
Are additional functions required to achieve these inputs and outputs?
If yes, include then in section 2.2 and analyze each.
What alternatives can be designed to achieve this same function?
Complete 2.3 for each alternative.

Figure 7. Functions analysis.

Once all functions are identified, sequenced, and examined, each function must be allocated (Figure 8). This allocation can be to man, machine, or a man-machine combination. The capabilities of the handicapped user and that of machines must be compared to determine which can perform a function best (Chapanis, 1965, p.18; Kennedy, 1962, p.17; Meister, 1971, p.63). First, how a function will be implemented must be determined (eg. will communications be written or spoken) and then various possible alternative configurations can be designed. These should include variations ranging from maximum machine functions to maximum human functions (Chapanis, 1969, p.60; Meister, 1971, p.64). Each alternative must be evaluated in terms of the client's ability to perform the function and whether that performance will meet the system requirements (Meister, 1971, p.63-64). In addition to the individual functions, the performance of the sequence of functions involving man, machine, and man-machine combinations, must be evaluated in terms of system requirements. For example the individual responses of voice output and selecting an appliance are useless unless they are performed together in the proper sequence. This step also provides the opportunity to evaluate alternative configurations that are feasible for achieving the system requirements. Each should be evaluated in term of cost-effectiveness (Meister, 1971, p.68). The results of this step should be incorporated into the second planning document along with a more complete description of the system and the total estimated client costs. Once again, the client is given the opportunity to continue with the process or terminate the HUMAN-SD for whatever reason.

2.4 ALLOCATE SYSTEM FUNCTIONS
How will each function be implemented?
What will the configuration look like?
Refer to "Relative Capabilites of Man and Machines" chart. (Table 1)
What are all the probable equipment functions?
What are all the probable client functions?
Which can the client perform?
Can the client perform these well enough to meet performance requirements?
What sequence will the functions be performed in?
Are additional functions identified as a result of this analysis?
Return to section 2.3 for each new function.
What alternative configurations could achieve the same goals?
Complete 2.4 for each alternative.
Rank the alternatives by estimated cost-effectiveness.
Estimate cost of consultant and training time.
Is hardware available to perform the functions identified?
Will hardware meet the client requirements?

Figure 8. Functions analysis.

Task Analysis

Task analysis is the third phase of HUMAN-SD (Figure 9). A task is defined here as "a composite of related (discriminatory-decision-motor)activities performed by an individual, and directed toward accomplishing a specific amount of work within a specific work context." (DeGreene, 1969a, p.21.). Once the functions have been allocated to man, machine, or a man-machine combination, the tasks that the handicapped user performs must be further analyzed. This process is the identification of tasks and analyzing each for equipment and behavioral implications (Meister, 1971, p.78). For example, the system function of displaying the menu of choices can be described by the following tasks: discriminating whether the menu is showing or not, choosing to display it, selecting or activating the appropriate interface to display it. Initially the actions and their sequence need to be described incorporating purpose, input/output, and necessary decision information into the description (DeGreene, 1969b, p.109; Meister, 1971, p.76-77). The final result of this first step is a verb-noun description of each task (eg. say menu to request the display of choices) and the equipment necessary to perform it (Meister, 1971, p.78.81).

Table 1

Relative Capabilities of Man and Machines

HUMANS are generally better in their abilities to:

* sense very low levels of certain kinds of stimuli: visual, auditory, tactural, olfactory, and taste.
* detect stimuli against high-"noise"-level background.
* recognize patterns of complex stimuli which may vary from situation to situation.
* sense unusual and unexpected events in the environment.
* store (remember) large amounts of information over long periods of time (principles and strategies more than details).
* retrieve pertinent information from storage (recall), frequently retrieving many related items of information; but reliability of recall is low.
* draw upon varied experience in making decisions; adapt decisions to situational requirements; act in emergencies.
* select alternative modes of operation if one fails.
* reason inductively, generalizing from observations.
* apply principles to solutions of varied problems.
* develop entirely new solutions.
* make subjective estimates and evaluations.
* concentrate on most important activities when overload conditions require.
* adapt physical response (within reason) to variations in operational requirements.

MACHINES are generally better in their abilites to:

* sense stimuli that are outside the normal range of human sensitivity.
* apply deductive reasoning, such as recognizing stimuli as belonging to a general class.
* monitor for prespecified events, especially when infrequent.
* store coded information quickly and in substantial quantity.
* retrieve coded information quickly and accurately when specifically requested.
* process quantitative information following specified programs.
* make rapid and consistent responses to input signals.
* perform repetitive activities reliably.
* exert considerable physical force in a highly controlled manner.
* maintain performance over extended periods of time.
* count or measure physical quantities.
* perform several programmed activities simultaneously.
* maintain efficient operations under conditions of heavy load.
* maintain efficient operations under distractions.

Source: McCormick, E.J. & Saunders, M.S. Human factors in engineering and design. NY: McGraw-Hill, 1982, pp.489-490.

3.1 DETERMINE TASKS
What functions will the client perform?
What sequence of activities achieve each function? (develop a flowchart)
Describe each activity or task.
What is the purpose of the activity?
What information will the client need to complete this activity? (eg. make the decision to perform it)
Is a display necessary? If indirect sensing is required:
What type of information must be displayed?
quantitative? (eg. level of volume)
qualitative? (eg. approximate level of volume)
status indication? (eg. on/off)

warning/signal? (eg. flashing light to indicate that the stove is on)
visual/representational? (eg. international symbols for the menu)
alphanumeric/symbolic? (eg. written words for the menu)
Should it be a visual or auditory display? (see Table 2)
What will the client's response have to be to achieve this activity?
Will the primary output be motor or speech?
Must the information transmitted be continuous or discrete (eg. appliance only on while talking, or toggles on/off)
What will the machine output be?
Refer to input needed for next action in the sequence. (eg. when appliance activated the menu automatically returns)
Define each task using a verb/noun format.

Figure 9. Task analysis.

Table 2

When to Use the Auditory or Visual Form of Presentation

Use auditory presentation if:	Use visual presentation if:
1. The message is simple.	1. The message is complex.
2. The message is short.	2. The message is long.
3. The message will not be referred to later.	3. The message will be referred to later.
4. The message deals with events in time.	4. The message deals with location in space.
5. The message calls for immediate action	5. The message calls for immediate action.
6. The visual system of the person is overburdened.	6. The auditory system is overburdened.
7. The receiving location is too bright or dark-adaptation integrity is necessary.	7. The receiving location is too noisy.
8. The person's job requires him to move about continually.	8. The person's job allows him to remain in one position.

Source: Deatherage, 1972, p. 124, table 4-1.

Step two of the Task Analysis phase (Figure 10) entails the determination of appropriate control and displays that will facilitate the performance of task (Chapanis, 1965, pp.20-24; DeGreene, 1969b, p.109). Client abilities and task requirements (communication, maintenance, feedback, input and output) are the source of information in making this determination (Meister, 1971, p.81). Each task is analyzed in terms of what, how, time requirements to perform the task, frequency of performance, and behavior categories (see Table 3) (DeGreene, 1969b, p.83, 109; Meister, 1971, p.84). The tasks are then listed and sequenced in order of performance and their interrelationships (see Table 4) are examined and matched to client abilities (DeGreene, 1969b, p.93, 109; Meister, 1971, p.83-85). A tentative list of control and display devices is generated to match these specifications. The planning document is again revised and update with the new information. Analysis and estimations of system design and costs are resubmitted to the client who decides whether to proceed with the HUMAN-SD.

3.2 DETERMINE APPROPRIATE CONTROLS & DISPLAYS
Compare classification of each task behavior (see Table 3) to a list of appropriate equipment for each behavior (see Table 4) Select a tentative list of possible control-display devices to be used performing these tasks.
Do they meet performance requirements?
Do they optimize the input and output characteristics of the equipment?

3.3 ANALYZE THE TASK DEMANDS
Analyze each task with reference to specific controls and displays.
What needs to be accomplished? (eg. menu display)
How must it be accomplished? (eg. visual representation, clear, uncluttered)
What are the task time requirements? (eg. automatic return to the menu after the selection is made)
How frequently must the task be performed?
What category of behavior does it fall into? (eg. trasmission/receipt/storage of information, delay, decision, control operation, display monitoring)
Diagram the task
Develop a flow diagram to show sequence of all tasks.
List the tasks in order of performance.
What interrelationships exist between tasks? (eg. completion of one task initiates beginning of another)
Do these interrelationships match the client's abilities?
Can the client perform the task? (eg. sensory, motor, decision-making, & communication requirement)
Are excessive demands imposed on the client? (eg. frequency, duration, accuracy, etc.)
Do the following events affect client performance?
speed of occurrence?
number of responses required?
length of event presentation?
amount of movement required?
level of intensity or stress of event?
predictability of events? (eg. correct appliance always accessed)
Does the physical environment affect performance? (eg. temperature, noise, vibration, lighting, safety, etc.)
Is stress created by the task mission, potential emergencies, accuracy and speed requirements for responses, or task importance to the client?
Are the displays too complex? (eg. requires complex perception, memory tasks, etc.)
Are the controls too complex? (eg. motor requirements, sequence)
Can the client meet performance requirements with this control or display?
If no:
Is the input to the client clear?
Can the displays be modified?
Can the controls be modified?
Is the process too complex?
Does the client lack the skill or training?
Does the client lack the motivation?
Reanalyze the new task demands by repeating 3.3.

Figure 10. Task analysis.

Table 3

Task Behaviors Classification

Processes	Activities	Specific Behaviors	Processes	Activities	Specific Behaviors
Perceptual processes	Searching for and receiving information	Detects Inspects Observes Reads Receives Scans Surveys	Communication processes		Advises Answers Communicates Directs
	Identifies objects, actions & events	Discriminates Identifies Locates			Indicates Informs Instructs Requests Transmits
Mediational processes	Information processing	Categorizes Calculates Codes Computes Interpolates Itemizes Tabulates Translates	Motor Processes	Simple/ Discrete	Activates Closes Connects Disconnects Joins Moves Presses Sets
	Problem solving & decision-making	Analyzes Calculates Chooses Compares Computes Estimates Plans		Complex/ Continuous	Adjusts Aligns Regulates Synchronizes Tracks

Source: Meister, D. Human factors: Theory and practice, NY: Wiley-Interscience, 1971, p. 80.

Table 4

Behavior/Equipment Comparison Chart

Type of Information	Type of Display: Visual	Type of Display: Auditory
quantitative	fixed scales w/moving pointers moving scales w/fixed pointers digital displays counters	to indicate specific values: voice synthesizers variable dissensions auditory signals (frequency, intensity, duration)
qualitative	color coded scales shape coded scales check-reading scales	to indicate ranges of values: voice systhesizers variable dissension auditory signals single dimension signals
status	signal light check-reading scales	single disension signals continuous signals w/variable dimensions voice systhesizers
warning	flashing lights steady state lights	alarms interrupted/variable signals voice synthesizers
codes	alphanumeric geometric shapes configurations color representational (iconic)	international codes (eg. morse code)

Source: McCormick & Saunders, 1982, pp. 63-141.

Interface Analysis

The last phase in the planning process, before system construction and evaluation, is the interface analysis (Figure 11). Beyond identifying what controls and displays are appropriate, their placement on a panel or piece of equipment that the handicapped user can manipulate must be evaluated in terms of spacing and size (Meister, 1971, p.88-89). This interface is the piece of equipment that assures that the handicapped user will be able to efficiently operate the system. Once the equipment design has been developed for efficient access, a mock-up or prototype of the system is constructed and the client is asked to perform the identified tasks (Chapanis, 1969, 56-7; DeGreene, 1969b, p.96). As the client performs the tasks, further analyses are done. One of the critical factors evaluated is the amount of time required for performance of the task (Meister, 1971, p.89). Errors in performance are also noted and classified in order to make modifications that will prevent these errors from occurring (DeGreene, 1969b, p.113; Kidd, 1962, p.161; Meister, 1971, p.91). Even though the prototype configuration allows performance within the system requirements, better alternatives may exist and the client may be evaluated for task performance on other mock-ups to assure the best and most efficient system.

4.1 SELECT APPROPRIATE INTERFACES

Determine the appropriate size.
- How many controls & displays are needed?
- Is the display/control consistent with the purpose of the system?
- Does the display/control limit system portability?
- Can the number of controls/displays be reduced?

Determine the appropriate spacing of controls/displays.
- Do compatibility with expectations affect the spacing?
  - spatial compatibility (eg. physical similarities between controls and displays)
  - compatibility of movement relationships (eg. turn the dial to the left to move the display lever to the left)
  - conceptual compatibility (eg. use visual symbols that represent concrete objects)
  - general population response tendencies (eg. sequencing the controls left to right)
- How do client abilities affect the spacing requirements? (eg. motor, visual, hearing)

Create a mock-up of the system.

Train the client.

Analyze each task as the client performs it.

Evaluate the client's ability to perform each task in sequence.
- Can the client perform the task?
- Are excessive demands imposed on the client? (eg. motor, memory, etc.)
- Do the following events aff[illegible]t performance?
  - Does the physical environment affect performance?
  - Is stress created?
  - Are the displays too complex?
  - Are the controls too complex?

Does the client meet the performance criterion?
- Can the client perform all tasks in the required sequence within a specified amount of time?
- If not:
  - Determine error classification.
    - Complete the Error Analysis Matrix (Table 5)
  - Can the error be prevented by:
    - automating the error-likely operation? (eg. automatically returning to the menu instead of pressing a switch)
    - modifying equipment or environment? (eg. add more microphones)
    - modifying the sequence or procedure? (eg. select multiple appliances before activation)
    - additional training?
    - improving monitoring to eliminate some error?
    - improving feedback (eg. increase sensitivity to habits)
  - Modify the arrangement.
    - Repeat questions in section 4.1 beginning with "Determine the appropriate size."

Are other alternatives available?
- Is another sequence possible?
- Are other equipment functions possible?
- Can the tasks be reprioritized?
- Can the frequency of task performance be changed?
- Modify the arrangement.
- Create a new mock-up and try with the client.
  - Repeat the questions in section 4.1 starting with "Create a mock-up . . ."

Figure 11. Interface analysis.

Table 5

Error Analysis Matrix

	Situational	Idiosyncratic
Incorrect performance	(eg. switch too far to reach)	(eg. lack control - miss switch)
Failure to perform	(eg. visual cue too short)	(eg. vision limited - missed cue)
Out of sequence	(eg. switches in random order)	(eg. short memory - forgot sequence)
Nonrequired action	(eg. press two keys at once)	(eg. lack control - bump switch)
Not within time limit or criterion	(eg. knob hard to adjust - takes too long)	(eg. lacks fine motor ability to adjust knob)

Source: adapted from DeGreene, K.B., Systems Analysis Techniques. In K.B. DeGreene (Ed.), Systems psychology, NY: McGraw-Hill, 1970, p. 113 and Meister, D. Human factors: Theory and practice. NY: Wiley-Interscience, 1971, p. 44.

The final step in selecting the appropriate interface is to evaluate the cost-effectiveness of each alternative system (Figure 12) that meets system requirements. Specific system characteristics are compared (technical performance, quality of interactions, economic benefit, psychological satisfaction and overall satisfaction) and a final revision is made to the planning document.

4.2 EVALUATE COST-EFFECTIVENESS

Determine the client's cost. (hardware, maintenance, software, training, consultant)

Does the system meet system requirements? (technical performance, quality of man-machine interactions, economic benefit, psychological satisfaction, overall satisfaction)

Is the system cost-effective?

Are there other alternatives?
- If yes, repeat this section of questions (4.2) for each.

Complete "Trade-off Comparison of Alternate Approaches" chart. (Table 6)
Which system is most cost effective?
Figure 12. Interface analysis.

Table 6

Trade Off Comparison of Alternative Approaches

Requirements	Alternative 1		Alternative 2		Alternative 3	
	Pros	Cons	Pros	Cons	Pros	Cons
System:						
technical performances						
quality of interactions						
economic benefit						
psychological satisfaction						
overall satisfaction						
Costs:						
hardware						
maintenance						
software						
training						
consultant						
Constraints:						

An example of a general matrix for evaluating alternative systems. Pros and cons are listed side-by-side for each requirement and constraint. This allows for an easy comparison.

Source: adapted from DeGreene, K.B., Systems analysis techniques. In K.B. DeGreene (Ed.), Systems psychology, NY: McGraw-Hill, 1970, p. 92.

Field Evaluation

If the client chooses to continue, the final phase of the HUMAN-SD is the actual building of the system and the field testing of it (Figure 13). The field test must insure that all identified situations, environments, and users are evaluated in terms of system requirements, task performance and client satisfaction. Only under realistic conditions can a good analysis of performance take place (Gagne, 1962a, p.9). Minor modifications can be made if any are found necessary. The field test should ideally be extended to include 3, 6, and 12 month follow-ups to assure the proper performance of the system. Again minor modifications can be made at those times.

5.1 PRODUCE THE SYSTEM
Purchase the hardware and software.
Assemble the system.
Train the client.
Conduct a field test with the client.
Evaluate client satisfaction.
Conduct a longitudinal follow-up.

6.0 SYSTEM COMPLETE
Write a final report detailing the procedure and results.
Figure 13. Field evaluation.

Summary

In summary, the HUMAN-SD systems development approach provides a framework for designing systems in which the handicapped user will be a vital link. This adapted approach to systems development is designed for small systems with one human component and that individual is handicapped. It is designed to provide recommendations for the development of individualized systems and eliminating the costly trial and error methods of purchasing equipment. The HUMAN-SD systematically evaluates the individual's capabilities, compares them with machine capabilities and determines which system component can best perform a given function. Based on principles of human factors engineering research, the best alternative can be selected before initiating purchase of equipment and training of handicapped users.

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The Use of Computers in Rehabilitation Facilities

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Abstract

The Research and Training Center at the University of Wisconsin-Stout is conducting a 2-part survey of computer uses in rehabilitation facilities across the nation. This report presents the preliminary data from the first part of that survey. The initial findings, based upon 849 returned surveys, are presented and include such information as how computers are currently being used in facilities, the types of equipment being used, the costs involved, the training and information needs of the facilities, and the problems encountered by users. The findings suggest that there has been a dramatic increase in the use of microcomputers in the past two years and that this trend will continue. Computers are currently used most often for administrative applications and less often for production and rehabilitation services functions. Finally, there is a clear need for information on the part of facilities on how best to use computers.

The Research and Training Center at the University of Wisconsin-Stout is one of 27 centers funded by the National Institute for Handicapped Research to conduct research and training related to improving the lives and well-being of handicapped people. Each of the centers has a unique focus. Many of the centers research medical questions related to handicapping conditions. Others investigate issues related to mental retardation and mental illness. Ours is one of the few centers which addresses issues directly related to vocational rehabilitation. One of our primary missions is to conduct research and training designed to improve the rehabilitation services provided by sheltered workshops (vocational evaluation, work adjustment, and placement). A second mission is to conduct efforts which will lead to the improvement of the economic viability of those facilities. The latter focus is quite new for our center but is one which offers many opportunities to make meaningful contributions to the field of rehabilitation.

This paper will present some preliminary findings from one of the research projects that we are currently engaged in. We are conducting a two-part survey of virtually all of the rehabilitation facilities in this country. We are investigating a number of aspects of computer use within facilities. This study relates to both of our mission areas concerning sheltered workshops. It has implications for the economic viability of facilities since computers are potentially powerful tools for increasing productivity. This project also relates to the services provided by facilities, in that computers could increase the efficiency of those services now provided to handicapped people and possibly increase the variety of services, as well.

Before discussing what we hope to accomplish with this study, let us first review its rationale and some of the previous work done in this area. To start, we should perhaps mention the obvious. That is, that since they first became commercially available some three decades ago, there has been a virtual explosion in the use of computers to enhance business and industrial operations. Today, computers are used in a wide variety of administrative applications including such tasks as accounting, budgeting, billing, payroll, and mailing lists. Computers are also used in a large number of industrial applications, such as monitoring production lines, controlling machinery, and tracking inventory levels. It appears that computers can now be used to assist in virtually every area of business operations.

In the early stages of their development, computers were used almost exclusively by large businesses, universities, or government agencies. The great expense and difficulty in operating those machines prevented their use by smaller businesses such as sheltered workshops. Advances in technology in recent years have resulted in dramatic decreases in the cost of computers and increases in ease of use, however, and now computer systems capable of handling the needs of a small business are available at prices such a business can afford.

The rationale for the use of computers by business is that these machines can increase efficiency, thus lowering operating costs and increasing profits. Increases in efficiency can result in a number of ways, such as making numerical computations more rapid and accurate, by making changes and corrections in letters and other documents simplier and quicker, and by making the analysis of large amounts of information (e.g., cash flow analysis) faster.

Cimler and Henderson (1979), who authored a booklet on the potential uses of microcomputers in workshops, argued that the increases in efficiency made possible by computers can benefit sheltered workshops. They contend that computers can "reduce costs through greater effectiveness and improved efficiency" in workshops. They listed a number of potential uses of computers in sheltered workshops which included 17 administrative tasks, 4 uses relating to the rehabilitation services provided to handicapped clients, and several more functions relating to the production component of workshops.

Other writers have also discussed the need for and potential benefits of using computers in sheltered workshops. Cole (1983), for instance, discussed several useful programs he has written for use on a very inexpensive Timex microcomputer. These included one program which calculates the weekly payroll for the 120 clients employed at Cole's facility. Another program Cole developed monitors inventory for the production line and a third program calculates staff/client ratios on an hourly basis. In another article, Crimando and Sawyer (1983) discussed a number of potential uses for microcomputers in work adjustment. These authors argued that micros could be used in four general areas related to work adjustment services; these included computer-assisted instruction, skill training, service planning, and client progress tracking. Yet another author, Pogorelc (1983) argued strongly for the use of computers in sheltered workshops to allow them to keep pace with other businesses with whom they compete. He contends that as "computers become utilized more and more in business, education and government, rehabilitation facilities will either be required to adapt accordingly, or they will be at a competitive disadvantage."

The articles by Cimler and Henderson (1979), by Cole (1983) and by Pogorelc (1983) all asserted that using computers to assist in many of the administrative and production tasks carried out in sheltered workshops would greatly enhance efficiency and thereby lead to improved economic viability in those facilities. All of those authors also cautioned that the use of computers will not automatically lead to great benefits, however. Indeed, one of the themes running through the literature dealing with how to choose a computer system for a small business (e.g., Pace, 1981) is that computers do not always accomplish what the purchasers had hoped they would. Careful consideration must be given to the needs of a facility and to how best to meet those needs.

In 1981, Charles Miller of the Rehabilitation Workshop Administration Training Center at Seattle University conducted a 1-page survey of approximately 2500 sheltered workshops scattered throughout the nation. His instrument asked workshop personnel if they used computers, and, if so, whether they owned or leased them or employed a service bureau or some similar arrangement. Miller found that the major form of computer use among his respondents was the use of a service bureau, which is an organization with a large computer that provides data processing services to numerous customers. A little over 800 facilities responded to the survey and 51% of them indicated that they were using computers. Approximately 135 of the users owned their own computer.

About 40 of the computers owned by facilities were microcomputers. The majority of those were manufactured by Apple and Radio Shack. In the article which discussed the results of his survey, Miller also presented some details of a 2-year project in which his center was training sheltered workshop personnel in the use of microcomputers. Miller concluded that the individuals they dealt with in that project had little awareness of the potential range of applications for computers.

In a second study, Leicht (1982) conducted a more limited survey of computer use in sheltered workshops. She used a more extensive questionnaire to survey 39 facilities located in the state of Wisconsin. The results of her study indicated that those facilities which employed computers used them mostly for administrative functions such as calculating the payroll, maintaining production records, and for mailing lists. For almost all of the possible areas of computer use listed on the survey form, the respondents indicated that they were not now using computers in that way but would like to do so.

Perhaps the most interesting results of Leicht's (1982) study were the responses pertaining to the information needs of the respondents who were already using computers. Eighty percent of them stated that they would like to have information on useful commercially developed programs. The possibility of setting up a "user's group" for facilities which use computers, and the need for short-term training on the use of computers were also seen as important by the respondents.

There seems to be a common thread running through all of the articles that we've discussed thus far. That is, that there is a need among facility personnel for information on how best to utilize computers. Writers like Cole (1983), Cimler and Henderson (1979), and Pogorelc (1983) alluded to that need when they discussed the pitfalls associated with the purchase and operation of a computer system. The vast majority of the subjects in Leicht's (1982) study indicated a need for information related to how best to use computers within their facilities. Finally, Miller (1981) concluded that the individuals who attended the training sessions that they provided for workshop personnel had very limited knowledge of the large variety of ways in which computers could be effectively used in facilities.

It is the need for information on how best to use computers to enhance the business and rehabilitation components of rehabilitation facilities that we hope to address in this project. Specifically, we want to find out: (1) to what extent computers are being used in facilities nationwide, (2) how they are being used in terms of administration, rehabilitation, and production, (3) what specific types of hardware and software are being used, and; (4) what trends are likely to affect the progress of computer use in facilities. We anticipate that this research could benefit facilities in a number of ways. The data should provide facilities which are contemplating the purchase of computer equipment in the near future with realistic estimates of the costs of various types of equipment, of the amount of training they will probably require and the identity of software packages (both commercially developed and "homegrown" programs written by personnel in facilities) which other facilities are finding useful. This project should also help current computer users identify ways to expand and enhance their systems. I am particularly excited about the prospect of identifying programs which relate to the services provided to handicapped individuals within facilities. We hope to "spread the word", so to speak, about such programs so that a greater number of people can benefit from them.

Method

As we stated previously, this project will consist of a two-part survey. We will be reporting the preliminary findings of the initial part of the survey here.

Subjects

All of the facilities included in the Research and Training Center's mailing list were sent a copy of the initial part of the survey. There are approximately 4500 facilities in this list. To date, we have received 600 returned letters which the post office was unable to deliver. Thus, the actual number of facilities which have received copies of the first part of the survey is around 3900.

Instruments

The initial part of this 2-part survey is a 33-item questionnaire developed by the Research and Training Center. This instrument has two sections, one for current computer users and one for nonusers. Section 1 asked users about: (1) how they use computers in administration, production and rehabilitation services, (2) what type of computer hardware they have and whether they own it, lease it, or employ a service bureau, (3) the costs involved in various aspects of computer use, (4) what the computer-related training needs of the facility are, (5) some general information about how effective they feel their computer operation is, and (6) some information about the facility itself (e.g., its budget, number of clients served, etc.). Section 2 of the survey applies to facilities which are not currently using computers. This section asks: (1) whether the facility is actively planning to purchase a computer system, (2) what they will use it for, (3) how much they expect to pay for hardware, software, consulting, and training, and (4) some information on the general characteristics of the facility.

The second part of the survey, which is not yet fully developed, will be mailed only to those respondents who are currently using a computer. This part of the survey will be more specific than the first and will ask users such things as the names of specific software packages they use, who their consultants were, who has written any specialized programming for them, the academic background of the personnel who handle their data processing, etc.

Procedure

The first part of the survey was mailed to all 4500 of the facilities contained in our mailing list. To date we have received 849 surveys which were appropriately filled out and, as was already mentioned, we have received 600 which were undeliverable. Thus, we have a return rate of about 22% at this point. We will be conducting a follow-up mailing in about 10 days for those facilities which have not yet returned the first part of the survey to us.

The second part of the survey will be sent out in about 2 months.

Results and Discussion

As we mentioned earlier, the results we will be presenting here are the preliminary findings of this study. We will only discuss the data we received from the initial mailing of the first part of the survey. The statistics used to analyze the data thus far have all been descriptive.

The first question in the survey asked whether the facility currently uses a computer for any purpose. Of the 849 responses, 462 (54%) answered that the facility does use a computer. This is quite close to Miller's (1981) results for the same question. Fifty-one percent of his respondents used computers.

Responses of Facilities Which Currently Use Computers.

Users were first asked how they are using computers in three general areas: administration, production, and rehabilitation services. The responses to these questions can be seen in Table 1. As is evident from reading the table, the most frequently cited uses of computers by these facilities were for various administrative purposes. The most heavily used was accounting (73%), with bookkeeping and staff payroll functions used by more than 60% of the respondents. As can also be seen, the use of spreadsheets and program evaluation packages were least often cited. These data seem to suggest that most facilities which use computers perform a number of administrative functions with them.

Table 1

Current Computer use in Administrative, Production, and Rehabilitation Services Applications

Administrative		Production		Rehabilitation Services	
Application	%	Application	%	Application	%
Accounting	73%*	Production Control	14%	Assessment (Vocational Evaluation, Psychological Testing, etc.)	24%
Bookkeeping	66%	Production Scheduling	12%		
Word Processing	50%	Inventory	29%	Adjustment Personal, Social, Work)	13%
Mailing Lists	54%	Motion-Time Study	8%	Residential	11%
Spreadsheets (Business Projections)	40%	Contract Bidding	10%	Independent Living Training	10%
		Cost Control	25%		
Staff Payroll	63%	Production Records/Reports	34%	Job Skill Training	16%
Client Payroll	51%	Other	5%	Other	0%
Program Evaluation	35%				
Other	21%				

* Percentage of current computer users employing computers for this application.

The percentage of use of computers for production tends to be considerably lower than for administrative uses. The most heavily used function in this category was production record keeping/reporting which is used by 34% of the respondents. Computers are used for inventory and cost control by 29% and 25%, respectively. The respondents use computers considerably less often for the remaining production tasks which were listed in the survey. The highest percentage of users for the remaining tasks was 14%.

The most frequent use of computers for providing rehabilitation services is for assessment, which includes vocational evaluation and psychological assessment. Twenty-four percent of the respondents use computers for this purpose. The extent of use of computers for independent living training, residential programs, placement, work adjustment, and job-skill training ranges from 10% to 16%. Overall, these data suggest that computers are primarily used for administrative purposes in facilities at this time.

The next part of the survey asked computer users a number of questions about the computer hardware they use. In the first of these questions, we wanted to determine what class of computers facilities own or lease. We listed three classes of computers: microcomputers, minicomputers, and mainframe computers.

In response to this question, 201 (44%) of the current computer users indicated that they own at least 1 microcomputer and another 8% said they lease at least one microcomputer. Eighteen percent of the current computer users own a minicomputer and another 7% lease one. Seventeen percent said they own or lease a main-frame computer.

In the next item we had users list the brand and model of their computer(s). We left several blanks for users with more than one machine. On this question 127 (30%) of the respondents indicated that they do not own a computer. Presumably these were facilities which employ a service bureau or have a timesharing arrangement. Of those facilities which did respond to this question, 54% indicated that they had one computer whereas the remaining 46% have more than one machine. Twenty-three percent have 2 computers and 8% have three. Three percent of the respondents have 9 or more computers. We were quite surprised at the number of facilities using more than one computer. This finding seems to reflect the impact of low-cost microcomputers which allow facilities to purchase smaller machines for specific tasks.

There is great diversity in terms of the types of computers which facilities use. There are over 90 different brands or models of computers in use in these 462 facilities. By far, the most widely used machine is the Apple II which makes up 24% of the computers used in facilities at present. The next most popular brand is Radio Shack with 16% of the computers in facilities followed by IBM with 9% of the microcomputers in use. The most popular minicomputers are IBMs.

The next two questions asked whether a facility uses a timesharing arrangement or a service bureau. In the former arrangement, one rents processing time on someone else's computer, usually a mainframe, whereas in the latter arrangement a professional service does all of one's data processing. Nineteen percent of the current users employ timesharing and 35% indicated they use a service bureau. This latter figure is lower than the 51% found by Miller in 1981. This may indicate that users who were formerly using service bureaus have begun doing their own data processing. It is also possible, however, that Miller included timesharing and service bureau arrangements together. If the latter is true, then the data from this study are very comparable to Miller's.

Next we turn to three questions concerning the costs of equipment, software and operating expenses. The data we have thus far provide only very gross estimates of actual costs because facilities were forced by these questions to give just one cost figure. The second part of the survey will allow respondents to indicate how much each separate component of their computer system cost.

In the preliminary analyses, we have attempted to separate costs by class of computer and examined only the data for facilities which have only one computer. There were 76 respondents who indicated that they currently use a single microcomputer system. The mean cost per system was $6250. This estimate includes the costs of the computer plus all peripheral equipment such as printers, disk storage systems, etc. Closer inspection of the data revealed that 61% of these facilities paid $5000 or less for their equipment. Only 18% of these respondents paid more than $10,000 for their system. Several of the computers in the latter price range were mutiple-user systems. The cost of software for the microcomputer users averaged around $1900. The average yearly operating expenses were estimated at $2400.

The next analyses examined the costs of using minicomputers in those facilities which have only a single computer. There were 28 facilities in this category. The average price these facilities paid for equipment is $48,385. The costs of this equipment ranged from a low of $8600 to a high of $250,000. The average cost of software for these machines was $7240 and the annual operating expenses were estimated at $14,200. The latter figure no doubt represents the expense of needing more highly qualified individuals to operate a minicomputer system.

Only two facilities indicated that they own a mainframe computer. The purchase price of each of these machines was in excess of $800,000. The software costs were estimated at $9900 and the annual operating expenses were estimated at $50,000.

The next section of the questionnaire addressed the training and information needs of facilities currently using computers. The respondents perceive a strong need for training in the areas of identifying computer uses and applications (65% said 'yes' to this item), computer system management (61%), and, in computer programming (54%). In addition, 33% of the respondents perceive a need for training which would help facilities select equipment. This latter figure was somewhat surprising since these facilities already have equipment.

We also asked the respondents about their need for customized software in specific areas of use. They indicated a strong need for customized programs for administrative applications (69%), rehabilitation services (69%) and in production (62%). There was also considerable interest in software for residential programs (38%). Additional information on the specific software needs of facilities will be gathered in the second phase of this survey.

In addition to the above training and software needs, the respondents indicated a great deal of interest in the possibility of forming a "users network" (65% yes), and in an introductory-level handbook describing how computers can be effectively used in rehabilitation facilities (59%). We hope to address these needs in the future.

The next two questions related to training. In the first of these, 52% of the respondents stated that their training needs could effectively be met by local education agencies (e.g., technical schools). In answer to the second question, 66% of the respondents stated that they would send personnel to short-term training covering computer uses in facilities if it were available.

In the next several questions we asked how the facility went about purchasing equipment and software, how useful they think the computer has been in specific areas, and what problems they have encountered in using computers. In answer to the first of these questions, 42% of the current computer users said that they had hired a paid consultant to advise them on some aspect of computer operation. Surprisingly, 32% said they had used volunteers, such as a board member, to assist them in acquiring a computer system.

The next question asked whether any employees at the facility had developed any software in a number of applications areas. The respondents indicated that in 33% of the facilities an employee had written software for some administrative purpose. The response rate for the other items in this question were 18% for rehabilitation services, 15% for production, and 8% for residential programs. We also asked the facilities whether they had any 'outside' programmers develop any customized software for them. The percentages of respondents who answered affirmatively to this question were almost identical to the answers relating to software developed by facility employees. The response rates to these items were 36% for administrative, 23% for production, 20% for rehabilitation services, and 8% for residential programs.

We next asked the current users to indicate their degree of 'satisfaction' with the performance of their computer system in a number of areas. The most positively rated category was administrative uses. There, 70% of the respondents gave the highest rating. The next most useful application was for clerical functions where 45% of the respondents rated this category as extremely useful. The other areas of computer use (production, rehabilitation services, program evaluation, residential) rated considerably lower than these two areas.

The next item on the questionnaire asked the respondents to indicate any problems they have encountered with their computer systems. The frequently cited problem (39%) was a lack of training opportunities. Other problem areas included such things as long 'break in' time for learning to use the system (28%), limitations of the computer system (28%), and the high cost of software (27%). Equipment breakdowns and maintenance expenses were the least often cited problems (18% and 17%, respectively).

Responses of Facilities Which Currently Do Not Use Computers

This part of the survey was filled out by the 387 facilities that responded to our survey which currently do not use computers. The first question asked about any plans the facility might have to purchase computer equipment. Twenty-nine percent of the respondents indicated that they definitely plan to purchase a computer within the next 18 months. Forty-eight percent indicated that they may purchase a computer within the next year and one-half and the remaining 18% said that they definitely would not be purchasing a computer during that time period.

Next, we asked those facilities in the 'maybe' and 'definitely will not be purchasing a computer' categories what would prevent them from doing so. Forty-eight percent indicated that a lack of financial resources is a problem which could prevent them from purchasing a computer. Twenty-six percent indicated that a lack of experienced personnel was a problem, while 23% said they lacked sufficient knowledge about computers. Only 12% stated that they were not convinced that computer use could benefit their facility.

We then asked facilities which are definitely or tentatively planning to purchase a computer, how they plan to use it. Not surprisingly, they cited administrative functions as those they would most like to computerize. The percentages indicating yes to the various administrative functions ranged from 39% for business projections (spreadsheets), to a high of 57% for accounting and bookkeeping. There was also considerable interest in production applications of computers where the percentages of interested respondents ranged from 17% for production scheduling to 43% for production record keeping and reporting. Interest in using computers for rehabilitation services was somewhat lower. The percentages of facilities indicating an interest in using computers in these applications ranged from 11% for use in residential programs to 35% for assessment uses.

The next series of questions assessed the amount of money these facilities anticipated spending on equipment software and training. The mean amount these facilities expect to pay for hardware is $4920. They also expect to pay an average of $1870 for software and an average of $630 for training. These are only very rough estimates but they suggest that most facilities which plan to purchase their initial equipment in the near future will be purchasing microcomputers.

When asked how they plan to finance the purchase of equipment, only 33% indicated they would use operating revenues. Thirteen percent said they would use a special fund raiser, 25% would seek grant funding, and 27% would seek donations of equipment or money.

The final data that we will discuss relates to the characteristics of the facilities which responded to this survey. For purposes of comparison, we will talk about both facilities which currently have computers and those which do not now have them. The most striking differences between the 'haves' and the 'have nots' is in terms of the size of the facilities. The average number of clients served yearly by those facilities which use computers is 1098, whereas, the average for facilities which do not use computers is 512 clients. There is also a sizeable difference in the number of employees in these two groups of facilities. The facilities which have computers employ an average of 139 people, whereas, the nonusers employ 53 people, on the average. The annual operating budgets for these two groups also differ greatly. The average budget for the facilities which do not use computers is $899,000 and the average budget for the users is $2,185,000. Thus, there is a large disparity in the size and amount of resources of rehabilitation facilities which currently do and do not use computers.

We also examined the types of services provided by facilities with and without computers. There were several noticeable differences between them that we found. The users provided more medical services (42% vs 22%), psychological testing (54% vs 28%), personal and work adjustment (71% vs 59%), skill training (51% vs 35%), on-the-job training (56% vs 42%), and sheltered employment (65% vs 52%). These findings, plus those noted above regarding differences in the size of these facilities, suggest that it is the more comprehensive facilities which are now using computers.

Summary and Conclusions.

As we stated at the beginning of this paper, the data we have presented here are only the preliminary findings of this project. These data seem sufficient to lead to a number of conclusions, however. The first of these is that microcomputers appear to be having a sizeable impact on the operations of rehabilitation facilities. There are more than five times as many facilities using microcomputers now than just 2 years ago when Miller (1981) conducted his survey. The data also suggest that those facilities which are not now using computers but plan to in the near future, will most likely purchase a microcomputer.

Another clear conclusion to be drawn from these data is that facilities, both those which do not have computers and those which do, have a need for information on how to use computers, the hardware and software. There is also a great need for training in these areas.

Analysis of these data also leads one to conclude that the facilities which currently are using computers tend to be much larger than those which are not using computers and have greater resources and a wider variety of services. The use of computers probably provides these larger facilities with a competitive advantage in both the business and rehabilitation services they provide.

Finally, these data clearly indicate that computers are being used by rehabilitation facilities most often for administrative functions. There is also considerable use in both the production and rehabilitation service components of facilities, however. It is in these last two areas, and particularly in rehabilitation services, that we suspect we will find a large number of 'homegrown' programs when we conduct the second phase of this survey. We believe that such programs, written by front line rehabilitation professionals, could be beneficial to a large number of other facilities if they were made aware of their existence. It is information about such programs, as well as, greater details about other aspects of computer uses in facilities that we hope to obtain in our second phase of this survey.

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Microcomputers and Employment for the Disabled

The CHPI Experience

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Abstract

This paper discusses the experience of Computers to Help People, Inc., in trying to provide employment in the computer field to severely handicapped persons. The company, a nonprofit organization, is interested in the broad field of how computer technology can be used to benefit people, but is focusing on providing jobs for severely disabled people who might be considered "unemployable" in some vocational rehabilitation programs. It was started by a deaf-blind graduate student in Computer Sciences and has a programmer with cerebral palsy. To find and develop computer and business abilities among other handicapped persons in the Madison area, the company conducted a human resources development program during the summer of 1983. During this summer, CHPI also received funds from a CDBG grant to Madison to help it expand its operations, and a contract to work with other organizations in the training of disabled persons. The paper discusses the founding of CHPI, the employment and human resources programs, the problems we have encountered, and our plans for the future, including the grant and contract.

Computers to Help People, Inc. is a nonprofit corporation founded in 1981. It is my firm belief that technology should be consciously applied to meeting human needs, solving human problems and furthering human aspirations. That is, these results should not be merely byproducts of the profit-making process. CHPI embodies this belief. Since my field is computers (I am studying for a Ph.D in Computer Sciences at the University of Wisconsin-Madison) it was natural to put this belief into practice with computer technology. Of course, the possible ways in which computers could aid people of all vocations and aspirations are almost limitless. Perhaps no tool invented by the human mind has such great flexibility. CHPI was started to explore and realize some of these possibilities, but where do we begin? Who is most in need of technological applications to attain their goals and even fulfill basic needs? Probably the handicapped population. This conclusion is bolstered by my own experience, for I am myself deaf and blind, and without computers and various products of computer technology it would be quite impossible for me to pursue graduate work. And in what area would applications of computer technology be of most benefit to handicapped persons? Probably in employment. Again, this is borne out by my personal experience, for I have been told that I would not be able to succeed in one field after another, and I have learned that without a job it is almost impossible to lead a normal life and enjoy respect in our society. And from my contact with other people having various handicaps I know that my experience is not unique. Moreover, there is a precedent.

In 1952, Henry Viscardi started Abilities, Inc. on Long Island. This company employed severely disabled people in factory-type jobs and in less than five years was grossing over a million dollars in sales. I learned about this venture during my undergraduate days through his book Give Us the Tools, and I could not help thinking that it would be nice to establish such a business of my own someday. This idea remained with me throughout my subsequent training as a computer programmer and through more than ten years of work in various computer centers as a programmer and systems analyst.

CHPI Now

As it stands today, CHPI is primarily interested in "employing the unemployable" in computer-related jobs. It is not a placement agency: it does not seek to find jobs for severely handicapped people, but, like Abilities, Inc., to provide those jobs. There are already many placement agencies in existence, of which the most notable are the various state Divisions of Vocational Rehabilitation. Of what use would another be, especially when the real need is for more jobs. Although CHPI has engaged in training of handicapped computer programmers, and may again do so, this work is primarily aimed at finding and developing human resources for the company or at providing work for handicapped instructors. A stated policy is to employ disabled people in as many positions as possible. Eventually, all employees will probably be severely disabled. Another stated policy is to use computers in as many aspects of operations as possible, since this generally makes information more accessible to people with varying abilities. The rest of this paper will discuss our experience in putting these policies into effect and our plans for the future.

Employment Program

Our first handicapped employee (I am not currently being paid by the company) was Michael Reece, a young man with cerebral palsy severe enough so that he had been considered "unemployable." He had had some training in programming, but this had not been too successful, both because of an outdated approach to the subject and because of inadequate computer facilities which could be used by handicapped persons. I therefore set about retraining him, using an Apple II plus personal computer. We quickly found that the best way for us to communicate was through the machine itself. He would type using a mouthstick, and I would read the screen using an Optacon (a reading machine which converts patterns of light into raised form). His training was funded by CETA through its Work-Experience Program, and provided the rest of us with valuable experience as well. Mike has now become a part-time employee paid directly by CHPI, and will be working more hours as the volume of business increases.

As the result of word-of-mouth advertising and of a group training project which will be discussed later, several other severely disabled persons are now interested in employment with CHPI, and I myself would like to be paid for my work, so that I am not dependent upon disability payments. We have received grants which will enable us to hire another part-time employee and to improve the accessibility of our building, but we do not want to rely on such grants indefinitely. The goal is complete self-support, both for the company and for all those employed by it.

But to become self-supporting we must have more business and provide more services. What kind of business, and what kind of service? At present, we are distributing special software for handicapped persons, mostly to schools. However, most of this software is in the public domain, and we can charge only a small fee to cover costs. Eventually, we may develop some proprietary software for the handicapped, and we may even distribute some special devices, but the handicapped market is small, and, in any case, neither Mike nor I want to work exclusively in the "handicapped industry."

Human Resources Development Program

Another service which we have provided, and will probably provide again, is training of handicapped persons from the Madison area in computer programming. This experiment was started because of a workshop on computers and the disabled which we presented for Access to Independence, Inc., another Madison area organization, in the spring of 1983. So much interest was expressed by a number of severely disabled people that we decided to set up a trial course for the summer to train some of them in computer fundamentals. This would prepare them to enter mainstream programs in data processing and computer science. It would also give us experience and a chance to see first-hand what problems might be encountered by severely disabled people using microcomputers on the job. Finally, we might be able to find some good computer and/or business talent, hence its name.

The program ran from June 7 through August 11, 1983. Classes met twice a week for three hours and were taken up with four major activities: lectures on computer concepts, demonstrations of equipment and programming techniques, individual evaluations, and commented reading from a BASIC programming tutorial manual.

The lecture series began with discussions of the basic components of a computer (processor, memory and i/O), the basic ideas of programming, and the difference between hardware and software. The concept of a "software system" composed of control program, programming tools (compilers, editors, utilities, etc.) and applications programs was then introduced, and attention was concentrated on the CP/M operating system. This system was chosen because it is used in many microcomputers and because its commands resemble those found in many time-sharing systems. A more "friendly" operating system could have been chosen, but it was considered important to present something like what the students would probably have to use on the job or at a college or university. The BASIC programming language was used in examples presented throughout the lectures, and a number of lectures were devoted to it.

The hardware and software demonstrations were hampered by the fact that we have only one Apple II+ and that the classes could not be held in our building because of lack of accessibility. It was necessary to mount the Apple, disk drives, printer, etc. on a large board so that the equipment could be carried back and forth with the minimum of danger and inconvenience. The Apple was fitted with a RAMcard and SoftCard from Microsoft, so that CP/M and the UCSD P-system (PASCAL) could be run. The Microsoft version of BASIC was used for most programming demonstrations because of its power and because it is becoming a de facto standard language for microcomputers. A number of simple business-type programs and one system-type program were used as examples. Some of these were given as homework assignments. All were demonstrated and discussed in class. Simple graphics were also demonstrated and discussed. To give the students some idea of what modern computer hardware is like, the cover was taken off the Apple and the various components pointed out and described.

The individual evaluations were also hampered by lack of equipment. With only one machine, it was of course not possible for anyone to have much hands-on experience. The evaluations consisted of having each student type on the Apple keyboard using whatever method he/she could and noting speed and any difficulties. One or two students were unable to type at all. Methods by which these people could use the computer, such as scanning and head-pointing devices were described to the class.

Because many of the students had difficulty reading ordinary printed material, either because they could not hold the book and turn pages, because the print was too small, or because they had mild dyslexia, many class periods were devoted to reading and explaining the programming tutorial. In this way, they at least got to hear the material once, and any difficulties caused by computer jargon could be dealt with immediately.

Seven students started the class. Most of these had cerebral palsy, one had spina bifida, and one had multiple sclerosis. One person could use crutches. The rest were in wheelchairs. Two people dropped out later, while another ambulatory person with cerebral palsy joined. Ability and previous experience varied widely. Some had difficulty understanding any of the material. Two people already had personal computers and were very quick. Some had never held a job of any kind, while one had worked as a bookkeeper before his disability became too severe.

Two people who might become future employees were located by this program. We also learned about the special devices, such as key guards, which would be needed to make motor-impaired employees more productive. And of course we learned a great deal about organizing such a venture. We also decided that we should charge a small tuition fee. Several have expressed interest in attending our next class, but since we have other commitments, it is hard to say when that will be.

Plans for Commercial Activities

Distribution of special software and introducing handicapped persons to the world of computers are fine as public services, but they bring in only token income. To become self-supporting and provide more jobs we must, like Abilities, Inc. engage in commercial activities. Of course, we will take whatever business we can get, just as we will provide whatever services we can. At this point, we are still trying to establish contacts in the business community, but we have isolated a number of promising areas.

1) Software Development. We will write and document programs for local businesses and organizations. People engaged in this kind of work will be provided with personal computers which they can use in their own homes, if desired. This will also allow each person to work at his own pace and at his best hours, something which is important for many handicapped persons. Once a week, each programmer or technical writer will come to the main office, bringing his work on floppy disks. This will allow for face-to-face interactions with other personnel—very important from a psychological point of view. The computer at the main office will also provide an electronic mail service, and the employees' personal computers will have modems for transferring small amounts of data.

2) Consulting. Part of this will be the normal type of consulting on equipment and software. However, we will also provide advice to other organizations, both for profit and nonprofit, on employing and training the handicapped.

3) Training. This will consist of courses on computer basics for business or sales people who must use or sell microcomputers. It will be separate from any program to train handicapped persons, which will continue to be on a nonprofit basis.

4) Research and Development. We are already doing some of this for our own purposes. As our knowledge and expertise increase, we expect to get grants and contracts from both government and private organizations. The most likely area in which we will be doing research and development is in applying computers to the problems of handicapped persons.

5) Electronic Publishing. With the proliferation of microcomputers and the development of computerized

typesetting, this can be expected to be a growing industry in the next few years.

Needs and Problems

To achieve these goals of self-support and increased public service we need three things: more equipment, better accessibility of our building, and more business know-how. All of these, in turn require more capital.

As indicated in the discussion of our software development program, we expect to provide each employee with a personal computer having floppy disks and a modem. We will also have a small business-type computer with a winchester disk, modem and a few terminals at our main office.

A more immediate need than more equipment, however, is better wheelchair accessibility. Our offices are in an old house which might almost have been designed to be inaccessible. Yet most of the people we work with are in wheelchairs. It is possible to get a manual wheelchair up the steps, but not a motorized one. In concrete terms, this means, for example, that Mike cannot use the mobility conferred by his motorized wheelchair, and I cannot work independently with him, since somebody must be here to call cabs.

CHPI's officers are all people with much experience in computers, but little in business. The company is structured more like a business enterprise than most nonprofit organizations, but we have had major problems with marketing and accounting. Volunteer help has proven inadequate, so that we must hire a management consulting firm before we can proceed.

It would seem that we should also hire a professional fund-raiser, since our own efforts to raise money from the public have produced only small amounts, and our efforts to raise money from foundations nothing at all. Indeed, we may do so in the future.

The Grant

I am happy to report that for the near future our problems of capitalization have been partly eased through a grant and a contract secured for us by our Secretary, Mary Brady.

In the spring of 1983 Mary learned that the city of Madison had received a considerable amount of money through a Community Development Block Grant. After much talking she persuaded the Board of Directors that CHPI should apply for a share of these funds. As finally worked out, the grant application requested money for skills development, planning and accessibility.

The skills development program calls for employing Mike and another handicapped person half-time to develop techniques of using microcomputer workstations (the personal computers mentioned earlier) for programming in various languages, producing documentation, communications, and other activities which future employees must perform.

The planning part of the proposal calls for hiring an outside consultant to advise us on management, marketing, accounting, fundraising, and so on.

The accessibility part covers installation of a porch lift to raise wheelchairs to the level of the entrance of our building, reconstruction of the entrance itself to eliminate an impossible ninety-degree turn, and remodelling of the bathroom so that it can be used by persons in wheelchairs. This will make the first floor available to everyone. Since making the other floors accessible would be too expensive, they will be used as offices for those able to climb stairs.

The grant was approved and will become effective in January of 1984. The accessibility work, however, is being done as part of the program of another Madison organization, Design Coalition, Inc.

Through her contacts at the Trace Research and Development Center, where she is Program Coordinator, Mary also obtained a contract with Access to Independence Inc. for CHPI to provide tutoring and consulting services in a three-year program which they are setting up to train persons with cerebral palsy as computer programmers.

The prospects for the future, therefore, are looking good. We expect to make great progress over the next year.

Overuse of Sound Effects in A Microcomputer Program and Its Impact on the Performance of Students with Learning Difficulties

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Abstract

This study used a repeated measure design to investigate the effect of sounds on the rate of learning to match 10 pairs of look-alike words by 50 students with learning difficulties. All subjects played the picture-matching game of Elementary Volume 7 by the MECC to become familiar with the format. Half of the subjects then played a modified word-matching game with sound effects, followed by the same game without sounds. The other half of subjects reversed the order of presentation of the two versions of word-matching game. The results indicated that there was no sequence effect. However, signifcantly fewer trials were needed when there was no sound effect in the program. Practical implications of the results with respect to development, evaluation, and use of pedagologically and technologically sound microcomputer courseware are discussed.

Integration of microcomputer programs into special education instruction is growing rapidly. However, systematic investigations of the effectiveness of these software programs have not paralleled the general enthusiasm about their potential benefits. One major problem with many current software is that technical capabilities of microcomputers, such as the features of color, graphics, animation, and sound, are sometimes applied inappropriately from the instructional point of view. For example, the high-resolution graphics in the MECC version of Oregon Trail is found to be "a good example of the misuse, or perhaps overuse, of graphics" (Goodson, 1981, p. 23). The Hangman program by the Midwest Visual Equipment Company and the Alpine Skier reading comprehension program by Imperial International Learning Corporation (1981) are other examples of programs lacking educational validity because graphics or animations occur only after an error response is made and thereby reinforce the student making errors.

The importance of making appropriate use of sound in presenting instruction has been emphasized by many software reviewers (Hannaford & Taber, 1982; Lathrop, 1982, Hakansson, 1981). In fact, Lathrop (1982) listed inappropriate use and control of sound effects as one of the ten commendments for rejecting instructional software. Audible responses are not only annoying and distracting but may serve to advertise the user's error responses to others in class. Furthermore, in her article "How to evaluate educational courseware?", Hakansson (1981) stressed the importance of utilizing various elements such as color, graphics, animation, and sound harmoniously so that various feature may compliment each other to achieve the educational purpose of the program. For these reasons, whether sound is used effectively has been often included as one of the essential criteria for courseware evaluation.

In spite of the common sense that sound effects inappropriately used in microcomputer educational programs may be counterproductive, there has been no empirical evidence supporting or rejecting such an assertion. The primary purpose of this study is to test the hypothesis that inappropriate use of sounds will interfere with students' learning.

Method

Subjects

Fifty students attending a diagnostic tutoring clinic participated in the study. These children were referred to the Diagnostic Center for testing and tutoring by their teachers following a period of learning difficulties in their classroom settings. They were considered by school personnel to be achieving below grade level, and suspected of having some kind of learning disabilities. However, these students had not been formally identified as learning disabled and were not receiving special education services. The sample was comprised of 31 males and 19 females. Sixteen of them were second graders, 10 were third graders and 24 fourth graders. Their average age was 9.48 years (S.D. = 1.07).

Instrumentation

The Elementary Volume 7 of Minnesota Educational Computing Consortium includes a program of matching pictures and a program of matching words, both using a concentration game format. To reinforce their visual memory of pictures or words and their locations, the students needed to recall the 10 pairs of words or pictures hidden behind 20 boxes labelled with letters A through T. They selected two boxes by keying the letters of the boxes that contain the same pictures or words. After the match was made, the two boxes became blank so the object of the program was to clear the boxes in as few trials as possible.

The picture-matching program was used without any modification as a warm-up activity in this experimental study. It also served the purpose of providing demonstration and training exercises to familiarize the subjects with the format of the game. The word-matching program was modified to suit the purpose of this study by providing the experimenter an option of having sound effects or not. If the sound effects option was chosen, every correct response would be followed by one type of 6-note musical string and every incorrect matching followed by a different type of 6-note music. The two types of music sounds were kept at the same pitch level and remained constant and repetitious. A second modification involved the use of 48 look-alike words (e.g. skip-ship; house-horse) to be randomly chosen for the 10 pairs of matching words. However, all of these words still had than six letters in length.

Experimental Design

A Latin Square repeated measure design was used with each of the subjects going through the picture-matching condition first, followed by the two word-matching conditions. This design used a counterbalancing technique to control the possible effects of the order in which the different program conditions were presented. Therefore, one half of the subjects played the word-matching game with sound effects first, followed by the game without sounds. The other half of the subjects played the word-matching game without sound effects first, followed by the game with sounds. The measure recorded was the number of trials a subject needed to clear the 10 pairs of matching boxes under the sound or silent condition.

Procedure

The experimenter accompanied students individually to a small testing room where an APPLE II Plus computer was stationed. The experimenter first explained to the student a concentration game would be played by matching pairs of pictures hidden in each box. Then the locations of the keys from A through T were briefly identified. No comments were made regarding strategies of how to play this game. However, the students were encouraged to begin the game by guessing the answers. They were also reminded to ask for help if they could not find a key for the letter they wanted to type.

The experimenter was with the student throughout the approximately 25-minute session to boot the disk, select the menu computer at the end of each game. Otherwise the programs were pretty much self-driven. No breaks were taken between the programs and verbal interactions between students and the experimenter were kept to a minimum.

Results

Table 1 presents the means and the standard deviations of the number of trials for each program type for the girls, the boys, and the total group. On the average, 23.22 trials were needed for the subjects to complete the picture-matching game. The girls (x=21.79) did somewhat better than the boys (x=24.10). It took the subjects 27.4 trials to complete the word-matching program when there was no sound effect; and 31.9 trials to complete the sounded version of word-matching. For the program without sound effect, the girls used significantly fewer trials (x=23.89) than the boys (x=29.59). Likewise, the girls' performance (x=27.63) was significantly better than that of the boys (x=34.58) on the word-matching program with sound effect.

Table 1

Means and Standard Deviations for Number of Trials by Program Types and Sex

	Female(N = 19)		Male (N = 31)		Total(N = 50)	
Program Type	Mean	SD	Mean	SD	Mean	SD
Picture-matching	21.79	4.16	24.10	5.35	23.22	5.02
Word-matching (without sounds)	23.89	4.76	29.59	6.84	27.42	6.69
Word-matching (with sound)	27.63	4.5	34.58	8.8	31.92	8.14

Analyses of variance with repeated measures on the sound effect were summarized in Table 2. The results indicated significant main effect of sound ($F(1, 48) = 33.15$, $p < .01$). The order effect was found not significant. The absence of a significant order effect indicates that the sequence in which the programs were presented did not play a significant role in this study. Therefore, the data presented in Table 3 regarding the means and standard deviations at three grade levels combined the first and the second-order presentations for the word-matching game. In general, the third-grade students in this sample used the least number of trials, the second graders used most trials, and the fourth-grade subjects needed slightly more trials than the third graders.

Table 2

Repeated Measure Analysis of Variance for Sound Effect and Order Effect

Source	SS	df	MS	F	P
Between Subjects	4694.6	49			
Groups	252.8	1	252.8	2.73	n.s.
Errors	4441.8	48	92.5		
Within Subjects	1251.5	50			
Sound Effect	506.3	1	506.3	33.12	<.01
Order Effect	12.3	1	12.3	.80	n.s.
Errors	733	48	15.27		

Table 3

Means and Standard Deviations for Number of Trials by Program Type and Grade

	Grade					
	Second(N = 16)		Third(N = 10)		Fourth(N = 24)	
Program Type	Mean	SD	Mean	SD	Mean	SD
Picture-matching	24.06	6.0	22.1	3.1	23.1	5.0
Word-matching (without sounds)	29.3	7.5	26.1	6.4	28.1	6.2
Word-matching (with sounds)	35.8	10.2	29.8	3.6	30.2	7.2

Discussion

The findings of the present study clearly confirms the hypothesis that repeated use of sounds effects as either reinforcer or feedback in a microcomputer instructional program will hamper students' rate of learning. The absence of order effect indicates that this conclusion applies equally to both presentation sequences with no regard to practice or carry-over effects.

One aspect of microcomputer instruction that is considered meritorious is to maximize the capabilities of the technology to motivate students. Sound effects used judiciously can certainly attract student attention and alleviate the fear that computers are only silent machines. However, when concentration is required of the student and a quiet learning environment is necessary, the sound effects can only be distracting and counterproductive. Such auditory distractions are particularly difficult for learning disabled students to deal with.

Given the existence of different learning styles and the mixed effects of sounds, the best solution lies in making sound effects an option for the user or teacher to choose. More recent computer courseware, such as the Game Show program by Computer Advanced Ideas (1981), have adopted such a feature in their programs. Similar options should be available for other microcomputer features including the use of graphics, animation, and praise statement.

From a programmer's viewpoint, the branching technique can be very readily incorporated to make these effects optional rather than mandatory. It is one of the program requirements that should be considered seriously for those courseware that may be used by students with learning difficulties. On the other hand, the availability of such options definitely needs to be monitored when evaluating courseware for special education students.

Finally, the present study also demonstrates the importance as well as the convenience of using microcomputers to conduct semi-automated research studies (Johnson, 1982). Further research might address other effects of microcomputing by using microcomputers not only as a research apparatus but for data collections, data analysis, and manuscript writing. For example, a study of similar design may be used to compare the effects of distracting sound upon the performance between learning disabled, normal, and emotionally disturbed students. In addition, studies can be designed to investigate whether teaching strategies for playing such games will result in better performance. Further research is also needed to determine how students feel about the use of sound effects in instructional courseware.

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Computers in Rehabilitation Another Way

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Abstract

It is both possible and practical for the rehabilitation professional to purchase a small computer and write programs which will improve services and save time. In this way programs are tailored to the specific situation, and they are easily modified when procedures or client needs change. This approach is inexpensive and cost effective for service providers with limited financial resources. Within the Martin Luther Home Workshop, a computer program has been written and implemented which computes weekly client wages, stores the information, and prepares written summaries of client wages for outside agencies. This program alone saves several hundred hours of staff time each year. A program is going to be implemented in November, 1983, which will reduce the time programming staff spend calculating and preparing monthly summaries of client progress. Other programs in use maintain management information from employee time cards, both providing a summary of the information and applying statistical tests to the individual employee record. A client communication device is in the latter stages of development, and additional client training and reinforcement uses are planned.

With the increasing availability and decreasing cost of small computers, a powerful resource has become available for the rehabilitation professional. The uses for evaluation and training of clients and management of agency functions are limited only by the vision and money of the service provider.

Most agencies have some limits on budgets and only a limited awareness of just what it is that a computer can do. Persons attending a major conference relating computers to the needs of the disabled will have opportunities to see and hear how computers are being used as they talk with practitioners and commercial vendors of the equipment. One way to bring computer technology into your agency is to purchase the commercial system that best meets your needs.

There is at least one other way. Purchase a small computer and program it yourself. Such an approach has the advantage of costing less than purchased software and, when finished, you will have a system which deals exactly with your situation. Disadvantages include the time it may take to write the program and the fact that the result is limited to your program writing skills. For many workshop situations, the problem can be solved internally in less time than would have been spent consulting. It is also possible that, since similar data skills are needed for the vocational rehabilitation professional and the computer programmer, we are as able to evaluate our needs and to prepare the program as is an outsider. Buying a computer and writing programs for your agency has many possibilities, but this option may raise more questions than it answers. A description of one situation in which it was attempted and the benefits which have come from the use of a small computer follow in the hope that some of the questions will be answered.

The Martin Luther Home Workshop in Beatrice, Nebraska is one component in a comprehensive range of services licensed as an intermediate care facility for the mentally retarded. The workshop provides training and productive work experiences for 120 persons whose primary disability is mental retardation. The staff includes 34 full and part time employees with an operating budget of $500,000.00 during fiscal year 1982-1983. As the number of clients and client needs have increased, the budget and staff have decreased. The workshop coordinator, who for purposes of this discussion is also the programmer, has an M.S. Degree in Vocational Evaluation. No additional training in business, computer use, or computer programming has been included in preparation for the introduction of computers into the workshop situation.

The computer system currently in use is the Sinclair ZX-81 which has been upgraded to 64K of Random Access Memory with a mechanical keyboard which includes a separate numeric keypad, and the printer which uses four inch wide paper to print 32 characters per line. A cassette tape recorder for program and data storage and a 12 inch television set complete the configuration. This system is certainly not to be recommended for use by other workshops. It is primitive and idiosyncratic. The primary (and perhaps only) advantage of this computer is that it is inexpensive, and after a minimal initial investment, can be upgraded as need or money allow. It is, in fact, a relatively powerful computer for learning purposes. From it you may learn whether to go on with independent programming for your facility use.

In order to be of benefit to a facility, the computer must be useful. While that may sound similar to the comment of a great American philosopher that, "if it doesn't make a difference, it doesn't make a difference", usefulness is important. Computer systems have been installed where they appear to serve no useful purpose. Of course, "useful" is a concept that must be defined by each agency. For purposes of this discussion, a "useful" computer will do more work with less staff time and less staff effort. If that does not occur, it is not worth the effort to purchase, program, and use the computer. The computer must be useful.

The ways a computer can save time within a workshop depend on the tasks being done by staff and clients. Tasks in which the same data is used in several different ways are particularly appropriate for a computer. By entering the data once, several types of output are delivered with no additional work and little computer time. When data is subject to the same computation formula or similar calculations must be done on a regular basis to a variety of input, a computer can shorten the staff time needed for the process.

Within the workshop 120 clients are paid in cash each week. (We've always done it that way). Their pay is charged to the appropriate production cost center, and individual client Gross Wages, FICA, Net Wages, and Hours Worked are recorded weekly. In the past these records were kept manually using a number of document formats. It was computerized in two stages, with the first stage being a utility program that sorted wages by cost area and determined the correct amounts of the various values of money needed to pay each client in cash. This saved several hours a week and justified the expense of the additional hardware for the second stage. Stage one was implemented using the basic computer and 16K Random Access Memory which is currently available for under $100.00. The second stage was implemented using the upgraded computer described earlier.

To use the new client payroll program, the program and client records to date are loaded into the computer from a cassette. The records for a payroll quarter are kept on the single tape. When the program is loaded and the main menu is displayed, the operator has several options.

One option presents the operator with an additional menu enabling the operator to:

1) Return to the main menu
2) Assign the payroll dates for the current quarter
3) Add client names with time card and social security numbers
4) Review the payroll dates
5) Review the client information already entered.

The appropriate prompts appear on the screen and the information is displayed as it is entered. At the end of each input cycle, the operator has the option of deleting incorrect information or entering the information into the computer memory.

Another option is used to enter the information into the computer on a weekly basis. The first entry under this option is the payroll date, and all further information is filed under that date. A client time card number and number of hours worked that week are requested. The client name is then displayed and the cost area, quantity of work and rate are entered. When all cost areas for the client for the week are entered, the total pay for the week is displayed, and a decision is made to enter it into memory if it is correct or delete it if it is inaccurate. If correct, the information is sent to memory and the weekly wage record is printed by the computer. When all clients have been entered, a complete weekly wage report has been printed, the wages are totalled, the amount of money of each value is listed so that each client receives the correct coins and bills in their pay envelope, and the cost area totals are printed.

Additional time savings occur when the third option is selected. It is necessary to prepare monthly and quarterly summaries which list the hours worked, gross pay, FICA, and net pay by client for all of the clients during the period requested. This is done by entering the beginning date and the ending date for the period to be summarized.

Other agencies periodically request records of individual client earnings for a specified period. To print these records, the client time card number, the beginning date and the ending date are entered. The computer prints the requested information by week and totals the information at the end.

This is a very good example of entering the information once and receiving it in several different formats. The time savings of the above client pay program is about 155 hours a quarter. This is the equivalent of one-third of a full time employee.

Improved productivity of staff will benefit most agencies, and staff have appreciated having the repetitive parts of their jobs replaced by the computer. When staff discover that the computer sits on their desk and not in their chair, they respond very favorably to its use. All of the programs described were written in BASIC, a relatively simple computer language that uses many common English words with their typical meanings to instruct the computer. While BASIC is fairly simple to use, it is considered slow by many people, and is slower than some other programming languages. It is worth mentioning that fast or slow are relative terms. A BASIC program of about 10 lines can compute the mean and standard deviation for 35 staff with 26 entries per staff in less than a minute. If a better means to do the needed job is available, use it. If not, consider the possible benefits of a small computer.

The standard deviation sub-routine referred to above is part of a program which keeps staff time card information. Entries are made for each of the 26 pay periods per year which include: hours worked, sick time, vacation, holidays, and other hours. An individual employee record for the 26 weeks can be reviewed and totaled. The workshop staff hours are totalled each pay period and the statistics can be applied to the hours when needed. It is a very easy way to review records and compare an individual to whatever standard is selected. Unusual uses of time are easily and objectively identifiable. A few hours of programming have developed a very useful management tool which requires less than one-half hour every two weeks to maintain.

Client training is a very important part of the workshop program. Daily data is required for the behaviorally written goals for each client, and this data is converted to percentages on a monthly basis and transferred to a follow-up sticker for review by the Qualified Mental Retardation Professional who is responsible for client progress. Each month, staff will write the goal number, date, number of sessions trained, correct trials, reason sessions were not run, percentage of correct responses, whether there was progress during that month, and sign the completed sticker. This takes many staff many hours each month.

It would be nice to free the training staff from this task so they could spend more time with the clients. Since the secretary has extra time which was saved by the improved payroll program, she could enter the data into the computer, with the computer doing all of the writing. Such a program was written in less than two weeks of "spare" time. Removing the bugs (errors) took another week of intermittent activity. We will run the first sample in October, 1983. All of the goals will be prepared this way beginning in November. The program will also print a list of clients who have made progress, those who have made no progress, and those who have accomplished the goals each month. Another report will be sent to the staff psychologist reporting client progress on goals of special interest to that department. Such information is very helpful for the training supervisor who will spend the time which was used searching files to discover lack of progress to instead deal with any needed changes in client programs. The training staff will review the stickers and sign them as they are entered into the files. The time savings can be estimated to be quite large when one considers that the computer requires only four numerical entries per goal.

Most persons have at one time or another used an electronic calculator or have seen one in operation in a store. While impressed with the time savings and improved productivity, few understand how the electronics work. Many people think of falling out of an airplane when they think of programming a computer. A more appropriate comparison would be that of a hiker approaching a mountain. People in fact program computers for different purposes with different levels of complexity related to the job at hand. The important thing to remember is that progress is made one step at a time, with the option to turn around and go back at any time. People hike in the mountains for many reasons. Those who want to fish will tend to stay lower on the mountain and likely near water. The person who wants to get to the snow on top will take different equipment and a different route. Scenic vistas and personal solitude will lead persons in yet other directions. What they share in common is a bond with the mountain and their need to move in their chosen direction one step at a time.

Just how does a person write a computer program? Any way they want to write it. Having said that, there are some things which are generally helpful as one approaches a problem in the real world and attempts to prepare a computer solution to the problem. One of those things is a computer. Buy the one of your choice using the best information available to you at the time. It is more than likely that within weeks or months after your purchase, the price will go down on the computer which you purchase. Therefore, buy it for what it can do for you now (the useful concept again), and not as an investment for the future. The next thing that is important is the manual which will come with the computer.

The other things which are important are things which the potential programmer will need to do if the computer is to become useful. The first step is to review the current information system or procedures which are to be put on the computer. Determine how the system is working now and what changes in the system might be helpful. Perhaps the system could be improved even if there were no computer available, and if that is the case, now is a good time to make those changes.

Exactly what is it that the computer is going to do to improve the system? It may improve speed, it may improve accuracy, or it may improve and expand the management information available. If the answer is that it improves nothing, then go to the section which describes buying a computer and add "quality graphics" and "good game software" to the criteria for computer selection. In that way you will at least be improving the quality of life for employees during breaks. Assuming that the computer is useful, and assuming that the current system has been reviewed and analyzed, it is time to actually develop the program.

With pencil in hand, list the information which is needed at the end of the computer's work (output). Next an outline containing as much detail as needed is prepared. This should include how the information is to be entered and generally what will be done to it to generate the needed output. By now you have an idea of what needs to be done and something of idea of how to do it.

Now it is time to turn on the computer and pick up the manual which came with it. The manual contains useful information such as what happens when this or that key is pressed, and may go on to describe basic programming procedures to be used with the particular computer which you are using. The manual will also assist you in developing a programming style that fits your approach and needs. Books are available which deal with types of programs to be written and which deal with specific computers. These can also be a helpful guide in the actual work of programming. Do whatever you need to do and write the program. It is important to allow time at the end to go back and find out why it doesn't work. Typical reason include logic errors and inaccurate entry of the correct logic. The truth is that the creative programmer is able to create errors which defy description, but which can eventually be detected and corrected. The program is then ready for use. Once in use, it can begin saving staff time and improving client services. If the programmer works for the agency, improvements which meet changing needs of the agency are very easy to add to the existing program.

Individualized computer programs are needed to provide the best training experience to clients whose skills and needs vary greatly. For less than $100.00 a computer, a joystick, and a plug in joystick adapter can be purchased which will enable the client to use the computer by manipulating the joystick. When a television set and tape recorder are added, all that is needed is the specific client and the program. Having purchased the equipment, an afternoon was needed to write a three section program which taught the person to use the joystick, allowed practice, and presented a communication option. The first two sections were needed to develop a familiarity with the joystick and the communication section presented an alphabet where words or spaces were selected. The screen display can accommodate several hundred letters of message and has the option to clear and continue. For an auto accident victim who has low-normal receptive language with no speech and slow physical responses, such a device can be very helpful. Screen graphics and games for reinforcement are easily added. A speech synthesizer and printer could greatly expand the potential. The low cost and highly individualized result compare favorably to commercial communication devices. This device will likely be in use before Christmas. Since only the inexpensive joystick need be exposed to a behaviorally unstable client, the risk factor is reduced as the range of clients for whom it can be used is increased.

In summary, purchasing a small computer and programming it yourself can be efficient and cost effective. Within the workshop described, an initial investment of several hundred dollars will save several thousand dollars each year it is used. As more parts of the workshop operation are computerized, the savings will increase. While this is certainly not the only way to have computers in your facility, it is one of several viable alternatives.

Why should you purchase a small computer and write your own programs? The answer varies: for the philosophically minded, why not?; for super-achievers, because it is there; for the business oriented, because it will save money; for those who have forgotten the Biblical garden story, because it is appealing to the eye and will make you wise.

Computers for the Disabled: A Contradiction in Terms?

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Abstract

Written as a personal philosophical statement from the perspective of a visually impaired person, the author hopes to establish a framework within which the development of computer technology for the disabled may progress logically. Major goals described are complete accessibility to all computer functions and compatibility between specialized hardware/software and general purpose computer systems. Among the priorities suggested are encouraging major computer firms to recognize that the impaired user and general user may often be satisfied by the same product and marketing development. Multiplicity of special techniques, such as synthetic speech, voice recognition and easy to operate controls is urged. The author recommends that specialized developers work more closely together to avoid redundant effort and to help reduce high costs. Current and potential users need to create a better dialogue with developers and manufacturers. Guidelines for hardware and software selection should be established and standards for evaluation developed.

Admittedly, this paper is a philosophical statement. There is nothing presented here which is new about specialized computer hardware or software. What I hope to express, however, is a new or redefined sense of direction which I believe is needed in the field of computers for the disabled. There is an unparalleled opportunity to hasten the evolution in computer technology so that disabled persons may truly become part of the mainstream of society. We must understand the nature of our changing American society. We must understand, and help others to understand, the nature of our impairments and disabilities. As disabled persons, we must understand our needs and expectations, define goals, set realistic priorities, and stimulate action to realize our goals. Those of us in the disabled community, service providers, and leaders in computer technology must work together if computers and their applications are to truly benefit us.

The Information Age

As American society leaves behind its traditional industrial base, entering an age of information management, computers and their applications are becoming ever more pervasive in our lives. Microprocessor technology will dominate the workplace, have a major impact on education, and serve many of our personal needs.

It is estimated that by the year 2000, while 25% of our gross national product will be based upon industrial production, it will require 15 million fewer people to produce those goods. Increasingly, robots will perform difficult, hazardous and boring tasks. Where will the jobs be? Many will be in service industries related to our industrial production. Still more will be based on information gathering, distribution and retrieval.

Word processing will be the foundation of most business activities. Paperwork handling will be replaced by electronic filing and mailing. News will be gathered into massive data base retrieval systems, accessible upon command from office or home computer terminals. The lines of distinction between computers and telecommunications will blur. Computers will communicate over large distances with increasingly flexible terminal interfaces.

Children will learn to use computers at an early age. Students will use computers for individualized instruction, research, college and career planning, and so forth. Teachers, counselors and administrators will become increasingly dependent upon computers to enhance the educational experience and streamline testing and administrative tasks.

In addition to news retrieval, home computer terminals, tied to vast videotex systems, will make possible a broad range of services: electronic messaging, computer games, shopping and banking services, among others. We will be able to comparison shop from our homes, order merchandise, and have the store either debit our bank account or charge our credit card. Short of spitting out cash from the terminal, most banking functions, including bill paying, fund transfers and loan processing will be tied into our home computer.

Despite the power of computer technology, those of us, who have some impaired functioning, will not be able to participate fully or equally in the information age because the hardware and software have not been designed to accommodate our needs. In my opinion, to harness computer power requires a concentrated and logically pursued effort. It seems to me that one factor inhibiting leaders in computer technology from addressing our needs is their misunderstanding of the nature of our impairments, disabilities and handicaps.

Impairment, Disability or Handicap?

A great many people use these terms as synonyms. I believe this prevents us from being able to focus clearly on where computers can help and where they may not. Let me take a moment to review their meaning as defined by the World Health Organization (International Classification of Diseases, 1980).

Since I am visually impaired, permit me to use vision as a reference. Of course, you will be able to make the connection to whatever type of impairment interests you.

Recently I discovered an article by Dr. August Colenbrander (1977) where he describes four levels of performance: disorder, impairment, disability and handicap.

Colenbrander says a visual disorder involves the "components of the visual system and their pathology and may occur in any part of the system," such as the refracting media, retina, optic nerve or brain. The disorder may be defined as astigmatism, myopia and the like. But describing a disorder of the system says nothing about its effect. In fact, there may be no effect on the operation of the visual system, for example, glaucoma completely controlled by medication.

An impairment refers to the functioning of the system. In visual terms "we look at the visual system from a different dimension, not component parts but the overall functioning of the visual organ." Here we measure such functioning as visual acuity, visual field, binocular vision, color vision or night vision. An impairment may range from one (the glaucoma situation I mentioned earlier), to slight, moderate, severe, profound, near total and total. Some levels of impairment can be corrected, such as with glasses or contact lenses. If the functioning of the organ cannot be corrected, then the impairment will have an effect on us when we try to use the system. We move on to the level of disability.

Now we must have a "broader horizon with a perspective beyond the specific organ to the total abilities of the person. Ability involves looking at the skills needed to perform tasks." In my case, my visual impairment is severe enough that I do not have the ability to read normal print, or worse yet, in this new information age, see the display of a video terminal. In this context, I am disabled. You will readily see how this definition applies to other skills, such as manipulating the controls of a computer keyboard for someone with an orthopedic or neurologic impairment. As with impairments, levels of disability range from slight to total.

With appropriate aids and training, a person might be totally disabled visually, but entirely productive. For example, if reading and writing can be accomplished entirely by using braille, then the lack of vision is of no significance. Unfortunately, there is no current computer technology available which makes the entire display of a computer screen accessible to a visually disabled person with the same flexibility and ease of use as for a sighted person. To the extent that access to the computer screen is required to use the program, the disability becomes a handicap.

Colenbrander says:

On the golf course or on the racetrack, a handicap indicates the extra effort an individual has to put forward in order to win. Visual handicap, similarly, indicates the need for extra effort because of visual loss.

The degree of handicap is related to the degree of visual disability but, again, this is not a one-to-one relationship. It represents the balance between the individual's abilities and what is expected of him, both in terms of societal demands and in terms of his self-image and educating his environment about what can and cannot be expected may reduce the handicap considerably. Thus, the handicap dimension again widens our perspective, this time from the individual to the society in which he functions.

In the setting in which an individual functions, the need for extra effort is usually reflected in a reduced degree of independence.

The World Health Organization lists five parameters of handicap (ICD, 1980): Physical independence, mobility, economic independence, employment and social integration. Visual impairment has an impact upon visual skills, but it is the combination of visual and nonvisual skills that determines the abilities or disabilities of the individual. If the abilities needed to perform a task require too great a special effort, the individual will be handicapped in some way.

With respect to computer screens, my inability to see the terminal's screen is such that no amount of effort will permit me to use it. I am handicapped, if my employer requires this of me. I am handicapped, if I want to transact my banking business at an automatic teller machine or play video games with my children.

Computer technology has the potential to permit alternative access to computer screens such as synthetic speech, paperless braille, or an enhanced visual image. If this access is a flexible and easy to use as for a sighted person using the computer screen, my handicap is eliminated. My disability has vanished, at least for performing this task. I am left with an impairment as a result of a visual disorder, but it is meaningless with respect to using a computer terminal.

In this context, the term "computers for the disabled" may someday be a contradiction in terms. Alas, this is not yet true. Let's look for a moment at our needs and expectations, before considering defining goals and setting priorities.

Needs and Expectations

What we really need is our own personal $6 million man (or woman), available at the corner store for $199.95. To restore or replace our malfunctioning body parts would be nice, but is, of course, an unrealistic expectation. Intelligent prostheses research is still in its infancy.

We do have some realistic needs and I think some reasonable expectation of achieving them. Gregg C. Vanderheiden has made some interesting comments recently in an article published in Rehabilitation Literature (Vanderheiden, 1983). He says:

The practical use of microcomputers in rehabilitation is still very much in its infancy. Although some very interesting and useful programs have been demonstrated, researchers have not yet begun to tap the potential of microcomputers as aids to handicapped individuals. In part, this is due to the fact that microcomputers themselves are just beginning to mature, and portable microcomputers (which will be necessary for most personal aids to handicapped individuals) are only beginning to appear, and still lack the power and flexibility necessary.

Like many new tools, however, the microcomputer's potential is in many ways overestimated and its application oversimplified. The overestimating stems not from a lack of potential for the microcomputer (a potential which we have only begun to tap), but rather from a lack of understanding as to the other components which must also be in place if a microcomputer is to be able to play an effective role in the rehabilitation process. In other words, the microcomputer will not be a success with the rehabilitation field unless it is applied within an overall rehabilitation process. The exaggerated view of aids as "cures" is probably the single greatest cause of device failure in the rehabilitation process. The second greatest cause is a lack of understanding of the complexity and flexibility of the functions (communication, reading, writing, mobility, and the like) which the individual has lost, and which the aid is trying to replace. The application of microcomputers is not immune to either of these sources of failure.

. . . The major contribution of microcomputers will not be in opening up new tools (as electronics did), but rather in making these tools more cost-effective and within the reach of more handicapped individuals. Microcomputers represent a pre-made and mass produced function block around which specialized aids for handicapped individuals can be constructed. In some cases the microcomputers can be used without any hardware enhancements by simply creating special programs for them. In other cases, the microcomputer may require some minor custom or semicustom hardware enhancements in order to fill the desired functions. In either case, however, the cost of the overall aid can be greatly reduced because a large portion of the aid (the portion represented by the microcomputer) can be mass-produced. Thus many techniques or aids which were previously implementable only with hardware which was custom designed for handicapped individuals, and produced in only small quantities at relatively high cost, can now be implemented using these tools.

In the field of sensory aids for visually impaired individuals, I am of the opinion that we have just come through the first generation. Many devices have been especially designed for visually impaired persons and, although, they employ microprocessors, they are very specialized and costly. The existing market for these devices is small, if we consider only the visually impaired population. Products such as the Opticon, Kurzweil Reading Machine, VersaBraille and the like cost several thousands of dollars. They are not affordable for most individuals and sales are limited to organizations which can place them in institutional settings (schools, libraries, rehabilitation centers, etc.), or they are funded for individuals by third parties under vocational rehabilitation programs.

In adddition to high cost, these devices lack the flexibility and compatibility to be used on the job, in the school or at home with the same ease as a microcomputer used by the general public.

This first generation of devices and software has doubtless been necessary, Innovation usually begins on a small scale and at a high cost. However, if we are ever to have full and equal access to the new information age, we need a different approach. Because the cost of computer technology is rapidly decreasing and flexibility increasing, I believe there is a reasonable expectation that our goals can be reached.

Goals and Priorities

Our primary goal must be to have computers used by the general public in the school, work place and home, equally accessible to individuals with communicative, sensory or motion impairments. Most of the technology is available or soon will be. It is the application of that technology which must be redirected.

I don't mean to imply that small entrepreneurs and specialized companies should be displaced. They have been the innovators. Leaders in the computer business need to understand that they have another market which can be sought hand-in-hand with their current ones. Ingenuity in product development and marketing is all it takes.

Digital Equipment Corporation (DEC) has recently been working along two paralled lines which I think will illustrate my point. DEC has discovered that proofreading word processing output directly from the video screen is not very efficient. Errors are overlooked, in part, because of the low resolution of the screen's display. By coupling synthetic speech of high quality with the video display, proofreading error rates have dropped. In another area, DEC has developed an access technique, using synthetic speech, which permits executives and sales personnel in the field to read their electronic mail by telephone and to enter sales orders through use of the touch-tone key pad. The output is the voice of the computer.

It's a relatively small step to cause all the functions of a word processor, electronic mail or order entry system to be fully accessible to visually impaired individuals.

Some of you may respond by saying that computers already exist to do these functions, for example, Maryland Computer System's "Information Through Speech." The trouble is that the system is independent of equipment used in most offices, unless they happen to have the particular Hewlett-Packard microcomputer used in the "Information Through Speech." Compatibility is the problem.

Almost none of the array of computers now available to serve visually impaired people are compatible with each other or the mainstream of computer products used by the general public. One reason for this is that developers and manufacturers have been producing complete systems. I think they need to concentrate in the future on developing products which make existing general purpose computers accessible.

For example, David Holladay's Braille-Edit program can become one of the basic programs in our field. However, at this point, it works only with Apple II models. It should be designed to also operate with CP/M and IBM operating systems. Not every school, office or home has an Apple. In fact, the Braille-Edit program could go on one step further. Upon command, as needed, the entire contents of the computer screen should be translatable. Visually impaired users must have all the information available and must be able to scan for it easily.

With one exception, current synthetic speech related devices cannot be used to access the entire screen display (video buffer memory). The exception is the "Zero Card" developed by Cyberon for use with the Apple II-E and the Cybertalker speech device. Actually, the Zero Card attempts to get at the heart of the operating system and will, I believe, go through another generation or two before it becomes a really useful device.

Visualtek is making its "Large Print Computer" available in versions to work with several different computers: Tandy TRS-80, Apple II or IBM PC.

Accessibility and compatibility of existing products are our major goals.

The highest priority should be given to developing peripherals which do not require the user buying a complete system or limiting oneself to a particular model of microcomputer. This is beginning to happen and should be encouraged.

Another priority is to coordinate research where possible and to improve information about who is working on what. I don't know if it's realistic to expect broad communication among developers. There are a number of publications, such as David Holladay's Raised Dot Computing. Perhaps we don't need more publications, but we should make better use of the ones we have.

I am distressed, for example, that paperless braille development has resulted in four major products which are not compatible. A user cannot go from one system to another using the same types of commands and protocols. Cassettes used for the MicroBrailler will not work with the VersaBraille. This is but one example of the non-standardization of hardware and software. This field is too small for us to be able to afford the confusion which once afflicted the computer industry as a whole.

Another priority is to help educate the potential purchaser about what a product can do and what it can't do. Almost all the people who need accessible computer equipment have no idea what questions to ask or how to evaluate the reliability and applicability of the answers given. An objective set of guidelines and evaluation of products is sorely needed.

Actions Recommended

I would like to see three actions taken to help implement the goals and priorities discussed above. You will recognize that for each type of impairment there may be different actions needed, depending upon the stage of development for the product area.

First, I suggest that potential and actual users meet and work together to form a consensus of what approaches need to be taken. Second, developers and manufacturers should work more closely together in order to increase general accessibility, compatibility and reduce redundant efforts. Third, I would like to see major companies in computer technology brought into closer working relationships with developers and users, by helping companies identify common product development and marketing approaches. By joining forces with leaders in the industry, impaired individuals have a better chance of obtaining accessible products at a cost they can afford.

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Adapting Computer Equipment for Handicapped Children: A Review of Current Strategies and a Report of a Project

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Abstract

Various methods for adapting commercially available computer equipment for the use by physically disabled person .ave been devised. Strategies that have been employed include changes in direct input, construction of remote input devices, "transparent" modifications, and alterations in the type of output. By using this adapted equipment, the disabled computer user often can have access to computer programs designed originally for the general public. Adapted computers may also be found to be extremely useful as educational aids for physically disabled children at a cost for school systems that should not be prohibitive. An example of one method of adaptation by using a Timex Sinclair 100 computer is presented. This computer was modified to serve as an adaptable and versatile communication aid.

Impetus for this review came about when the author was asked if a child with severe dyskinetic cerebral palsy and problems with oral communication could benefit from the use of a microcomputer. Because of this child's physical impairments, the use of a standard computer keyboard would be difficult if not impossible. In order for this child or other children with similar problems to have access to a computer, it is necessary that some type of adapted equipment can be purchased or constructed.

The first electronic communication aids and computer systems for disabled persons were designed in specialized laboratories by rehabilitation engineers and other scientists. Those devices were usually one of a kind, and as such were built at a high cost. Today, many of those devices that had been developed are now available commercially which has usually lowered the cost significantly ("International Hardware/Software", 1982).

After reading about some of these specially designed and expensive electronic devices, similarities were noted between this equipment and various computers, voice synthesizers and other hardware being marketed to the general public. The question was asked—"Is there any way to adapt commercially available computers or other electronic aids so that the high cost of hardware specifically designed for use by handicapped persons can be avoided"?

At the present time, the vast majority of hardware and software being specifically produced for use by disabled persons is designed to serve only one particular need, such as an aid for communication. One problem with this approach is that it is not addressing the fact that disabled persons usually have similar needs and desires to use certain hardware and software as anyone else. Word processing, games, computer-assisted instruction, and financial management programs are only a few of the possible types of software which could appeal to both disabled and nondisabled persons. The sights and sounds of computer video games, for example, undoubtedly appeals to most children whether they are physically disabled or not.

Many people, including this author, have previously accepted the belief that if some device is able to be used by a disabled person, a piece of equipment has to be specially designed "from the ground up," otherwise, it would not be adequate. This belief is not always correct, and in a way, a piece of equipment designed only for use by handicapped people may be just another way to keep a handicapped person removed from society at large. An exaggerated fictional example of how this might occur would be the required use by handicapped persons in wheelchairs of specially designed elevators constructed in buildings that already have the standard type of elevator. Rather than adapting the standard elevator so that a wheelchair-bound individual could use it, the handicapped person would then be separated unnecessarily from the rest of the public. This is not to say that sometimes separate or special hardware is not needed. However, it seems very important that those of us who are "temporarily able-bodied" as well as those that are disabled, should try to examine ways that something might be adapted for handicapped persons, rather than taking the more costly and often unnecessary route of "starting from scratch."

Recently, major efforts have been made to adapt computers that are designed for the mass so that these can be used by disabled persons and, in particular, for disabled children. The following is a review of some of the techniques involved in this adaptation process.

Strategies

Many disabled persons do not have the physical capabilities to use an unmodified keyboard in order to enter messages into the computer. For these persons, modifications of, or additions to the commonly used input and output devices are necessary. In general, specialized input devices to these electronic systems consist of either a direct selection device or a remote control device.

Direct selection requires that either a part of the person's body (finger, toe, elbow, etc.) or a special device (headstick, mouthstick, etc.) be used as a pointing mechanism. The "pointer" then will make direct contact with either a regular keyboard, a specially-built keyboard or some other device such as a touch panel. A touch panel is a pressure sensitive matrix of translucent switches that is directly attached to a video screen. By making contact with this panel directly on the screen a selection can be sent to the computer.

The simplest adaptation that allows direct selection is the use of a keyguard that can be fastened over the computer keyboard. These devices consist simply of a firm sheet of plastic or metal with holes drilled out so that two or more neighboring keys cannot be accidently pushed at the same time. The use of keyguards, of course, are for those disabled users who have mild to moderate impairments of movement, rather than those with more severe limitations.

Remote input refers to a device in which much more simpler movement or even speech or sounds can be used as a selection control. A joystick, such as that used to play certain video games on a computer, can often be used, without modification, to provide a great deal of access to many computer programs for those disabled persons who could use these.

A device that has become known as a "scanning communication board" that can be controlled by a single switch is often used as a remote control input device to computers. Several manufacturers, such as the Zygo Company and the Prentke-Romich Company make this type of equipment ("Communication Systems", 1983; "Access to Computers", 1982). A light scans across squares on these boards which contain pictures, symbols or letters of the alphabet and the light stops when a switch is activated. The information on that particular square, for example the letter A, causes a signal representing the letter A to be sent to the computer. The switches that can be used to control such a device often can be controlled by such small movements such as blowing or sucking or a tube (pneumatic switch) or by contracting slightly a single muscle (myoelectric switch).

Possibly the most important recent development for the handicapped computer user is the development of "transparent" modifications. These remote-control types of modifications are made in hardware and/or software so that any piece of standard software can be used and neither the computer nor the standard software program being used is disrupted or interfered with by the modification. Conversely, the computer or software should not be able to disrupt or negate the modifications in a truly transparent situation.

One type of device that is currently being developed demonstrates one of the best ways of adapting computer equipment. These devices usually are what could be called transparent modifications. This group of devices are called keyboard emulators. Essentially, a keyboard emulator is an electronic "box" that will allow the disabled user to use some type of modified keyboard or other input device in order to access the computer. One example of how these emulators work is by having a connector on the side of the special keyboard or input device that would accept a standard signal format, such as RS-232C serial, parallel, or other signals and send them by wires to the appropriate connectors on the emulator. The emulator then would translate the signal into something that a computer would think is coming from its own keyboard. By having a keyboard emulator, the special keyboard or input device can be selected or made so that someone with a specific disability can have a device individually designed to meet their needs.

Hopefully, keyboard emulators will become popular for use in school systems. With their use, disabled children could possibly have much improved access to computers that are already available in their schools. These children could then be able to utilize the same educational software programs as their nondisabled schoolmates. For example, a keyboard emulator that works with the Apple (TM) computer is now commercially available for a price of approximately $400.00. This emulator was originally designed by Paul Schwejda from the Alternative Communications Project of the University of Washington (Schwejda & Vanderheiden, 1982). Since Apple (TM) computers are very common in the schools systems in the United States, this device, or something similar, could play an important role in helping with the education of disabled children. With the use of this relatively inexpensive keyboard emulator, or others that may be devised, combined with specialized keyboards or input devices, physically disabled children will be able to obtain early and valuable experience in using computers.

Transparent adaptation for computer hardware can also be made so that the output of the computer can be altered to meet specific needs. This type of modification is especially important for those users who are visually impaired. One important system that has been developed is called the VersaBraille. This device consists of a small box full of electronics that is connected to the output of the computer. This box has small rods which will move in response to output from the computer and form different Braille characters ("The VersaBraille System", updated). A visually impaired user, therefore, would be able to "see" the output that normally would be sent to a videoscreen. Somewhat similar systems which use synthesized voice output through a speaker to allow "reading" of what is shown on the screen have also been developed (Blazie, 1981). These techniques, however, are not entirely adequate since audio or limited Braille output requires the user to memorize to an extreme extent what the output from the computer should be at any particular time. Many times modifications in the software itself have to be made so that visually impaired users can optimize their success in using a computer.

Transparent modifications, although probably the best approach for allowing disabled users access to computers, usually require development or modification of computer hardware and therefore can be costly. Recently, in order to lower the cost of adaptation, a type of strategy called "semi-transparent" modifications has been developed. This technique is usually a type of software program that will be in the computer's memory at the same time that a regular program is loaded. One example of the software only method for making semi-transparent modifications are the programs written by Peter Maggs of the University of Illinois at Champaigne-Urbana (Maggs, 1981). These programs, written for the Apple (TM) computer, provide voice output of what is shown on the television screen. No special hardware is needed other than the voice synthesizer which is available commercially. Another type of semitransparent modification is the use of special hardware that incorporates ROM (Read Only Memory) to act as an interpreter for the computer itself. Essentially these involve a very simple computer acting as a "controller" for the microcomputer.

The Shadow-Vet voice entry device for the Apple (TM) computer is an example of this latter type of semi-transparent modification ("Access to Computers", 1982). The Shadow-Vet allows the disabled user to run programs, even protected programs, such as Word Star (TM), using voice commands only.

Voice input is a relatively new method of sending information to a computer. Many disabled children can produce a number of sounds which, though consistently used as a vocabulary, are not understandable to other people. Even vocalizations such as these can be used to "train" the computer to respond to them in a meaningful way. This type of device can easily be turned into a communication aid in which the computer would recognize the sound and translate these sounds into words printed on a video screen. Development is currently underway on equipment using sound or voice input which will be translated by the computer into synthesized speech that should be easily understood by the listener.

Superficially appearing to be the most complex, but probably the most efficient and adaptable approach is the use of a dual computer system. This method may actually be one of the least expensive approaches since no special hardware has to be constructed. One computer, probably the smaller and least expensive of the two, would act as an input device and could also serve as an accelerator device to increase the efficiency of the disabled user by allowing more than one task to be going on at the same time. It may also allow short codes, abbreviations, or symbols to be entered that would be interpreted as long commands or possibly whole tasks. This first computer, either by using its only hardware or by sending output to a keyboard emulator, then would control the second computer. The second computer, essentially unaltered and completely free of extra programs in its memory would therefore be able to run standard software programs without any type of modification.

Since the two computers are separate, the control programs for the first computer can be easily written in a high level language such as BASIC and these programs could then be more easily changed as the skills or the need of the disabled user changes. In addition, this "control program" probably could be easily changed so that another disabled user with different abilities could use a similar system. The Trace Research Center at the University of Wisconsin, Madison, Wisconsin has done some preliminary work that uses this approach (Van Vorheiden, 1982). This type of approach would seem to be very desirable for use by disabled children. The disabled child could begin learning the system at a simple level—possibly by playing games. Later, as the skills and the needs of the child change, new programs for control of more complicated tasks could be developed.

One of the major uses for computer technology for disabled children is in the area of communication. Specialized computers have been and will be increasingly used by nonverbal disabled persons as communication aids. The price of these commercially available devices range from one hundred to several thousand dollars. These communication aids have been very effective in helping these children to gain more independence and a sense of autonomy.

When you are dealing with a child who is nonvocal and has physical disabilities, communication can be a problem. Except in the case of typewritten notes, the receiver of the child's message has to be physically present to obtain the communication. Because of the new advances in technology, today the output from these children can appear as pictures or words on a CRT screen (a television-like screen), words printed on paper or even spoken language using voice synthesis.

In addition to allowing these children to interact with other people, computerized devices can also permit them to interact with their environment to control electrically operated devices, such as radios or lights. Computer systems could also allow a physically handicapped child with impaired motor abilities to do extensive drill and practice at school for remedial training on concepts. This would require minimum time from school personnel and allow children to practice independently and at their own speed. Besides providing feedback to the child, computers can also help encourage social interaction with other children through games or other program.

Assessment

Since every disabled child's needs and abilities are different, it is often somewhat difficult to develop a special communication system or computer system that is best suited to them. This is a process that usually requires extensive planning by an experienced team of professionals to evaluate the child's current and potential abilities. This team should include such people as speech and language therapists, physical therapists, occupational therapists, rehabilitation engineers, special education and others who by their training or expertise are appropriate.

Assessment of the child should be done prior to obtaining equipment so that devices that are unusable are not inadvertently purchased. In general the assessment is best done by a systematic approach that compares what the child can do with what the system does. Working with these electronic systems requires some knowledge about, 1) how information can be put into the electronic device, 2) what degree of physical ability is needed to work the device, and 3) what the output of the device is and how the output might be changed to be more easily understood. A child with poor vision, as an example, would probably require special changes in all three of these areas. As another example, a child with only minor physical limitations may need only a special keyguard in order to be totally functional with computers or communication aids that have standard keyboards.

It is with children who have moderate to severe limitations that the need for the combined knowledge and experience of the team of professionals as outlined above is needed to its utmost. In evaluating a child with severe limitations, the team's main task is to determine which movements a child can consistently control and how these movements can be used to control some type of input device to enter information the computer. In addition, decisions have to be made about what output would be the most acceptable and useful to both the computer user and whomever is going to receive this information. This output information could be on a television-like screen, printed page, or synthesized speech.

One extremely important consideration in this area of adapting computer equipment for use by disabled persons is the need for proper positioning. Obviously, those who are severely physically handicapped will have difficulty maintaining a position that allows optimum functioning. Most of these children require special seats or wheelchairs to be able to work a computer or communication system. Proper positioning, done by trained personnel, is very important so that the child can be stable as possible with improved control of muscle movements. When stabilized, they will be able to more easily maintain their attention to working with the electronic system with less effort and energy being expended in trying to keep an adequate position in relation to the devices.

Probably the best initial step in the process of adapting computer equipment for the disabled user is to learn as much as possible about what already is available. The best sources of information are companies who have produced specialized electronic products for the disabled, such as the Zygo Company or Prentke-Romich Company ("Communication Systems", 1983; "Access to Computers", 1982). Another source of information is contained within the pages of computer magazines. Most brands of computers have at least one magazine each that is published specifically for that computer and are full of advertisements from companies that make add-on peripheral hardware or software for that specific computer. Although these advertisements are not specifically addressed to the disabled user, they are still one of the better sources of information about what is available for particular computers. Without this first step of information gathering, the building up of the system might be somewhat haphazard, often more expensive, and possibly lead to the design of a system that would not meet the needs of a specific disabled user or one that is not able to be easily altered as the skills of the user improve.

As alluded to above, another consideration to make when planning a computerized system for a child or anyone who is disabled, is the adaptability of the basic computer itself. Even with a computerized communication aid, if this aid has a fixed vocabulary in memory, it is much less adaptable and therefore less desirable for a child who will be learning more and developing new skills. It is best to have a system in which new material can be added easily.

There are several issues that should be important to the parents of disabled children or other purchasers or potential purchasers of computerized systems. The first of these is the maintenance of the system. Hopefully, the companies that manufacture aids will include long-term warranties and possibly make available maintenance agreements. If a commercially available computer, such as an Apple II (TM) is modified, it is helpful if the modification is actually a plug-in, add-on, peripheral which will not void the warranty on the computer.

The purchaser should also try to be as aware of the available possibilities and to enlist the aid of knowledgeable professionals, such as speech therapists, rehabilitation engineers, or special education personnel. This is often a difficult task, mainly because of the fact that in this high technology field changes are so rapid that many of these professionals are just beginning to learn about these devices themselves. Also, as with anyone currently going through the process of buying a personal computer can attest, there will always be a continuous dilemna between deciding on currently available equipment or waiting for future developments.

Project-Adapting a Timex Sinclair Computer

The Timex Sinclair 1000 is one of the least expensive computers on the market at this time. The Timex was selected as the computer to be adapted after comparing several computers that, in cost, were under the arbitrary price ceiling of $100. The most important factors that were compared between these computers were not the computers themselves, but were the types of "peripherals" available for each computer, such as printer outputs, speech synthesis boards, etc. Specifically, what was looked for with these commercially available peripherals was how they might be beneficial to someone who was disabled. For example, a device that could be connected to the computer that would control electrical appliances and lights might be very beneficial for a person whose mobility was impaired. The cost of these peripherals for each computer was also compared. It was often noted that the cost was not necessarily reflective of the quality or the utility of the device. Also determined was the fact that substantial savings could often be realized if certain devices could be obtained in kit form. These kits often come with very detailed instructions that would allow someone with minimal skills to complete them.

At the conclusion of this somewhat superficial survey, the Timex appeared to have the largest number of peripherals that were appropriate. In addition, most of these were at a less expensive price than for other computer types. A possible reason for this finding appears to be related to the large interest shown in the Timex computer by computer hobbyists and by several smaller, "cottage," electronic manufacturing firms. These firms often sell devices in kits at a reasonable cost or completely assembled for only a few additional dollars.

After minimal expense and work time, this computer was able to be transformed into a very versatile communication aid. The only modification to the computer itself was the soldering of several wires to the keyboard connections on the printed circuit board of the computer. This change actually could have been made without soldering, but this alternative method would have involved disconnecting the keyboard connections on the printed circuit board and therefore making the miniature membrane keyboard on the computer itself inoperable. The wiring itself was not difficult and this author, a person with minimal experience with electronics, was able to do the wiring without difficulty.

The initial plan for this project was to connect these newly added wires to a large membrane keyboard that will allow a disabled user to push each key despite limitations in finger or hand control. In other words, since the whole keyboard was expanded, each key would therefore be a much larger target. An attempt at this approach was made by using surplus membrane keyboards originally designed for copy machines. Each of these had several membrane keys which were separated and eventually rearranged into a pattern that could be wired directly to the Timex computer. The results were severely disappointing, mainly because each key required considerable pressure to actually register an entry into the computer and, in addition, required the pressure to be in the exact center.

At about this same time, information was obtained about a commercially available large membrane keyboard. This keyboard, (available from Unicorn Engineering of Oakland, California) is designed to be interfaced to an Apple (TM) computer through a keyboard emulator (Schwejda & Vanderheiden, 1982). Plans were initially made to purchase one of these expanded keyboards. However, phone conversations that were later made to personnel at that firm led to some slight doubt about the practicality of using that particular keyboard, in its original form, with the Timex computer. Since this keyboard costs about $150, the plan to use it was rejected at the particular time. This keyboard, however, reportedly works quite well for disabled users. If the funding for future projects occurs, attempts will probably be made by this author or others to adapt this keyboard or develop special software to allow its use with the Timex computer.

The second phase of development was the construction of a magnetic field sensitive keyboard. This keyboard is similar in funtion to one currently being used with an alternative communication device called the "Autocom" that is currently being produced and sold by the Prentke-Romich Company ("Access to Computers", 1982).

The keyboard that was constucted for the Timex computer was very inexpensive in terms of cost for the parts, however it was somewhat labor intensive requiring nearly nine hours to complete. This keyboard, when completed was directly connected to the Timex computer via the connection plug previously described. The keyboard was made by using a wooden lapboard from a wheelchair, onto the bottom of which was connected a wired matrix of glass-cased magnetic reed switches. These switches respond to a magnetic field by closing and therefore switching to "ON." This matrix of switches was connected so that each magnetic reed switch would take the place of each of the 40 keys that are on the unaltered Timex computer. The main difference, of course, is the large size of this newly designed keyboard. Each magnetic switch is sensitive to a moderately strong magnet placed within one inch in each direction from the center of the switch. The top of the wooden lapboard, with the matrix of switches underneath, was divided by lines which divided the surface into 40 equal areas that are 2 inches square. One magnetic reed switch was placed under each one of these square.

By using small magnets with this basic set-up, input could be made into the Timex computer without anything else needing to be altered. Any software for the Timex computer can be run without modifications being necessary. This magnetic sensitive keyboard is essentially a direct selection device which is used as a transparent modification for the computer. A special magnet-containing pointer for hand use and a magnet-containing head stick pointer were made to serve as examples of actual devices that could be used by someone who is disabled to "switch" on these individual reed switches.

Two commercially available options were purchased for the Timex computer, a 16K RAM module (more memory), and a Sinclair printer. An inexpensive a cassette recorder was used for program storage. A small TV set (5 inch screen) was used with the system so that the input and program output could be viewed. This system was designed so that it could be run by using a single 12 volt automobile-type battery, similar to that commonly found in electric wheelchairs, as its only power source.

A simple computer program, written in BASIC, was used to enable the computer to act as a message generator. This simple communication aid was planned to be used by a nonverbal child who is not reading and uses pictures or symbols to communicate. In this simple prototype that was developed, symbols were used on an expanded keyboard so that a child who does not know letters could touch pictures on the large keyboard and the appropriate word would be printed. The print out would be both on the TV screen and on paper using the Sinclair printer attached to the computer. This allows a child to type in messages to people not actually present and would also allow someone trying to communicate with the child directly to follow the conversation better by having a printed out message to refer to. A more complicated computer program could be written for this system that should make it possible that over 100 different characters or words could be produced using 35 symbols in each of three different "levels". Each of these levels could be accessed by some type of "control switch" that could be used.

Three modifications of this basic configuration has been recently pursued but are still in very early stages of development. The first is an attempt that has been made to attach a battery operated ("permanent") nonvolatile memory board to the Timex Sinclair computer. This device hopefully will eliminate the need for loading the "message generating" program into the computer from the tape recorder. The device used is available as a kit or fully assembled from Hunter, Inc., of Okemos, Michigan. This board was also discussed in a recent issue of Radio-Electronics (Hunter, 1983).

The second endeavor is intended to adapt the Timex Sinclair computer so that a joystick can be used as an input device. The joystick to be used is not the standard type but is a specialized "position sensitive" joystick. This joystick is available from Data-Soft, Inc. of Chatsworth, California. This joystick responds to changes in movement away from the vertical and then sends signals to the computer as with a regular joystick. For this project, this joystick was attached to a headband so that tilting of the head to the right or the left with the joystick attached would send these signals to the computer. Forward or backward movements of the head would, of course, send other signals to the computer, but these movements unfortunately, also make it extremely difficult to continously watch the television screen. A program, similar to the familiar "Space Invaders" (TM) developed by the Atari Company, is currently being planned that will take advantage of this head-operated joystick. This game will be somewhat slow-paced and will have continuous firing of the "lasers" at the "alien invaders." This will be done so that the trigger switch on the joystick does not have to be altered. Another possible program that could be written, that would require an adapted trigger switch, is a typewriter-like program in which letters could be selected from a programmed display of the alphabet on the television screen using this adapted trigger switch. As each letter, number, or symbol was selected, a message could be developed that could later be printed. This program would be similar to what has been developed for the "scanning communication aids" that were previously mentioned.

The most recent project involves the addition of a speech synthesis device to the Timex Sinclair Computer. The device used, available form Research in Speech Technology, Inc. (R.I.S.T.) of Brooklyn, New York, works by combining small subunits of speech called allophones or phomenes together to form words or phrases. This project has just recently begun and barely more than "Hello, have a nice day" has been produced. The speech produced, for the most part, was easily understood. Other speech synthesis devices, probably adaptable for use with the Timex-Sinclair, may actually be more useful for speech synthesis, but the costs of these more complex devices probably are significanltly higher than the device currently being utilized.

The project as outlined was this author's attempt to understand, at a practical level, some of what may be involved in the development and production of computer equipment adapted for disabled persons. The projects that were done were financed entirely by the author. In addition, the vast majority of the construction and programming was done by this author who has minimal knowledge and skills concerning electronics or computers. It should be obvious, therefore, that better solutions for the problems addressed by this project are highly possible.

Even though this particular project took a minimum of time, cost, and expertise, the final results left much to be desired. In the end it was concluded that the design of useful, durable, and inexpensive computerized aids that can be made generally available to handicapped individuals is not easy and probably should not be attempted by those with minimal skills. In addition, however, they should not be attempted without closely studying the needs and skills of handicapped people. With disabled children it also seems evident that those professionals that are working with each child (parents, educators, therapists, physicians, etc.) are the ones best capable of examining how each child's unique abilities can be used to their best advantage in using a computerized system.

Conclusions

The beginnings of the personal computer age represents a real change in the technology as available to disabled persons. All the evidence that was uncovered when this material was researched seems to indicate that the expertise and information available in the area of computers for the disabled will increase tremendously over the next few years. This will come not so much as demands from disabled persons increase, but rather as computer technology permeates its way into every aspect of our life. One area that hopefully will gain strength and grow is the use of computers by disabled children in their schools. This would include children with such diverse disabilities as learning disabilities, mental retardation, or physical impairments.

These modifications that were described do not require any waiting for new technology to be developed. For example, the technology to provide computers and computer-assisted instruction to disabled children already exists. However, in most school systems there is a lack of both funds and information about the results of previous research that seriously limits the schools' use of this knowledge.

It is important that we professionals who see handicapped children try to do whatever we can to entice the computer and electronic industry to be interested in producing devices for handicapped persons. The community of handicapped people is a large market, about ten percent of our total population, and would seem to be one that companies should be interested in. For an able-bodied person, a personal computer may be a fun tool or useful at work, but for a handicapped person, a computer may be almost a necessity to perform certain functions. This computer technology may actually prove to be one of the most important aids to vastly improve the quality of the life of handicapped persons. It may also be proven that, to be the most fruitful, these computerized systems should be used with many if not most physically handicapped children so that their skills will improve with age and they will be quite adept at their use by the time they are adults.

One worthwhile effort may be to try to encourage the development of more "cottage industries" that are interested in adapting and developing new hardware and modifying computers produced for the general public so that disabled persons, and especially children, can benefit from this new technology.

Those of us working with disabled children, parents of disabled children, and disabled individuals themselves will need to maintain good communication among ourselves to help insure that disabled children have access to what is available in our rapidly expanding electronic computer and information age. It is possible that for some handicapped children who have mild or no mental impairments, but possibly moderate or severe physical limitations, computers may prove to be the best way to essentially eliminate a disability.

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Integrating CAI with Traditional Instruction in the Elementary Classroom

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Abstract

Academic learning time can be enhanced through the use of CAI as one of a variety of resources used by teachers in presenting instruction. To develop optimum, individualized instructional plans, skillful teachers consider the type of learning, curricular area, and teaching method involved as well as the student's unique characteristics. A case history is presented to illustrate an instructional program which is based on the simple premise that different things are learned in different ways by different students. The plan makes extensive use of CAI as a supplement to traditional instruction.

An unquestionable goal of instruction is maximizing student achievement. Academic learning time (ALT), defined by Berliner (1977) as "on-task or engaged time [spent] by students, interacting with material or participating in activities of intermediate level difficulty, that are academically focused" (p. 3) has been identified by researchers as being highly correlated with student achievement (Fisher, Filby, & Marliave, 1977; Gage 1978).

It seems clear that the use of computer-assisted instruction (CAI) in the classroom can help to eliminate time-wasting activities which detract from ALT such as students' waiting in line to get papers corrected. What remains to be established is a framework within which teachers can make instructional decisions which allow them to use the variety of methods and materials within their repertoire -- including CAI—to enhance ALT for individual students. Gage (1978) has identified certain domains (i.e., type of learning, curricular area, teaching method, student characteristics) within which research analyses are likely to identify factors correlated with student achievement.

The following statement, albeit simplistic and self-evident, is proposed as a rudimentary version of an instructional planning framework which recognizes the importance of these domains in seeking to optimize ALT. Different things (types of learning, curricular area) are learned differently (method) by different learners (student characteristics). In the absence of clear and comprehensive research results which identify critical relationships within these domains, the individual teacher can proceed on the basis of experience-based professional judgement to consider this "framework" in formulating instructional plans. The following hypothetical case history illustrates how this might be done.

The case history concerns the planning process employed by a resource room teacher in formulating an instructional program for Mike, a learning disabled fourth grade student who attends the resource room for one 50-minute period a day.

Resource Room Features

Before plans for Mike's program are presented and explained, it is necessary to describe certain features of this hypothetical resource room.

Materials

Within the resource room, CAI is one of a variety of tools which the teacher uses in developing the "best" program for each student. There is one microcomputer in the room. The teacher has invested in one relatively expensive, commercially published software program which provides drill and practice on computational skills for grades 1 through 8. In addition, she has a number of small, teacher-made programs. She has a math facts review program, developed by a colleague, which permits selective review of math facts. She herself has written a program which presents selective math facts review in a game format.

Traditional materials available in the room include manipulatives and the math textbooks and workbooks used by the school district. Also available are educational games and teacher-made learning centers which provide practice in the areas of time, money, measurement, and word problems.

Since Mike only takes mathematics instruction in the resource room, only math materials have been described. However, an analogous set of materials for reading instruction, i.e., a combination of traditional, teacher-made and computer software materials, would also be available.

Schedule

The teacher conceptualizes the 50-minute period as being divided into four time segments which include a 10-minute "start up" segment, two solid instructional segments of 20 minutes and 15 minutes, and a 5-minute clean-up, reinforcement, and record-keeping segment (Figure 1). Based on previous experience, she knows that most students will have to be scheduled for independent work during the initial 10-minute period. This gives her the opportunity to see that all students become engaged in working and, also, to be able to respond immediately to students' daily crises. The instructional segments are the periods of time in which sustained instruction—whether it be teacher-directed, CAI, or independent—will occur. These periods are of brief enough duration to insure that students will be working at peak attention; they are long enough to promote substantial engagement of the learner with the topic of study. The need for a planned period of time for record-keeping, reinforcement, and clean-up is obvious.

	Monday	Tuesday	Wednesday	Thursday	Friday
10:00-10:10	Orientation Segment				
10:10-10:30	Instructional Segment				
10:30-10:45	Instructional Segment				
10:45-10:50	Record-keeping Reinforcement Clean-up				

Figure 1. The resource room's time structure.

Planning schedules of instruction for students in a resource room with a microcomputer is not unlike scheduling for a resource room without a microcomputer. A critical issue remains the same, i.e., allocating the limited time available in an equitable and educational sound way. Planning proceeds on the assumption that students benefit from as much direct teacher instruction as possible. The same assumption usually underlies allocating CAI time. One way to begin planning is to divide the total number of instructional segments available, i.e., 10, by the number of students scheduled into the resource room for that period. This yields the number of instructional segments theoretically available to each child for direct teacher instruction. The same formula can be used to determine the number of instructional segments during which each child will have access to the computer. Obviously, different arrangements would be made in the case of two or more children having similar enough instructional needs to permit grouping or where the meaningfulness of instruction is threatened by the literally equal distribution of teacher or computer time.

Mike's Instructional Program

A listing of short-term objectives for Mike as well as a brief description of his characteristics are given in Figure 2.

Mike Grade 4
Classified as learning disabled
Sent to RR for Math
Reads on grade level

Objectives:

1. To learn addition and subtraction math facts
2. To learn regrouping in subtraction
3. To learn units of measurement (linear)
4. To learn how to solve word problems in addition and subtraction.

Student Characteristics:

1. Mike's memory is poor.
2. Mike has difficulty working independently.
3. Mike has a high activity level.

Figure 2. Mike's characteristics and short-term objectives

In planning Mike's program, the teacher must take into account that there are four other children scheduled into the resource room at the same time as Mike. This has impact on how much time can be scheduled for direct teacher instruction and CAI for Mike and when this instruction can be given. Using the rough "formula" discussed above, Mike's teacher can estimate that Mike will have two instructional segments with her and two instructional segments for CAI. These estimates are subject to change as the teacher determines that Mike's or other students' needs are not being met.

Mike's program is presented in Figure 3. A review shows that Mike has been scheduled for CAI on selected math facts during most of the 10-minute orientation periods. CAI could not be allocated to any other students during that time in what the teacher considered an educationally sound way. It therefore became available for Mike's program and the teacher was able to put it to good use for him. He is scheduled to work on regrouping in subtraction during the first instructional segment, through a combination of direct teacher instruction, CAI, and workbook exercises. The second instructional segment is allocated to learning center activities concerning study of linear measurement and word problems. As is true of all students in the room, Mike will be responsible for record-keeping and clean-up during the last five minutes; also, the teacher will use this time to administer reinforcement for student demonstration of good work habits during that period.

	Monday	Tuesday	Wednesday	Thursday	Friday
10:00-10:10	CAI: Drill and practice of selected math facts	CAI: Game program on selected math facts	CAI: Drill and practice of selected math facts	CAI: Game program on selected math facts	Teacher administered paper and pencil quiz on selected math facts
10:10-10:30	Teacher instruction: Regrouping in subtraction using manipulatives	Teacher instruction: Regrouping in subtraction using manipulatives	CAI: Drill and practice program for subtraction problems with regrouping	Workbook: Practice on subtraction problems with regrouping	CAI: Drill and practice program for subtraction problems with regrouping
10:30-10:45	Learning Center Activity on units of linear measurements	Learning Center: Activity on word problems	Learning Center: Activity on units of linear measurement	Learning Center: Activity on word problems	Learning Center: Student's choice of educational game
10:45-10:50	Record-keeping Reinforcement Clean-up	———	———	———>	

Figure 3. Mike's instructional program

Mike's program is the result of many decisions made by his teacher. Her goal was to provide a maximum amount of academic learning time and the "best fit" for the particular combination of learning needs, available methods and materials, and student characteristics which Mike's case presents. The discussion which follows reviews the many "little" decisions that resulted in the overall plan and also how these decisions reflect the rudimentary framework presented above.

Maximizing Academic Learning Time

The overall program is structured to save time. Mike does not have to wait for teacher corrections or directions in any segments in which he is not working directly with the teacher. All CAI lessons provide continuous feedback; learning center activities were designed to be self-correcting. The consistency of his plan provides him with a good understanding of what he is supposed to be doing without having to wait to be told by the teacher. In addition, his teacher provides him with a "plan" at the beginning of each period which has the specific information he needs for the day, e.g., number of the computer disc to use, workbook pages, learning center activity card number.

Mike's specific program has been developed with the goal of making the best use of time. Mike works on selected math facts, i.e., only those facts which he does not know, as opposed to the frequent practice of "flashing" all the addition or subtraction cards. There are no loose pieces in the program. All work is sequentially ordered within the specific strands of math instruction in Mike's program. Mike's instructional segment in CAI is spent practicing what the teacher instructed the day before. The result is that one day's work builds instruction in Mike's program on that of the day before and the student is not as apt to forget what he has learned. Also, the work is coordinated across strands of math instruction. This eliminates instances of time being wasted and the student's becoming frustrated as, for example, he tries to practice work problems but gets hung up because he does not know the math facts involved. Finally, and perhaps best of all, no time is wasted by students having to copy math problems of any type out of a book. The student uses all of his time and energy during math instruction for math and not for the lengthy copying activities which can be particularly draining to learning disabled children.

Variety and student choice are built into the student's program in ways that maintain the overall coordination of the program. They are not isolated bits of learning that are enjoyed for the moment but easily forgotten. For example, on Friday, Mike can choose an educational game from a specific group of games. This group would probably include a subtraction game but not a game on beginning multiplication facts. The CAI game program for math facts gives him practice on the same facts he works on with the drill and practice program.

Different Things Are Learned in Different Ways

The initial and most important consideration in developing this program was the teacher's identification of the area of study which would have priority for direct teacher instruction. Since Mike is just beginning to learn regrouping in subtraction, she had to allocate her time to this objective. She has no other resources available to her for initial teaching of math concepts, particularly when—as in this case—the use of manipulatives is required for illustration.

Practice of math concepts which have already been introduced by a teacher, as well as practice of math facts, can be quite satisfactorily administered by computer. The teacher chose to use Mike's two instructional segments of CAI for practice of regrouping in subtraction since she expects a meaningful lesson to require a solid chunk of time. On the other hand, math facts review was an objective that could be nicely addressed by CAI in a shorter period of time.

The teacher had previously developed a series of learning center activities for study of verbal problem solving and units of measurement. She prefers this mode of instruction for these topics because she believes that students' understanding is enhanced through interaction with actual materials.

Attending to Differences in Learners

Mike has a poor memory. Applying this to planning Mike's math program, the teacher reasons that he will need more practice than the average child to master math facts. She therefore schedules him for daily practice of selected facts. In order to facilitate Mike's transfer of information memorized through CAI, the teacher provides opportunities for him to practice applying this information in traditional contexts, e.g., she gives him a paper and pencil quiz on math facts, she has him work on regrouping problems in a workbook as well as in CAI.

Mike has difficulty working independently. It is particularly important for this type of student to have consistency in the schedule. Mike's going, first thing, to the computer on every day but Friday facilitates his getting started with his work. The motivating aspects of working on the computer as well as the continuous interaction provid- help him to keep working.

Mike has a high activity level. It is particularly important for a student like Mike to have instructional segments kept to 20 minutes or less. After this length of time, Mike becomes restless and would stop making the best use of time. Having Mike work at learning centers at the end of the period allows for his tendency to become increasingly restless and to get out of his seat and provides him with a constructive focus for his activity.

Summary

The discussion of hypothetical fourth grade, learning disabled student's resource room program was intended to illustrate the decisions which a teacher might make in integrating CAI and other resources with traditional instruction in order to balance student achievement. Important considerations were the need to maximize academic learning time and to take into account that different things are learned in different ways by different students.

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Direct Optical Headpointing Input to Standard Computers Using a TV Screen Based Keyboard

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Abstract

There is a large population of handicapped people with limited motor control for manual writing and the manipulation of keys on standard keyboards. For many of these people the optimum interface for control of a communication and writing aid is direct selection headpointing. A Long Range Optical Pointer (LROP) technique has been developed to be used in conjunction with commercial computers to provide a powerful and flexible direct selection headpointing input. Software in the computer accelerates communication by allowing the user's keystrokes to be expanded into words and phrases (predefined by the user). The selections can be routed to printers for basic writing systems, or to keyboard emulators to transparently access the keyboard of a second computer. The second computer can then be used to use commercial software for wordprocessing, spreadsheet calculation, environmental control, or any other functions required by the user.

Many people are barred from participating in normal educational or vocational situations due to physical impairments which make it impossible for them to write or type on normal keyboards. The effects of this inability to write are quite severe, and effect more than just progress in school. One approach to alleviating this situation has been the use of microcomputers as personal writing and communication aids for these individuals.

Microcomputers have some major advantages as communication aids for handicapped individuals, especially as compared to aids built specifically as aids to the handicapped. They are general purpose, have a lower cost function ratio, are available on a wide-spread basis, and are easy to have maintained and repaired. The general purpose design includes high level program development tools and programmable memory. The use of high level program development tools allows more sophisticated input techniques, acceleration algorithms and functions to build into the aid at less cost and development time than for custom systems. Programs can also be developed independently at different locations for the same microcomputer, increasing the number of applications that the computer can be applied to. The programmable memory, used to store the programs, allows the functions to be easily changed and updated as more powerful and useful software becomes available. The lower cost/function ratio comes about from the mass produced nature of PCs, which are aimed at the general consumer market. In order to reach a large market it was necessary to build in capabilities to perform a wide variety of functions that consumers (which includes handicapped individuals) would want or need to use. The availability of microcomputers is very good, even in rural areas, and most dealers have provision for local servicing.

However, the use of microcomputers in this fashion also present some very real problems. Chief among these is the fact that handicapped individuals still need direct access to standard computer systems used by particular companies or educational institutions. Almost daily, new applications are found to increase a person's efficiency and production with computers by delegating mundane and repetetive jobs to the computer. Handicapped individuals need to be able to use these same computers in unmodified form if they are to be able to be employed in these occupations. The basic problem is that most of the commercial software (>99%) used by these computers requires input from a standard keyboard, which they may be unable to use, or able to use only at a much slower rate. Rewriting commercial software to adapt to the handicapped user input capabilities is impractical due to the hundreds of thousands of commercially available programs, even assuming the source code was available to be modified. In addition, the standard software needed for the job site or classroom can't be run simultaneously with the software to allow the microcomputer to function as a customized writing and communication aid with optimized input. The handicapped individual therefore has to choose between running the custom software to allow his or her writing and communication activities, and running the standard software being used by classmates or colleagues.

Headpointing System for Workstation Writing and Access to Computers

The system under discussion here was designed and developed to meet the needs of two clients in employment situations; one with the need for a writing system and the other for access to a standard computer system. Both clients are using dual computer systems, where one computer is performing the input and acceleration functions, and the second computer is unmodified and running standard applications software used by others in their workplaces. User selections from the input and acceleration functions on the first computer are converted to keystrokes for the second. In essence, the first computer is acting as a parallel keyboard to the standard keyboard of the second computer.

There are three basic parts to this system: the Long Range Optical Pointer (LROP), Ten-Branch abbreviation expansion algorithm and a keyboard emulator. The LROP is a television based headpointing input technique, and provides continuous head position feedback on the position that the user is pointing to on the television screen. The Ten-Branch abbreviation expansion algorithm has a user programmable vocabulary and uses the dynamic display of the television to display these expansions that can be selected on the next keystroke. The output of the aid is directed to a keyboard emulator for transparent access to the functions on the second computer. The input and acceleration techniques were implemented on a standard Apple II computer without any custom hardware modifications. (See Figure 1.)

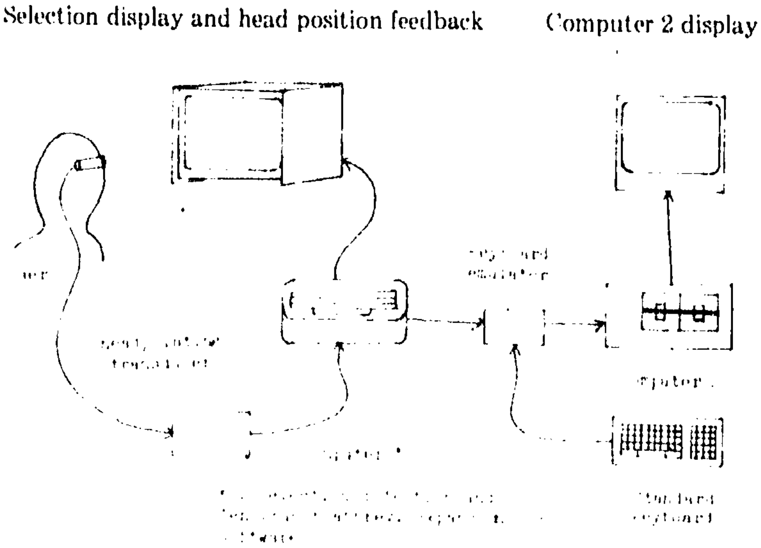

Figure 1. LROP Headpointing system in a dual computer configuration.

Long Range Optical Pointer

The LROP was developed to provide a headpointing technique that has continuous head position feedback and is compatible for use with standard computer systems. Currently most of the headpointing systems available only provide discrete position feedback. An example is the Express series of aids produced by Prentke Romich. Feedback consists of a single LED which is located in each of the elements of the vocabulary, providing only on-target off-target information. The user has little information on exactly where they are pointing, causing users to easily drift off target (while timing-out a selection) without realizing it until they are pointing to a different element. The LROP uses the high resolution graphics screen of the Apple to display a spot, about a ½ inch in diameter on standard television screen, for continuous position feedback. The resolution compared to the Express (8 X 16 LEDs) to the high-resolution screen of the Apple (192 X 280 pixels) is 420 times more head position information. It should be pointed out that LROP does not shine a light on the television screen to indicate where it is pointing, but rather detects the position it is pointing to on the television screen. This position information is coded in a form the computer can understand and is sent to the computer through a standard serial port. The computer calculates the position and draws a corresponding spot at that location on the high-resolution graphics display.

The use of a standard television for the selection display and head position feedback has some very useful characteristics. The selection display can take on an infinite number of configurations and be tailored to a particular input technique and application. In the aid developed for the stationary workstation a keyboard was drawn on the screen similar in configuration to standard keyboards on PCs and typewriters. The keyboard is a "one fingered keyboard" which allows upper, lower and control characters to be generated by locking shift, control, and caps keys. When locked on all subsequent key selections will be modified by the locked key, this is an encoding technique similar to level systems found on some aids. The status of the encoding keys is displayed to inform the user how key selections will be modified. The size of the keyboard is adjustable by selecting the size of the television to be used for the display. The size of the keyboard can then be better matched to a handicapped individual's needs; smaller keyboards, for person's with good control but limited range motion and larger keyboards, for more spastic individuals with a greater range of motion. (See Figure 2.)

Currently the selection algorithm is fairly simple; the user points to one of the keys for a specific time-out period to make a selection. This is the most basic type of selection and useful to many types of disabilities. The use of more sophisticated selections algorithms is possible with the use of position averaging and prediction methods. The use of these algorithms will increase the users information transfer rate, especially for populations with spastic motor control and have a difficult time pointing to a stationary area. Currently a number of different techniques are being studied at the TRACE Center to determine which techniques are most effective.

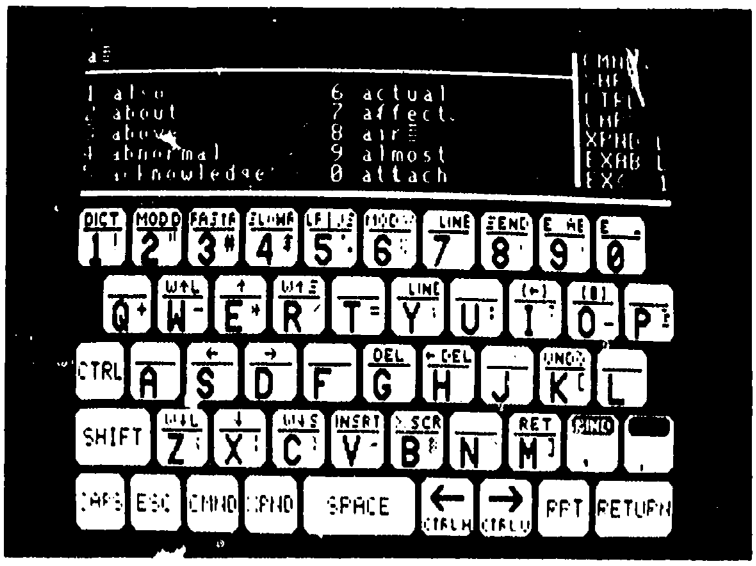

Figure 2. LROP keyboard and expansion feedback display.

Ten-Branch Abbreviation Expansion

The Ten-Branch abbreviation expansion algorithm was designed to provide easy access to a large expansion vocabulary with a minimum amount of key selections. The structure for an abbreviation is a series of letters (A-Z) followed by a numeric digit (0-9). When the numeric digit is selected the algorithm automatically expands the abbreviation, if it exists, and no extra expand key selection is required. (The expand function can be disabled to allow the selection of numbers without the aid trying to expand them). The user has access to over 6000 expansions in 3 keystrokes (0-2 letters and a digit). The abbreviations can have 0-22 preceding letters before the digit and the expansions can contain words and phrases of up to 255 ASCII characters. Memory limitations of the Apple limit the useful expansion vocabulary to about 600 ten character expansions.

The dynamic display capability of the television is used to display expansions to abbreviations that can be selected, and to provide an editing area for the ten-branch vocabulary. The top third of the screen displays the last letter keys selected and the ten abbreviations that could be selected on the entering of a digit key. This relieves the user from trying to remember all of the possible expansions they may have programmed into their vocabulary. The bottom two thirds of the screen displays the keyboard, which is removed during vocabulary edit mode when the user points way from the screen. When the screen is removed an editing area appears similar to a note pad for the display and editing of abbreviations and expansions. The keyboard reappears when the user points back toward the screen to select keys for editing.

Keyboard Emulator

The second computer in dual computer systems provides the functions the user needs for their different communication requirements. The major reason for the use of a second computer to provide these functions is the availability standard software which already currently available. Software written to combine a" 'ie parts of aid (input, acceleration and functions) ...o one computer cannot provide as powerful or diverse functions that is available with commercial software. The use of specialized software useful only to the handicapped, will further handicap the individual by decreasing the usefulness of their computer to perform the functions they need. In many educational and employment situations (like the one for the client) they will require access to standard computer systems already in place at the job or educational location. This demands that they have access to standard unmodified computer systems to be able to fully participate in education and are not further restricted in employment opportunities.

Keyboard emulators allow the handicapped to use commercial software programs. Keyboard emulators receive ASCII characters and control codes, and convert them to the proper electrical signals to the second computer for interpretation as normal key closures. The emulators must allow access to all the keys on the keyboard including special keypad and function keys. The special keys can be activated with the use of special ASCII character strings called escape sequences. The escape sequence is initiated with a escape character and followed by a alphanumeric string identifying the special key. Escape sequences also allow shift, control and caps keys to be held down for multiple key entries. Currently the TRACE Center is trying to establish a standard for the communication protocol and interface between communication aids and keyboard emulators.

Conclusion

The physical limitations of severely physically handicapped individuals will require them to pursue careers which will draw upon them to use their intelligence and reasoning abilities. These types of careers require good communication skills to be able not only to communicate ideas and thoughts, but also to listen and understand the ideas and thoughts of others. To provide this the severely physically handicapped need communication aids that do not provide token and restricted communication capabilities, but communication aids that provides functional equality with the non-handicapped. An important part of this communication will be writing and access to computers at rates comparable to that of non-handicapped populations. The technology is here today to offset some of the communication disabilities of the handicapped. Applying this technology will allow the severely physically handicapped to compete on more equal footing with their contemporaries in their chosen fields of study.

For Further Information

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Information on the Long Range Optical Pointer, abbreviation expansion software for standard computers and keyboard emulators can be obtained as it becomes available from the TRACE Center. In addition, the articles listed above are available (at cost) from the Trace Center Reprint Service. For information, please send a self-addressed, stamped envelope to:

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A Coordinated System Approach

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Abstract

This article provides a focus for a coordinated system approach. It emphasizes the need to consider four key elements in order to provide an agency with a means to incorporate a computer based system for service delivery management and development. Those elements, personnel and training issues, the role of assessment, the decisions about multi-user access and a plan of implementation, are a foundation for achievement of maximum benefits to persons who are disabled. Clients and agency personnel will both benefit from the comprehensive strategies encouraged and complimented by the use of computers.

Computers offer significant opportunities for improving the effectiveness of agencies and organizations which serve persons who are disabled. Achievement of maximum benefits to the persons who are disabled will require organizations and agencies to adopt comprehensive strategies to guide their planning, system selection, administrative procedures, direct service practices and follow-through activities which incorporate computer based systems.

This paper describes key elements involved in initiating and incorporating a computer based system for service delivery management and development. Those elements include personnel and training issues, the role of assessment, multi-user access decisions and a comprehensive plan of implementation.

Agencies contemplating a computerized system should consider the impact on the personnel. Since staff and management may not be comfortable with the concept of a computer in their work environment, consideration should be given to recognizing the myths and fears which might have to be overcome. Because there are implied or real threats to routines and job descriptions, caution should be a by-word in the planning. Personnel of the agency should be encouraged to participate in the decisions at the very start. Planners who recognize the usefulness of problem ownership understand the need for reduction of tension through participatory decision making. As an example, staff should be queried about tasks which they would like to see automated, or tasks which they could suggest for more efficient or effective handling. This involvement tends to reduce the tension and at the same time contribute to development of a truly useful system.

An useful technique implemented recently by the Wisconsin Division of Vocational Rehabilitation was to demonstrate a selected area of agency concern. By the use of electronic spreadsheets, case service resource allocations were demonstrated to central and field office managers. Application of variables within the spreadsheet would show immediate implications of budget shifts. The technique not only provided a new base for central office decisions and projections, but agency personnel saw immediately how the computer would be an asset to them in their decision making. Once exposed to a successful and useful experience, some of the myths and fears which a "new" system generates will be reduced.

Personnel in agencies will recognize that the computer assists in making their tasks more efficient. The computer is a tool. Once a decision has been made to use this tool, it has to be acknowledged that the bottom line is the cost benefit to the agency. Some tasks may NOT be best assigned to the computer. Those tasks which ARE selected for inclusion in the agency's new tool must receive scrutiny for eventual payoff to the agency. One method of quickly evaluating the cost benefit impact was outlined in a publication entitled VR-TECHS (July, 1983). A checklist for managers provides an outline for both Costs and Benefits; when used as a planning tool and shared, further participatory decision making would be generated.

As personnel become comfortable with the computer as tool, additional applications will become apparent. Since improving the effectiveness of agencies serving the disabled is a focus for this paper, one additional use for the computer is assessment. Assessment of the client's needs from a functional point of view would enhance decisions about the client.

Agency personnel will come up with other suggestions relating to the assessment process, but the author has already had an opportunity to develop a series of menus from which many agency personnel can select the type of assessment they desire. Functional assessment is dependent on a broad base of data; by developing a data base from client data, agency and resource data almost any type of statistical information can be generated. By selecting the appropriate software and utilizing available data, both clients and staff can demonstrate application of the computer as a tool for assessment.

Wisconsin's Division of Vocational Rehabilitation approach to functional assessment now includes MESA (Micro Evaluation Screening Assessment) as a tool for evaluators. A portion of the client's vocational evaluation is done by the client on the terminal of a computer. The results are part of a 3 to 4 hour pre-vocational screening device. Long-range projections for similar functional assessment procedures will further develop both client and counselor use of computerized information.

Once data is obtained from a multitude of sources, persons considering assessment applications can utilize software systems, such as a word processing package, to draw from the data base and generate reports, communications and client decisions. Assessment in a coordinated system approach must include both client and agency personnel input. Clients should be permitted maximum opportunities to participate both in the input and the assessment output. By mutually sharing data generated by the client, the agency and other resources, both the agency and the client can call upon the computer to respond to the variables, thus providing a communication technique of a personalized nature. The client becomes a part of the assessment rather than a target for assessment.

A concern of significant proportions is the potential for misuse of information, or inappropriate access to information, when a computer has data on clients. Agencies often have several terminals with a central computer. Or, the micro-computer may have several levels of staff and management utilizing the machine. When these conditions exist, and of certainty, they often will exist, client confidentiality and file security are of extreme importance.

File security and program access should be of high concern. Recent news articles and reports have demonstrated the potential threat to files contained in computer banks. Constant attention to security of the information can be enhanced through the use of limited access codes, frequent changes in passwords, or review of personnel identified for access. Users of the programs should not be able to tamper with the program itself. Most programs can be built to prevent access to change, and most software packages can be designed to thwart access except to authorized personnel. Should further concern about access to the computerized files and programs develop, customization of the programs by a programming expert should alleviate some of the problem of multi-user access.

Some of the newer access concerns are exacerbated by the possibilities developing through movable work stations. Briefcase (or smaller) size computers which link the user with the main-frame computer through telephone line contact create potential problems. Without controlling factors, client and agency files could be wide open to anyone from any telephone source. By recognizing the potential for maximum access and providing "gates" to the information, security, and client confidentiality can receive the high priority they deserve.

If a coordinated system approach with computers is to work, all of the elements identified must be part of a comprehensive plan of implementation. Personnel and training issues must be recognized and plans made for them. Decisions about assessment tools, prodecures and application must be considered. Security and confidentiality of client information should be placed in high regard as a component of the total plan. The planning for implementation of a computer based system should be a detailed list of assigned responsibilities. Although not comprehensive in this article, such a list would include target information needed, and a financial plan. A step-by-step plan keeps the implementation of a coordinated system approach for agencies delivering services to disabled persons on task, clearly moving toward a more effective approach.

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Operations and Specifications of the Lip-reader Trainer

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Abstract

This paper will present the specifications and operation of the Lip-reader Trainer. The Lip-reader Trainer operates on an APPLE II/APPLE IIe microcomputer, requires 48K, 1 disk drive, and 2 game controls. The Lip-reader Trainer presents an animated mouth, lips, teeth, and tongue, under control of sentences predefined by the instructor or parent. Multiple choice responses, also defined by the instructor or parent, are used to solicit the student's response. During the use of the Lip-reader Trainer the student's responses are saved for later evaluation.

The Lip-reader Trainer is an animation/simulation software package that, through animated sequences, provides the instructor or parent with the ability to expose the student or child to a wide variety of lip-reading examples. The Lip-reader Trainer has unlimited vocabulary as the animation sequences are controlled by "phonetic sentences". The range of lip-reading experiences is easily controlled by the instructor or parent as he or she determines the words or sentences to be animated. Progress of the student or child can be monitored as the responses to each word or sentence are recorded in a "student file". Over a period of time these records can indicate the progress of the student and where lip-reading difficulties lie.

The Lip-reader Trainer consists of six sub-programs: (1) Setup, (2) Menu, (3) Sentence Group Writer/Editor, (4) Lip-reader Animator, (5) Evaluator/Record lister, and (6) Sentence Group/Library lister.

Operation of the Lip-reader Trainer

The Lip-reader Trainer is designed to operate with one or two disk drives and, optionally, a John Bell voice synthesizer and a printer device. The John Bell voice synthesizer is used to produce "lip-synchronized" speech. The synthesizer and printer devices are not required for proper operation of the Lip-reader Trainer. If a two drive system is available the Lip-reader Trainer program diskette must be booted in drive 1. The second drive of a two drive system is for the student file diskette. This allows more student files to be stored on a disk and permits individual classes or students to be kept separate from one another. If only one drive is available then the student files will be generated on the program diskette.

After the Lip-reader Trainer is "booted" a copyright notice is displayed for a short length of time and then the SET-UP function is entered.

Set-up: Program Configuration

SET-UP allows the instructor to "set-up"specific operating parameters prior to operating the Lip-reader Trainer. First the date is requested, and is used when generating student files,. listing or printing "sentence groups" and the "library". Next, the option to display multiple choice responses is presented. This option allows the selection of responses to be displayed prior to the animation display. Next, the use of 1 or 2 disk drives may be selected. Next, if a printer is part of the system, the location of the printer interface card is requested. Also, some parameters concerning the page size, page length and interface control code sequences are set.

If a John Bell voice synthesizer is part of the system then the location of the synthesizer is requested. After these preliminary questions have been answered the MAIN MENU program is run.

Main Menu

The MAIN MENU is used to select the Lip-reader Trainer functions. These functions include, (1) SENTENCE GROUP WRITER/EDITOR, (2) LIP-READER ANIMATOR, (3) EVALUATOR/RECORD LISTER, (4) PRINT SENTENCE GROUPS/LIBRARY, and (5) END. When a selection is entered the screen displays "LOADING PROGRAM..." as the program selection is loaded into memory.

Sentence Group Writer

SENTENCE GROUP WRITER/EDITOR allow the instructor or parent to create, add to, or edit groups of words or sentences for animation. Also, individual sentences may be deleted from sentence groups. The Sentence Group Writer displays a menu that provides the selection of (1) PHONETIC Table, (2) ADD/APPEND SENTENCE GROUPS, (3) EDIT SENTENCE GROUPS and (4) RETURN TO MAIN MENU.

<u>Phonetic Table</u>

Selection 1 displays the "Phonetic Table". The Phonetic Table correlates phonetic symbols used by FUNK & WAGNALLS and WEBSTER'S dictionaries to the keyboard characters.

<u>Keyboard phonetics.</u> To facilitate entry of phonetic characters the keyboard should be asked to indicate the following phonetic characters.

Ctrl A . . . Bar A	(. . . Two dot U/Bar 00
Ctrl E . . . Bar E	) . . . One dot U/Plain 00
Ctrl I . . . Bar I	@ . . . Schwa
Ctrl O . . . Bar O	. . . NG
Ctrl Y . . . Bar U/YBar 00	* . . . Two dot A

When a "CTRL" key is pressed the character displayed is high-lighted. The "SHIFTED" characters display as special characters. The rule of thumb is CTRL characters represent "long" sounding vowels and SHIFTED characters represent a different "enunciation" of some vowels. Characters not shown are most consonants and special enunciation of some consonant sounds. Consonants are represented by their usual alphabetical symbols. The dictionary's phonetic spelling of words may be used but will have to be converted to the appropriate keyboard character before they can be entered.

<u>Graphic phonetics.</u> The "Lip-reader Animator" uses 19 different mouth shapes to represent all of the phonetic characters in the English language. Some of the shapes used represent more than one phoneme. The following table lists the shapes that are used more than once to represent different phonemes. The shape is listed by the letter of the alphabet that the shape represents.

F,V	T,D,N
P,B,M	CH,SH,ZH,J,SOFT G; (GEM)
BAR 00,W	K,NG,CK,HARD G; (GUARD)
TWO DOT A,ONE DOT O	S,C,Z

When two or more phonemes represented by the same shape are adjacent in a word or sentence only one of the phonemes should be used. The "space" character causes a delay proportional to game paddle 2 to be inserted into the word to simulate syllabication. Any characters not defined will produce a "neutral" mouth shape.

Add/Append Sentence Groups

Selection 2 of the menu allows for the creation of sentence groups or the addition of sentences to existing sentence groups.

A sentence group consists of up to 20 sentences. Each sentence that is to be animated requires up to 6 individual "entries". The maximum length for each entry is 115 characters. The first entry is the "master" sentence and must be entered using phonetics. The next four entries are used as "multiple choice" responses and are spelled normally. The last entry is used to indicate which of the four multiple choice responses is the "correct" response.

Sentences will be added to a specified sentence group, if it already exists, or to a new sentence group if it does not exist. During the entry of the master sentence the phonetic table may be referenced as needed. After all of the entries for that sentence have entered a confirmation for correctness is prompted. At this point any errors that may have been made may be corrected. Otherwise, the errors would have to be corrected through the "Editor" function. If more sentences are to be entered in the present group the previous procedure would be repeated.

The key to successful and productive teaching or practice sessions lies in the selection of the master sentence and the multiple choice responses. Words and sentences should be selected for the proper age and learning ability for the student. The multiple choice responses can be selected to produce easy or difficult sessions. For example, if the word being animated is "CAT" then a difficult set of responses could include, HAT, BAT, and PAT. An easy set of responses could include, JUMP, YELLOW, and JOKE. The difficult responses are selected so that if the response word was spoken it would look very much like the word that really was spoken. The easy selection could contain words that would not look like the word if they were spoken. Also, another aspect to keep in mind is to create specific sentence groups that drill the student on specific phoneme sounds. This would aid in evaluating the student records. If the student does well with a specific sentence group then it would be evident that the student is able to discern that particular phoneme sound. However, if the student's record indicates that a particular sentence group is difficult then it can be assumed that the student is having difficulty with that particular phoneme sound.

Editor

Selection 3 accesses the sentence group editor. The editor allows for the changing of any entries in any desired sentence group. Also, the editor allows for the deletion of sentences from sentence groups. To delete entire sentence groups the Lip-reader Trainer program would be exited and the normal APPLE DOS "DELETE" command would be used. The editor is very similar to the Add Append function in that the method of changing entries is the same. However, no new sentences may be added. The editor lists the current correct sentence entries from the group. The selection of which sentence to edit is made from this list.

If it is desirable to delete a sentence from the group the aster sentence would be replaced with a hyphen "-". Before the sentences are saved back to the disk this sentence could still be re-edited.

Lip-reader Animator

Lip-reader Animator allows the student to retrieve sentence groups and view them as animated mouth sequences. Also, student files are generated for post evaluation.

Necessary graphic data is read into memory and then the student is prompted to enter his or her name. If a John Bell voice synthesizer is part of the system the student will be asked if the use of the synthesizer is desired. Students with some level of hearing may benefit from the additional audio. After this preliminary set-up the Lip-reader Animator menu is displayed. The menu allows selection of, (1) READ LIPS, (2) CHANGE STUDENTS, or (3) RETURN TO MAIN MENU.

Read Lips

Selection 1 enters the "READ LIPS" function. This function allows selection of sentences from sentence groups, keyboard, or the library and produces animated mouth movements. Read Lips produces a sub-menu that allows the student to select from what source the animation sentences will be retrieved. Sentences may be retrieved from, (1) SENTENCE GROUPS, (2) KEYBOARD, or (3) LIBRARY.

Sentence group entry. of sentences from sentence groups. This selection also causes the student file to be updated and the entire sentence group to be viewed.

The sentence group number from which sentences are to be retrieved is requested, and the first sentence for that group is read into memory. If, in the Set-up routine, the "display multiple choice responses" option was selected the prompt, "I AM GOING TO SPEAK ONE OF THESE..." is displayed along with the multiple choice responses. If the option was not selected then the prompt and multiple choice responses are not displayed. Towards the bottom of the screen the words "LETTER SPEED" and "WORD SPEED" are displayed, next to each is displayed a number that correlates to a game control paddle. The number next to letter speed is controlled by game paddle 1 and the number after word speed is controlled by game paddle 2. Letter speed indicates a relative time delay that each "shape" will remain on the screen before the next shape is displayed. Word speed indicates a relative time delay for spaces. When a space in the master sentence is encountered a delay controlled by game control 2 is executed. The greater the number the longer the delay.

To view the animated sentence the student would "PRESS ANY KEY". The screen then displays an animation sequence that "mouths" the master sentence. If the voice synthesizer is selected and turned on the sentence is spoken aloud. After the animation is complete the multiple choice responses are displayed. The student then enters the number of the sentence that he or she thought was animated. The student may see the sentence as many times as desired. Also, the letter speed and word speed may be adjusted during the animation for a setting that is suited to each student. If an incorrect answer is selected the student will be allowed to (1) repeat the animation, (2) select the next sentence in the group, or (3) quit this group. If the student quits this group the student file is updated and the student may select another group. If the correct answer is selected the student is told so and the next sentence in the group is retrieved. When the last sentence in the sentence group has been animated the student file is updated a. .d the student may select another group.

Keyboard Entry. Selection 2 allows sentences to be entered from the keyboard. However, the sentences must be entered in the same phonetic characters as is used by the Sentence Group Writer. This 'immediate mode" allows the instructor to work on "problem phonetics" of words or create impromptu teaching sessions with sudents. The word or sentence to be animated is entered phonetically and then displayed. After the animation is displayed the options (1) repeat the animation, (2) select the next sentence in the group, or (3) quit this group are offered. The above selections have the same effect as they do when viewing sentence group entries but no student files are updated.

Library Entry. from the library. The library is made up of the "correct" sentences in each group. Also, student files are not updated. This permits the student to practice reading sentences without generating data and without being forced to view an entire group of sentences. To access a library sentence a library number must be entered. This number consists of the sentence group number and the sentence number separated by a stroke; ie. 1/1, 3/2, etc. After the library number is entered the statement "I AM GOING TO SPEAK THIS SENTENCE" is displayed along with the correct sentence entry. After the animation the options (1) repeat the animation, (2) select the next sentence in the group, or (3) quit this group are offered. The above selections have the same effect as they do when viewing sentence groups but no student files are updated.

Change students.

Selection 2 of the menu allows for change of student and the selection of the voice synthesizer.

Return to main menu.

Selection 3 of the menu returns the student to the MAIN MENU.

Evaluator/Record Lister

The Evaluator menu allows selection of (1) EVALUATE, (2) CATALOG STUDENT DISK, nd (3) RETURN TO MAIN MENU.

Evaluate

Selection 1 enters the Evaluator function. This function retrieves student files and lists them to the screen or printer.

The name of the student whose file is to be retrieved is requested. If the system has a printer the option to print the student's file is offered. All or part of the student's file may be retrieved. If the records are to be printed the records will be printed 2 across the page and will be separated vertically on the page by a dashed line. If the records are listed to the screen, the records will be listed 1 record to the screen.

The records report the sentence group, sentence number, number of times the sentence was seen, response status, and animation speed. Over a period of time the student records combined with prints of the sentence groups can indicate the student's progress and/or difficulties. For example, John Doe viewed sentence number 1-1 3 times at a letter speed of 161 and was able to read the sentence correctly. Sentence ½ was viewed 5 times with an letter speed of 220. John got this sentence correct also. However, John had to slow down the animation and view the sentence more times than sentence 1/1. Depending upon what the sentence or word was and the selection of multiple choice responses this record could indicate that John may have a problem with specific words or "sounds". Sentence ⅓ was very difficult for John. He had to view this sentence 9 times, slow down the animation, and still did not get the sentence correct. John "GAVE UP" on this sentence and went on to another. John may not have been ready for this sentence. However, John did not quit viewing sentences. He apparently was still interested and continued. If the status "QUIT" had shown up in the report it would have indicated that John terminated the session, and was possibly frustrated. It is important to evaluate each student frequently, and to tailor the sentence groups assigned to the student to promote the best learning experience possible.

Catalog

Selection 2 catalogs the student file diskette. This permits searching different diskettes for the desired student file.

Return to main menu

Selection 3 returns to the MAIN MENU.

Print Sentence Groups/Library

Sentence Group/Library Lister allows the instructor or parent to list or print the sentence groups and list or print the library sentences. The choice to (1) LIST SENTENCE GROUPS, (2) LIST THE LIBRARY, or (3) RETURN TO MAIN MENU is offered. If a printer is available the option to list the groups to the printer is also offered.

List sentence groups

Selection 1 will list sentence groups, and requests the range of sentence groups to be listed. As the sentence groups are retrieved from the disk the word "SEARCHING" will appear with the sentence group number. If the sentence group is found the word "SEARCHING" will change to "READING". The word "TRANSLATING" will appear as the master sentences are translated to show control characters. A right pointing carat ">" will precede control characters in the listing. After an entire sentence group has been read into memory the sentences are listed. Each sentence is listed with its associated multiple choice responses, and separated from the next sentence with a dashed line. The number of the master sentence is displayed and the rest of the entry numbers are blanked. This makes it easier to locate each master sentence in the group.

List library sentences

Selection 2 will list the library, and also requests the range of sentence groups to be listed. The sentence groups are retrieved in the same manner as in selection 1, however, the master sentence is not translated. The library sentences are listed with a heading and the library number is listed to the left of each sentence. Only the correct spelling of the master sentence is listed. The library should be printed out and made available to the students so that they may select sentences at random for practice.

The Conversational Lip-reader

Presently under development is a Conversational Lip-reader. This proposed program will provide the instructor with fullface graphic animation and conversational branching. Conversations will be written with a standard word processor using predefined directive commands. The memory expansion board will allow for storage of necessary facial graphics and additional user defined graphics. Thus, the instruction may be allowed to display "supporting" graphics to the conversation. The student will converse through the use of selectable responses.

The Conversational Lip-reader will not replace the Lip-reader Trainer, but rather provide advanced lip-reading practice.

BRAILLE-EDIT:
A Versatile Tool for the Blind and Sighted

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BRAILLE-EDIT

Raised Dot Computing distributes a word processing program for the Apple II called BRAILLE-EDIT. BRAILLE-EDIT is both powerful and flexible. It meets a need for software that will work with many of the specialized computer-based tools for the blind. BRAILLE-EDIT can be easily "customized" by the user to handle the user's special needs and special equipment. BRAILLE-EDIT also contains two fast braille translators. One translates from regular text into grade two braille, the other translates from grade two braille into regular text.

No one feature (except possibly the close support for some unusual braille output devices and the reverse braille translator) is terribly unique. It is the way that these elements are combined that makes the whole much more useful than the parts.

Motivation

Currently there are a number of low-cost commercial voice synthesizers for personal computers. These devices attach to the computer to allow a blind person to follow what would otherwise be displayed on a television screen. These devices are very successful when used with a wide variety of educational software. This approach does not work with word processing. A word processor is a computer program which allows a person to type in text, make corrections, assess the current state of the text, save material on disk, and finally get a clean printout. For example, a word processer allows a user to make a quick insertion of a document so that the user does not have to retype the whole paper. Word processing requires a high degree of co-ordination between the keyboard, the text being typed, and the information about the text which must be displayed to the user.

Quite frankly, the most successful approach to word processing for the blind is to write a computer program from scratch which "knows" about voice output. BRAILLE-EDIT allows the user to control the flow of speech. The user can hear a single character, a single word, a phrase, a section, or a whole file. There is a "where am I?" command and a means to hear some of the following text without changing the current cursor position. A user can easily hold down the repeat key to scan a large file. If the user hears a problem, the user releases the repeat key to position the cursor at the spot.

Four Kinds of Flexibility

BRAILLE-EDIT has four different sources of power and flexibility. First it is a good word processor loaded with features. The program has all the insertion, deletion, and rearranging capabilities found in commercial word processors. The print formatter is fairly powerful, yielding attractive documents. Second, there is flexibility over where the text is coming from and where it is going. It is easy to bring a remote file into BRAILLE-EDIT, and easy to send a BRAILLE-EDIT file into another system. Third, BRAILLE-EDIT offers unique flexibility in the selection of devices to control and monitor the user interaction with the program. It is easy to switch between use with screen alone (for sighted persons), voice output, or braille terminals. The user can operate the program in the manner that they are most comfortable. Fourth, there are extensive translation and reformatting capabilities. These capabilities are essential to allow files from one device to be transferred to other devices.

So far, all I have covered is the actual capabilities of the program disk. As you may know, a disk is useless unless you know what to do with it. The BRAILLE-EDIT program is aggressively supported by good documentation (including a manual on getting your Apple interfaced to all the devices mentioned in this article and many more), and a well received monthly newsletter (available in audio or print). Since many devices for the blind are bought and used in an information vacuum, these support services are especially valuable.

Word Processing Capabilities

BRAILLE-EDIT uses a heirarchy of text. A disk can hold a number of files called "chapters". Each chapter can hold one or more pages. Each page can hold up to 4,096 characters. Any ASCII character can be entered, represented, and manipulated in BRAILLE-EDIT. BRAILLE-EDIT is "character-oriented" (as opposed to "line-oriented"). Commands refer to the position of characters in a page. While some may find this inconvenient, it allows for a wide variety of text formats. The BRAILLE-EDIT page can be regarded as "an arbitrary bag of characters". That bag can either be the Magna Carta, or 400 control characters in a row.

BRAILLE-EDIT contains standard word processing capabilities in terms of insertion, deletion, and rearranging of text. It is particularly easy to combine files, copy files, rearrange files, and borrow between files. Pages can be split, rearranged, and merged with ease.

The print formatter can do page numbering, centering, underlining, margins, and tabs. It is easy to change the format of lines and paragraphs. There is even the capability of putting in braille page numbers for braille page embossers.

File Transfers (Input and Output)

BRAILLE-EDIT can receive text from the keyboard, from a disk, from a VersaBraille, or from an external port. It is easy to combine sections of text which come from a variety of sources. For example, it is possible to absorb material being read by the Kurzweil Reading Machine. Usually, text is entered by the keyboard. BRAILLE-EDIT can handle upper and lower case on both the Apple II plus and the Apple IIe. A user can enter braille information directly by using 6 keys on the Apple keyboard as an electronic braillewriter.

Text can be sent to the screen (in regular print or as inkprint braille dot patterns), to a voice output device, to an inkprint printer, to a braille embosser, or to a VersaBraille. The support for the VersaBraille tapes with automatic print page indicators. There are special driver programs for a variety of exotic braille output devices. The most successful is the Dipner Dot method. This is a means of generating a form of paper braille off of a letter quality printer. It is also possible to get inkprint braille dot patterns off of a letter quality printer. Inkprint braille is useful for braille transcribers to check their work.

The best way of summarizing the flexibility of outputing text is to point out that it has been a long time since anyone asked me how to output to a device which BRAILLE-EDIT does not support.

Customizing to User Needs and Equipment

All the commands to the computer can come from a variety of sources. You can enter commands from the keyboard, or from a remote terminal (such as a VersaBraille). You can even use the Apple keyboard as a braille keyboard to enter commands. The output from the computer (things the computer wants to tell you about how things are going), can come out on the screen (as they would for sighted users), voice output, the VersaBraille, or other output device.

The heart of the flexibility of input and output is the configuration system. One of the first things you can do when you start to use BRAILLE-EDIT is enter a configuration. A configuration is the collection of answers to a number of questions about your equipment and your preferences. Each configuration has a name. When you start up the program, you give the name of the configuration you want to use. This means the same program disk can be shared by blind and sighted persons. Each user just gives the name of the configuration they need to interact with the computer as efficiently as possible. Setting up a configuration may seem complicated. Actually it is quite straightforward. Enclosed is a sample transaction with the computer:

SYSTEM CONFIGURATION

ENTER TYPE OF PAPERLESS BRAILLER: no (no paperless brailler)
DO YOU ONLY WANT THE SCREEN FOR OUTPUT? n
DO YOU WANT AN ECHO 2? y
DO YOU WANT FAST SPEECH? n
DO YOU WANT TO SET THE ECHO PITCH? y
ENTER PITCH CODE: 15
DO YOU WANT TO USE THE KEYBOARD? y
DO YOU WANT A BRAILLE KEYBOARD? n
DOES YOUR KEYBOARD HAVE LOWER CASE? n
ENTER PRINTER SLOT: 1
ENTER PRINTER TYPE: ? (entered a question mark to get a list of legal codes)
ENTER ONE OF THE FOLLOWING:
I-INKPRINT PRINTER
S-SAGEM BRAILLER
B-BRAILLE PRINTER (LED-120, THIEL, RESUS)
L-LED-120 (OLD MODEL)
E-ETF-80 AND IBM BRAILLEWRITER
D-DIABLO MODIFIED FOR BRAILLE
P-PERKINS (CRANMER MODIFICATION)
M-MIT BRAILLEMBOSS
FOR MORE INFORMATION, SEE THE INTERFACING MANUAL
ENTER PRINTER TYPE: i INKPRINT PRINTER
ENTER CARRIAGE WIDTH: 72
ENTER FORM LENGTH: 60
DO YOU WANT UPPER CASE ONLY? n
DO YOU WANT PAUSE AFTER FORM FEED? n
ENTER NUMBER OF DISK DRIVES: 2
ENTER NAME FOR THIS CONFIGURATION: dfh (my initials)

Translation and Reformation

BRAILLE-EDIT can translate text into grade two braille and can translate from braille to regular text. Some people have difficulty understanding what a computer is doing when it is translating material into braille. Most computerized braille devices use a common code for representing braille characters with regular "printable" characters. If you send a percent sign to a braille device, the device will display the "sh" sign (dots 1-4-6). If the computer is going to translate the word "shove" into braille, it must replace the "sh" with "%" to make "%ove". Of course "%ove" does not make any sense on an inkprint printer. On a braille device (such as a braille embosser or a VersaBraille), the result is proper grade two for the word "shove".

The grade two translators are written in assembly language (for speed and space) and are table-driven. The user can modify the translation tables if he or she wants to. The translators do not make perfect Library of Congress standard braille, but accuracy is quite good, and is steadily improving.

There is a powerful table-driven "global replace" feature in BRAILLE-EDIT. The user can set up a file describing how text is to be changed. To actually make the change, the user can just invoke the name of the "transformation chapter". If a user's job requires the constant reformatting of files (different devices and different programs often require different text formats), it is possible to highly automate these transformations.

Typical Applications

A user can type in text and get feedback in either screen or voice. When the user is convinced that the text is correct, the user can make an inkprint printout. This is the way a standard word processor works, except it can also be done with voice.

Another common application involved taking the text that has been previously entered and running the grade two translator. The text can be transferred to a VersaBraille or produced on a braille embosser.

A chapter can be written in grade two on the VersaBraille. It can be transferred to the Apple, translated into regular text, and produced in inkprint (complete with centering, underlining, page numbers, margins, tabs, etc.).

A Kurzweil Reading Maching can be used to automatically scan a printed page, and send the text to the Apple. The Apple can save the material on disk. This material can be reformatted, run through the translator, and sent to a braille device. Lest somebody reading this think that I am talking about what is impossible, there are over ten individuals and groups that are using their Apple and Kurzweil with BRAILLE-EDIT as an optical scanner. There are some problems with this technique (the Kurzweil was not really built to do this very well), but it does work. Users are going from inkprint to grade two braille in a manner of minutes.

Summary

There are 175 copies of BRAILLE-EDIT in use around the world. As we have seen, the BRAILLE-EDIT program was not written to serve any one specific application. Instead, it is intended to cover virtually any application regarding word processing by a blind person. There are some aspects of the program that will annoy just about everyone. Blind persons may not like the way some of the prompts are spoken. Transcribers may think that they are operating a program written only for blind persons. Persons relying solely on braille devices may not like the way data entry works. Any person used to line-oriented editors will be irritated by the character-oriented editor of BRAILLE-EDIT. It is my hope that there is enough that will meet everyone's special needs to overcome these problems.

An Electronic Blackboard for a Blind Teacher

D. Holladay

Raised Dot Computing
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I have written the widely used BRAILLE-EDIT program for the Apple computer. Since my wife is a blind professor and since she does have a VersaBraille (a portable paperless brailler that acts as a self-contained braille word processing system), many people assume that she is a heavy user of the program. Caryn Navy, my wife, makes extensive use of the Nemeth code in her work. She uses the regular BRAILLE-EDIT program for the preparation of non-technical correspondence and memos. I have written a series of programs which manipulate the braille mathematics code (Nemeth code). She uses these programs to present mathematical material to her students and her colleagues.

A Brief Primer on Braille Codes

Braille is an alphabet, not a language. Just as the same alphabet can be used for a variety of languages, so braille can be used for entirely different encoding systems.

There are six dots to a braille cell (three rows, two columns). There are 64 unique braille symbols (if you include "space" as a symbol). There is only one alphabet. In normal print, we use both upper and lower case letters. In braille, a letter is assumed to be lower case. If you want an upper case letter, a special symbol is placed before the letter or word. Braille makes extensive use of "composition signs" which modify the meaning of following symbols. Composition signs are like mode changes in computer programs. Numbers in braille are formed by using a composition sign followed by the letters a-j to stand for the digits 1-0 (a=1, b=2...j=0). Punctuation is indicated with different symbols.

The most common braille code is grade two braille. Grade two is moderately contracted, or abbreviated. There are about 200 different abbreviations. A description of these abbreviations is beyond the scope of this article.

There is an unusual braille code called "computer braille" or "terminal code". This is a simple one-for-one correspondence between each of the 64 braille symbols and a symbol represented on a computer (an ASCII character). This system is used by different computerized devices as a means for sending and receiving braille characters. It is also an ideal way to internally represent braille in a computer.

The American braille mathematics code was developed in 1956 by Abraham Nemeth, a prominent blind mathematician. This code has been under periodic revision. The current version was approved in 1972. For the purposes of this article, I will write braille in the terminal code, and describe how it is interpreted in Nemeth code.

Terminal Code	Conventional Meaning
x + y	x plus y
x ^ 2 " + y^2 "	x squared plus y squared
e ^ -x ^^2"	e raised to the minus x squared power
.> x + y]	the square root of x plus y
? x + y/17 #	the quant[illegible] plus y divided by 17
. a + .b .k .g	alpha plus beta is equal to gamma

The mark "^" stands for dots 4-5. It raises the expression to a different superscript level (dots 5-6 lower to a different subscript level). The double quote mark stands for dot 5. In this context it means go back to the main line. Dot 5 also starts an expression with parts directly above and below. The Nemeth code can easily represent 15 superscript and superscript levels. The ">" symbol (also the "ar" symbol in grade two) starts a square root. The bracket is the termination sign. It ends a square root or an above or below combination. The termination symbol is also the "er" symbol in grade two braille. The question mark ("th" sign), slash ("st" sign), and number mark ("ble" sign) are used to indicate a fraction. The period before a letter makes it into a Greek letter. A space period k space is an equal sign. Thus a Greek kappa and an equal sign are exactly the same symbols. Only context keeps them apart in a reader's mind.

I have chosen not to demonstrate how fractions of fractions or other complex symbols are built up. Suffice it to say that the math symobls in Nemeth code are fairly logical, and can be combined in logical ways.

The Task

The task I set out to accomplish was to write a program to go from Nemeth code to printed math symbols. I wanted to allow Caryn to write out material for her students on her VersaBraille. The Apple computer was to be used to generate a printed copy of all the math symbols. A dot matrix printer was to be used to print all the unusual mathematical symbols.

I used the translator from grade two braille into print symbols as a starting point. I quickly realized that the translation and display were a two stage process. I would have a translation stage which would generate a stream of characters that was similar to those being printed. I knew what Nemeth code was like, and I knew what printed math symbols looked like. When I started, I did not know how to structure the intermediate code.

Eventually, I used the standard ASCII characters. I reserved one symbol (the accent mark) to mean to print a special symbol. Each accent mark was followed by two related symbols. Typically, it was accent "alphabet code" "letter". For example gb meant print a beta (alphabet "g" is the Greek alphabet). I reserved about 6 "alphabets" to mean special control of the print position. Without getting into the hairy programming details, I relied on a "stack" of position (column and row) to handle fractions, square roots, subscripts, superscripts, and "above and below" expressions. The use of a stack means that these elements can be combined in a logical way to produce some very complicated mathematical expressions. The translator can handle 15 levels of superscripts and subscripts, 16 levels of square roots, 3 levels of fractions, and a complex fraction involving multiple levels of square roots on each level of the fraction. The translator can only handle one level of "above and below" expressions. This is sufficient to handle summation symbols.

Early into the project, I started to have contact with Prof. Nemeth. He was irritated that my project was geared to the VersaBraille, which is quite expensive. He wanted a means to use some of this capability without needing a VersaBraille. I took my available translator and attached it to the braille keyboard program. This new program, the Electronic Blackboard, takes direct keyed entry from the Apple keyboard and displays the text on the Apple screen. It is not a mathematical symbol processor. It is a means of allowing a blind person to share their work (text or equations) with a sighted person. The Electronic Blackboard is very fast. It was a very effective means to debug the translation programs, the translation tables, and the display program.

The Electronic Blackboard was used to write NUMBERS (Nemeth Users Mathematical from Braille Effortless Reproduction System), the program which allows a user to go from Nemeth code to printed equations. It is highly automated. The most difficult step is bumping off one's spouse from the computer to run off a handout for a class in the next hour. After that, three keystrokes on the Apple, and two symbols on the VersaBraille start up the automated transfer, translation and printing. The NUMBERS program was written for an IDS 460G or Microprism printer.

To operate these programs, the user has to make some adjustments to standard braille code. Much of braille is ambiguous. Computers have great difficulty with ambiguous situations. For example, the same four braille symbols either mean "farmer" or f times the square root of m. My translators required that the user separate grade two from Nemeth code. The user signals the computer by keystroke (of the Electronic Blackboard) or by composition sign (for NUMBERS) that the user is switching from grade two to Nemeth code or vice versa.

Still More Programming

For over half a year, the NUMBERS program was a highly successful means for Prof. Navy to prepare for her classes. She would take the printouts from the computer and have copies made up for her entire class. While there remain to this day some unresolved issues (automating the correct format for fractions, implementing tabs and other formatting improvements), the program handles a wide range of mathematical material with no sighted intervention.

Last winter, Caryn got an evaluation which downplayed the role of good handouts. It emphasized the central role of the blackboard in teaching. It was felt that handouts made students lazy, while copying from a blackboard keeps the students on their toes. Back to the drawing board.

I have written a third Nemeth code program. Caryn has named this one "The Lecture Projector". It takes a translated NUMBERS file and displays it nicely on a video screen. There are a number of commands which give Caryn control of what is on the screen at any one time without sight and without using voice synthesis (which was regarded as potentially distracting to the class). Caryn can put in special symbols directing the program to end a screen display at that point. Additional symbols tell the computer to beep a certain number of times. For example, $sb4 means make a screen break and beep four times. Caryn takes a paper braille copy of the material to class, so she knows exactly where the screen breaks are. In addition, there are a series of controls to back up. The students get very annoyed when the professor advances to the next screen before they have finished copying from the last one.

The Full Production

This brings us to the present. Caryn writes the days material on the VersaBraille in Nemeth code and grade two. When she is ready, she asks me to stop using the Apple for a few minutes. Caryn uses the Numbers program to transfer the material, translate it, and get an inkprint copy. She uses regular BRAILLE-EDIT to print the braille copy to a Cranmer Brailler. Finally she copies the translated files to her "classroom disks". She has three disks which rotate between home and her classroom. These contain the display programs and tables necessary for the Lecture Projector. She takes the inkprint, the braille, and the classroom disk to her classroom. If necessary, the inkprint copy can be used as a basis for a handout for her class. Or she can use her Optacon to check the validity of the mathematical translation. Her classroom has an Apple computer which can be cabled into a data projector. A data projector is a large Cyclops eye mounted on the ceiling. It projects an image onto an ordinary movie or slide screen. Caryn can concentrate on reading the braille copy and occasionally hitting the spacebar on the Apple to go to the next screen. If necessary, she can backup, abort a file, or go into the Electronic Blackboard. She can use the Electronic Blackboard anytime a student asks a question about a particular problem that she has not worked up. She has to use the real blackboard for diagrams (none of these programs really does lines, charts, or plotted equations) or for doing things that still are not implemented on the program. Experience has shown the Lecture Projector and the Electronic Blackboard programs need to be more closely coordinated. There is still room for plenty of improvements.

The Significance of These Programs

This series of computer programs is of use to only a handful of individuals. I make no apologies for this. Computers are designed to be symbol manipulators. I have taken two very different systems of symbols, the braille mathematics code and the conventional means of writing printed mathematical symbols, and have linked them together. This is very much the sort of job that computers are good at, provided the rules are well defined. I have been asked frequently to write a program to translate from printed math symbols into Nemeth code. This task is both more difficult and of more widespread application. It is increasingly difficult to get material produced in Nemeth code for blind students. Few people are learning how to produce Nemeth code. So far, no one has written a computer program to help in the production of Nemeth code. I am interested in doing this. It will probably take several years before any such a program is ready for distribution.

These programs have made it much easier for one mathematics professor to prepare for her classes. Her classes also run more smoothly. No special pieces of equipment had to be developed. It was strictly a matter of writing the right instructions to a computer. This was an interesting sideline to working on BRAILLE-EDIT (especially since I consider BRAILLE-EDIT to be much more mundane). I know that in a vast field (computer applications for the disabled), barren of good technical people, I can be accused of tending one little field very heavily. I sometimes wonder how many applications for disabled persons that are not being met because of lack of interest, lack of time, or lack of money.

Speech Recognition for Inter-human and Human-machine Communications

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Abstract

Affective, physical, and instructional modifications are often necessary to help disabled persons achieve in academic and social/emotional areas. This presentation will discuss how some traditional strategies and techniques for special education and vocational rehabilitation may be augmented through speech recognition technology. Included in the discussion will be an overview of the state-of-the-art of speech recognition and how current technology may be applied to special populations. Comments will focus upon how speech-based programs may be designed to closely parallel the standard one-on-one approach to the special needs learner. General recommendations and considerations for applying today's technology to various impairments will be made in terms of individualized systems for oral communication.

With millions of handicapped persons in the United States, there is no one user-profile describing the disabled. The most common characteristic shared by handicapped persons is the difficulty, and often inability, to communicate with other people in a mutually meaningful way. This need for basic communication skills becomes intensified as the range of physical functions decreases. Physically handicapped individuals have in the past needed a range of motion to access a computer's keyboard (or extended keyboard) by using a finger, mouthstick, headstick, sipping and puffing, or the like. Effective computing, whether for communication enhancement, environmental control, or instructional purposes, has been dependent upon the speed and accuracy of user motor skills. Today, speech recognition technology provides the handicapped operator with voice control and direct access to existing software, electronic mail services, information networks, and computer-based devices for environmental control.

Speech recognition (voice recognition) is the computerized process of identifying a spoken word or phrase by matching an unknown utterance to a number of known utterances and selecting the closest match within prescribed tolerances. The basic logic of a speech recognition system involves processing an acoustic waveform to extract spectral data. Templates of the resulting digital data are then stored and become the active vocabulary of language model for the spoken words or phrases. Recognition occurs when a search and match is made between newly input speech and existing vocabulary templates. The matching or mapping process varies with the algorithm being used.

An Innovative Communication Medium

Individuals engaged in the delivery of human services spend the majority of their time constructing environmental-support systems and communications media appropriate to recipient needs. The actual physical setting and its management are shaped by expectations for inter-human and/or human-machine interaction. The introduction of high technology into academic or social/emotional support systems affects the nature of the expected experience and participant behaviors. In terms of communications media, the implicit and explicit signals, signs, and symbols change. For the disabled, this environmental-support system becomes a prothesis as lost functions in communciation and mobility are augmented by disability-appropriate technologies.

Regardless of disability, the task at hand is to more effectively order the utilization of human resources through speech recognition. The human factors to review involve the skills, knowledge, abilities, insight of the handicapped user, and his or her oral capabilities. Is this person capable of making consistantly repeatable utterances? Are such utterances used in a contextually meaningful way? What concrete meaning will the experience have for that individual in terms of productivity? What is the symbolic meaning of being able to talk to a computer using your own system of oral communcation (i.e., autonomy, technical competence or status)? What is the function of the voice-based activity? And, most importantly, does speech recognition facilitate the performance of specific activities or tasks?

Human-machine communications occur through multiple channels. The introduction of speech recognition technology into special education or rehabilitation programs necessitates consideration of these channels, user expectations, and the limitations of the technology—the degrees to which it may set new events and processes into action. Technological considerations include limitations on the duration of utterance that the technology will accept, which varies from 1.5 to 3 seconds. Another consideration is that current technology is not capable of distinguishing between certain "sound alike" words, like "too" and "two". The significance of dealing with speech disorders, paraverbal behaviors (i.e., rate, amplitude and pitch of language), which accurately indicate real human feelings as compared to the meaning of words, is meaningless to the technology. Speech recognition technology, however, has the potential to remove the practical barriers to many disabled persons denied computer access in a computer-dependent culture; the potential to provide equal access to existing software.

Research efforts are on-going and cost-effective, speech-based aids are being specially designed or modified for handicapped persons. Hands-free sensory aids, communication and process control aids, mobility aids, and various prosthetic devices are being developed using speech recognition. Today, these voice-based technologies are being used for process control, self-help, instruction, and communication.

Human Resource Development Tool

The VBLS tm voice-based learning system, developed by Scott Instruments Corporation, is a speech-controlled authoring and instructional delivery system designed to meet educational needs of handicapped and able-bodied learners. The System was designed to reinforce learning through the pronunciation of correct responses. The research objective was to develop an instructional tool that would provide the non-computer oriented user with the strategy to simultaneously design and create voice-based courseware. The instructional logic of the VBLS system incorporates a speaker adaptive concept, that has direct applications for persons with speech or communcative disorders. The Authoring System is used to generate and store lesson materials and their appropriate vocabulary. A master template for each word or phrase in the instructional material is made from the author's speech patterns. When a student enters his or her utterance into the System's microphone, the master template is adjusted to include it. A second sample of the student's speech is solicited and also averaged into the original template, thereby adapting the master to accomodate the unique speech qualities of the student. Once the student has trained the System to recognize his or her speech, including impediments, voice-controlled drill and repetition of instructor- or parent-authored materials may begin.

The response of handicapped users to the VBLS system has varied with disability and communication-modality preferences. Speech recognition has been incorporated into the client evaluation procedures at the Schneier Communication Unit in Syracus, New York. Carol Cohen, who is directing the project, reported comparison results made between direct keyboard access and voice entry techniques, including the VBLS package. Client demographics (as of July 1983) have a broad range. The primary data relates to average time for data to be entered: It took 3.3 seconds for a 13 year old cerebral palsied male with severe dysarthria to directly select one number plus the RETURN key; it took 1.6 to accomplish the same by voice. It took an average of 2.5 seconds to train the VBLS system to recognize four adult male vocalizations and an average of 1.93 seconds to access after training; this client, who is also cerebral palsied with severe dysarthria, takes an average of 12.57 seconds to directly select keys using his right thumb. A third client with severe arthritis uses two pencils for keyboard access, this adult female was timed entering the sentence "Now is the time for all good men to come to the aid of their party." The voice entry terminal was trained to recognize the alphabet and some commands needed to operate Apple Text Writer tm; some idiosyncratic names were used for sound alikes. It took 4.43 minutes to enter the sentence by voice and 47 seconds to enter it by typing. ("The Shado/VET tm terminal was very sensitive to any changes in intonation, posture or timing and, therefore, did not recognize many vocalizations. This problem was alleviated when a second speaker added a training session to the vocabulary.") This client felt that this approach to voice entry did not allow for creative composition because she always had to think about vocabulary and intonation. She did, however, feel that because she cannot type for long periods of time, that voice entry would be less fatiguing.

Future applications for speech recognition in terms of inter-human and human-machine communications are suggested by the results that Cohen reported for a 27 month old female with a brain stem lesion and normal or above average intelligence. The youngster was helped to train the voice entry terminal to recognize two unintelligible vocalizations ("ba" and "ga"). "Ba" is the oral equivalent for "baby" and "ga" is the counterpart for "dog." The process of training the system took 1.5 minutes. The voice terminal was interfaced with a Votrax tm personal speech synthesizer and the Center's "SCU Talk" software package. When the child made her utterance, the "appropriate" word was spoken. "Child was elated and reacted accordingly—parents ecstatic!"

Future Implications

"Is there really a future, or is it just some idea in the mind of a designer?"

"Of course . . ."

I am of the opinion that people who specialize in the delivery of human services, have chosen to participate in the guidance and protection of the future. The issue, however, is, "How does one go about the business of protecting something that keeps changing at accelerating rates?" And, "Yes," the future really is an idea in the mind of some designer—who is probably less than 20 years old and more "computer literate" at five than you are now, and who just happens to be inventing a technology that we have yet to dream about, to solve a problem that is as old as the human race. And you, the professional "people person," have accepted the responsibility for introducing this high technology into your culture for the sake of right human relations. I hope that speech recognition technology helps you to achieve your goals.

High Technology and the Handicapped Vocational Implications

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Abstract

Many disabled consumers and rehabilitation specialists are looking to the mystical world of high technology for jobs with a future. While high technology may continue to be a good occupation for a few well-trained physically disabled, evidence is surfacing that indicates for most disabled, high touch servicing occupations may hold far more potential.

Recently I was interviewing a prospective student for admission to a computer programming training project for the disabled at Michigan's State Technical Institute and Rehabilitation Center near Plainwell, Michigan.

The prospective candidate although somewhat nervous was very pleasant and easy to converse with although he had a speech impediment related to his mild cerebral palsy. When asked why he wanted to become a computer programmer, his reply was that the future is in computers and robots, and in order to get a good job he needed training in either programming or robotics. He said that he had first thought of computer programming when talking with his vocational rehabilitation counselor. He was currently working as a cook's assistant in a local restaurant chain-a job that he enjoys but doesn't see much of a future in it.

Today's media presents High Technology as representing a two-edged sword for the disabled offering hope and opportunities for few educationally competent and challenges and discouragement for the many who are not. The purpose of this paper will be to examine this assumption, and to suggest some alternatives.

It deals with two very nebulous and ever changing domains. The Federal and State bureaucracies have struggled for years to provide adequate definitions for what is meant by handicapped or disabled. Even the use of the terms themselves become meaningless. Spiral adaption of technology for industry will have many implications for the disabled, such that the work involved in the development of machines that see, hear, touch and move have great possibilities for people to see, hear, touch and move; thus further blurring the term disabled.

For example, Kirby Moon is a homebound computer programmer who operates his own computer service bureau from his Stryker bed. Although rhematoid arthritis has left Kirby immobile with the exception of two fingers on one hand he can expect to earn a salary this year equal to that of a high level executive of a major corporation.

On the other hand, there are up to two million unemployed workers who will never be able to return to the industries where they once worked. For according to an article in a recent issue of High Technology Magazine, by 1980 all industries must be high tech and that the basic smokestack industries will have much in common with Silicone Valley. The factory of the future is the factory with a future and will require sophisticated skills to maintain and operate. Thus, our manufacturing industries which have had such a remarkable record of thriving on nimble hands and dull minds further enhance their productivities through the use of programmable and unfeeling robots.

According to a survey by the University of North Carolina, high technology occupations are growing 88% faster than all other occupations; and, we can expect rapid growth in industries that barely exist today. For example, genetic engineering technicians and bionic medical technicians are expected to account for 450,000 jobs by 1990 while it has been reported that the number of laser process and robotic technicians may reach more than one million. There is no question that the jobs in the smokestack industries will continue to decline but where will be the new opportunities of the future for disabled workers. Newsweek lists the following as currently growing industries:

Occupations	Percentage Growth in Employment
Data Processing Machine Mechanics	157.1
Paralegal Personnel	143.0
Computer Systems Analyst	112.4
Computer Operator	91.7
Office Machine Servicers	86.7
Tax Preparers	77.9
Computer Programmers	77.2
Aero Astronautical Engineers	74.8
Employment Interviewer	72.0
Fast Food Workers	69.4

Given this kind of information it is no wonder that the prospective handicapped computer programming candidate and his vocational counselor are thinking computers and robots. After all we have all seen the IBM public relation pieces that show the high level quad or the deaf writing as computer programmers.

While most of these high growth jobs make a good fit for severely handicapped people who possess good intellectual skills, is it reality?

High Tech vs. Low Tech Jobs

However, Economists Levin and Rumsberger provide a contrasting view in that "expansion of the lowest skilled jobs in the economy will vastly out strip the growth of high technology once there is a proliferation of high technology industries. Their products are far more likely to reduce the skill requirements of jobs in the U.S. economy than upgrade them. . . . . .that nonetheless the educational system should strengthen the analytical and the communicational skills of students not because of the needs of high technology, but because such skills will help them deal with the changing political, economic, social, and cultural institutions they will face in their adult lives." (Levin & Rumsberger).

Computer Jobs for the Handicapped?

Though the computer industry often is perceived as a vast sea of high-paying jobs, experts note that it is actually a highly segmented market divided into occupations that require a wide range of skills.

Graduates of computer science programs at four-year colleges have few problems finding employment. Those with master's degrees can usually take their pick of several job offers, and the few hundred people who earn computer-related doctorates every year can find many employers eagerly bidding for their services.

But many prospective programmers, technicians, systems analysts and computer operators who have completed one- or two-year programs at the nation's community colleges and technical schools are finding they must scramble for work.

"What people in two-year programs are running into is a tight job market, and competition from people in four-year programs, says Tom Nardone, an economist with the Bureau of Labor Statistics.

Nardone says many companies laid off people from their computer departments along with other employees during the recent recession, and that at the same time 'there has been a big increase in the number of people going into the field.' For example, one four-year Michigan school increased its computer science graduates from 60 in 1979 to 1,200 in 1983-a 2000% increase in three years.

Nardone says graduates of two- and four-year computer programs aren't the only ones angling for the 150,000 annual computer-related job openings that the government expects to be available through the end of the decade. Many math, business and engineering graduates also are going after those jobs, he says. The result: fierce competition for entry-level jobs in many areas of the country, with employers giving the nod to candidates who have previous work experience.

'It's the old Catch-22,' Nardone says. 'Employers want people with experience, but how do you get experience without a job?'

Others who keep an eye on employment trends in the computer field cite that dilemma in explaining the challenge facing first-time job-seekers.

'There is a very, very strong market for people with experience right now,' says Thomas Weisenberger, a branch manager for Source EDP, the nation's largest recruiting company for data-processing professionals. 'But it's tough for entry-level people to break in right now.'

'If you've got a solid two years of experience, you can write your own ticket.' says Steven Epner, a St. Louis-based computer consultant. 'It's getting that first job that's hard.'

Epner is president of User Group Inc., a consulting company that helps corporations make efficient use of their computers. He notes that many major companies cut their computer training programs during the hard economic times in 1981-1982. 'There is a tremendous oversupply of recent two-year graduates who want to get into those training programs,' he says. Also, may companies have learned to do more with less through prepackage software, and programming aides.

And 150,000 jobs per year isn't all that many, compared with openings in other fields. For example, the greatest number of job openings in 1980 was for 757,000 retail clerks. Cashiers, cooks, janitors, typists, truck drivers and many other relatively unskilled positions also were filled in far greater numbers than were signed up for computer-related work. Computer programmers barely made the top 100 on the job list in 1980, with just over 30,000 openings, Nardone says.

Richard Kemmerly, president of data-processing employment agency in Dallas, says, 'About one out of 50 people (without experience) here find an opening that lets them get their foot in the door.' " (Dunn, 1983). According to a 1983 report by Electronic Business Magazine, in some areas of the country, secretaries with word processing skills are paid more than computer programmers with data processing skills.

Low Tech-High Touch Job Boom

In spite of the attention lavished on employment opportunities in high technology such as computers, according to Gene Maeroff of the New York Times, most jobs available this decade will be decidedly low tech and the greatest need according to the U.S. Bureau of Labor Statistics will be secretaries, nurses aides, orderlies, janitors, sales clerks, cashiers, nurses, truck drivers, office clerks, fast food workers, waitresses. In terms of total number of jobs, programmers, systems analysts, operators, data entry workers, and other computer specialists will account for only five percent of employment growth during the 1980's.

Mr. Herbert Bienstock, Director of the Center for Labor and Urban Programs at Queens College notes that most jobs require very little in the way of skill development or training and they may even require less computer sophistication and that many students without baccalaureate degrees and sometimes even without high school diplomas will be able to enter the job market through the service industry. While these service jobs have low repute, the key is to direct the supply of people to the demand and to demonstrate that these jobs are a beginning, not an end of a career.

Also, the sophistication needed to operate and program computers is obviously decreasing. How many of us would be able to hard-wire a 402 accounting machine versus using a micro-computer? It might be compared to the kinds of sophisticated skills that were needed to operate a Model-T Tin Lizzy, as that of the skill requirements to drive today's modern automobile. Along the way, many manual skills will be eliminated, thus becoming more accessible for the physically handicapped. For example, computer-aided design (CAD) means that draftsmen of today do not need to possess sophisticated manual skills such as lettering, lining, etc. Therefore, given a computer-aided design station, the quadraplegic mouthstick user may be able to perform the same skills more productively than his predecessor. But the efficiency of CAD will mean the 50%-80% fewer draftsmen will be needed, and, the jobs filled will likely be by experienced workers.

Training Implications

The training community is sometimes characterized by labor economists and others as overemphasizing the high tech emerging areas and will train people for jobs that might not currently exist. Many labor market experts claim that appropriate emphasis for the regular jobs is being ignored in favor of overextending resources on glamorous occupations in technology. In addition, there is some evidence that the advanced technology results in a de-skilling of the work force rather than increasing skill requirements. Many training program decision makers and others often say that the rate of technological advances is increasing, and its pervasiveness will lead to far reaching consequences. New occupations are emerging and pointed out regularly by many futurists. It is important therefore that these areas be identified so that students can be exposed to new technologies likely to be encountered in the working place. In the 1984 Cadillac Seville there are a possibility of 86 microprocessors that today's auto mechanic must be knowledgeable of.

Further, shortages of qualified workers are usually associated with new fast growing occupations, but there is a distinction between the occupational job content and trends. For example, the kinds of skills that will be required to be a laser optic technician are basically the same skills required of an electronic technician who has some additional skill training, either on-the-job training or university course work in optics, but the basic electronic technical training skill is fundamental and best accomplished in two-year and technical training institutions.

Much of the occupation related research in this area points out that truly new occupations are exceptional. More likely is the emergence of a sub-specialty from an existing occupation because of technological change. Is a laser optic technician a new occupation or is it a sub-specialty of electronic technicians? Are needed workers to be primarily trained in the field of electronics with curriculum reflective of technological innovations modified so that the trainees become proficient in laser optic technology? What about robotic technicians, word processing technicians, computer repair technicians? The fundamental is electronics and electronics training, a service area that has traditionally held high employment opportunities for handicapped persons.

Robotics

Robotics is currently generating a great deal of attention, but very little information is available to assist the educational rehabilitation community in counseling educators and students in planning for these training programs. How big will robotics be? How quickly will it grow? What occupations will be created? Will unemployment dramatically increase because of robots? Are we training workers whose skills will become obsolete? Also, does robotics make for a good fit with handicapped workers? Such questions were addressed in study by Timothy and Alan Hunt of the W.E. Upjohn Institute and Employment Research. To put robotics in perspective, the authors investigated current robotic populations, estimated future growth, actual anticipated cases of robotic technology, Michigan's share of the robotic populations, and historical parallels in the introduction of production technologies.

A consistent economic framework to measure the impact of robots on the labor market between now and 1990 was also developed. The current forecast of robot population provided this framework in analyzing job creation and job displacement together. No other robotic study was ever done this way. This study showed the true meaning of the so called robotic revolution with its clearly emerging skill twist. Robotic manufacturers have two-thirds of their work force in traditional white collar areas. This is a marked contrast of the 28% for all U.S. manufacturing. In the trade off between job placement and job creation, the jobs designed are semi-skilled and unskilled and those skill jobs created require significant technical background. This supports the notion that the future labor market will demand greater skills from workers.

The Hunts submit that the very use of the word revolution is inappropriate when dealing with the manufacturing process technology. History shows that old plants and equipment cannot be scrapped at the moment new technology emerges. It is too expensive to do so. Process Technologies are evolutionary because of physical, financial, and human restraints. Product technology, where the consumer dollar is available, is much different. Robotics is not foreseen as a consumer item for 1990.

Quite surprising, is the modest size of the robotics industry presently. U.S. robot population has placed 7,000 workers in the robot production. Some of the most sophisticated capabilities attributed to robots are not yet in widespread use. To a large extent, the visual and tactical sensation applications are not used extensively. Even the reprogrammable features of robots is not yet fully used. Most often robots are used in conjuction with existing automated production equipment.

According to the Hunt's study, there is no question that many robotic technicians will be employed. However, most of these technicians will be retrained by the auto industry where little outside hiring is expected. Thus only a small number of robotic technicians will be needed in other industries between now and 1990. An oversupply of robotic technicians because of high student interest is an area of real concern if care is not exercised. After all, the function of robots is to eliminate human labor not increase it.

In examining the nature of the work, the National Industrial Center for Hnadicapped Employment (NICHE) reported that changing motors, gears, and arms of a robot would not make a good vocational fit for most physically handicapped persons, and thus rehabilitation trainees should avoid embracing this as an occupation.

Summary

There has been much written about the size of high technology because of the various definitions of what are high technology industries, estimates range from four to seven percent of total employment in the nation. Not all occupations in such industries are high technology occupations since clerical, service and other support staff are significant elements of these industries.

The growth of these industries have been above the average total employment even through a depressed economy with its retarded expansion. The computer related industries have contributed much to the overall increase in high technology categories. It should be noted that high growth rates associated with relatively small employment places of many of the high tech areas can overdramatize their impact if their absolute change is not considered. For example, the U.S. Bureau of Labor Statistics says that for every computer programmer that is now needed, nine custodians and seven food service workers are also required. Thus, the future worker is more likely to be pushing a broom than a keyboard.

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Helen Keller, Me and You

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Abstract

The author discusses his own disability, Cerebral Palsy, and his experience with computers. Technology is a friend to the disabled. Microcomputers give people speech and mobility, they can teach finger spelling, provide basic living skills instruction to the learning disabled, and evaluate speech or gross motor performance. What is needed now is an awareness of the availability of the tool and the determination to use it.

When Helen Keller was 18 months old, she was stricken with an illness that left her deaf and blind. Years later she became able to communicate. The tools that restored her communication capabilities were Anne Sullivan and finger spelling. With tools alone she would not have succeeded. Helen needed determination. She had it.

When I was born I did not breathe for 18 minutes and as a result have Cerebral Palsy. Unlike Helen I have always had basic communication capabilities. I was forty-five when I acquired the tool that enabled me to communicate more effectively. My tool was a word processor. I also needed determination.

Computers, like people, have input and output devices, a memory and a processing unit. To function they both require a language. People receive input through their senses. Computers receive input primarily through keyboards. People produce output when they communicate. Computers communicate when they produce a printout or a video display. Stored information in both is called memory. The brain is where information is processed in people. In computers this unit is called a CPU (Central Processing Unit). Communication occurs only when there is a mutual understanding of a language.

Helen Keller's illness was never diagnosed but as her fever subsided she lost her sense of sight and hearing. Her brain could no longer receive input from her eyes or ears. However, the input already there remained. This was her memory. Remaining also were her other senses which continued to provide input to her brain. Because she had no language she could not communicate. Helen could no longer produce the output necessary to communicate most of her thoughts and feelings. Helen Keller said that she remembered the word "water" and continued to make some sound for that word after all other speech was lost. I ceased making the sound 'wah-wah' only when I learned to spell the word." When she finger spelled this first word she made the crucial connection between symbol and concept.

My condition, diagnosed as Cerebral Palsy, has left my senses intact. However, I have difficulty with fine motor control. My handwriting resembles the crazed scratchings of a demented chicken. Since I have great trouble reading it, others, of course, have the same problem. A typewriter, although helpful, is difficult for me to use. The invention of the home computer and its word processing capabilities was as significant to me as the finger spelling was for Helen Keller. That tool allowed her to communicate with the world. The word processor does this for me. Great thoughts have no purpose until they can be shared.

I have Cerebral Palsy. CP results from damage to the brain usually present from birth, although it can occur later in life from an illness or accident. Cerebral refers to the brain and palsy to lack of control over the muscles. It is a non-progressive condition that remains throughout life. There has not been a week, a day, an hour or a second in my nearly fifty years on this planet that CP has not been the single, dominant constant in my life. For many years I denied its existence, but it was there.

If we were to meet, my "palsy accent" (once called slurred speech) and my occasionally stumbling gait might lead you to think I was bombed out of my gourd. At one point in my life you might have been right, but no more! My fine motor coordination is fair. I can accomplish most tasks but need some help with putting in my contact lens. (The singular is correct.) I also have trouble cutting my own toenails. (I do have ten of them!)

My disability, frustrating as it is, isn't nearly as severe as that of millions of others. Take a moment to take stock of yourself and your physical capabilities. Many people understand what it is to have disability. However, for those who presently think they have no disability let's pretend for a moment.

Pretend you've sprained your wrist giving your pet elephant a bath. Unfortunately your favorite hand is temporarily out of commission. Starting your day you try to brush your teeth-forget the toothpaste! Can't tie your shoes-slip into loafers. You can break an egg with one hand? OK show off! But how about peanut butter on your English muffin? This is ridiculous! Call work, stay home, it's only temporary. Did you have a problem dialing the phone? A month later you sprain your ankle. This just isn't your year. Since you can't put weight on that foot you're about to become good friends with Grandpa's old cane. You watch TV! You watch the "I Love Lucy Show" re-run for the fifth time because it's too difficult to change the channel. Skip your shower, it's only temporary. With all your frustration you do have the satisfaction of knowing it's only temporary. But what if these temporary nuisances don't go away?

If you're like most you've probably never given your capabilities a second thought. If you fit into this category, and many people do, you've entered the world of the TAB. A TAB, by defintion, is one who is Temporarily-Able-Bodied.

I'm not a TAB. Never have been. Never will be. I'm a disabled individual. If I want a glass of water, I can get it. It will take me longer than a TAB (the person, not the soda). If I fill it too full I will probably spill some. Like many CP's I might dribble. My ability to get a glass of water is only slightly impaired. For thousands of persons who have disabilities getting a glass of water is an impossibility.

Let's pretend again. You are now imprisoned in a way you have never imagined. You cannot move your arms, your legs, your mouth. You do have use of your right index finger. You can move it an inch or so in two directions, with difficulty, Your vision and hearing are intact. Now exist. Live. Be independent. People should be self-sufficient. Isn't that what we've all been taught? Your nose starts to itch. It's one of those itches that won't go away unless scratched deeply and intensely. You can't think about anything but the simple fact that your nose is itching. What are you going to do? A TAB wouldn't have a problem but YOU DO. The memory of how good it is to scratch a raging itch consumes your thoughts. But you're caught. Nothing works like it did when you were a TAB. There is no way that itch is going to get scratched by you. Maybe you decide to get the wife or kid to do it. How are you going to tell them what you want? Maybe they're not in the room. Maybe THEY don't exist. Like Blanche in "Streetcar" you are now "dependent on the kindness of strangers."

An itch is a small thing. Yet it has assumed mammoth proportions simply because you cannot scratch it. Consider how enormous major concerns like getting your next meal can become.

You have now encountered the world of the disabled person. Your disabilities were not only temporary but imaginary. As a person whose disabilities are permanent and real I suggest that you keep in mind that TAB means "TEMPORARILY-Able-Bodied." Disability is an equal opportunity state of affairs.

Technology is a friend to the disabled. My company, Al Mann Associates, is based on the conviction that high technology can be essential and invaluable to the disabled. We are bringing this fast-developing technology to the disabled.

Not long ago, I was in a supermarket and thought I'd buy a can of soda. The machine I went up to surprised the hell out of me by saying, "Push the button for Coke, Dr. Pepper or Tab." I wanted a Coke but I was so shocked that I hit the Tab button. The machine then told me to insert my money. It counted off the coins as I put them in, told me that I had put in ten cents too much and said that it was returning a dime to me along with my Tab. When I took out the can it reminded me that I hadn't picked up my dime. When I did so it thanked me and told me to have a nice day.

Since I use voice synthesizers in my work with the disabled, I knew how this simple device had been incorporated into the soda machine. A voice synthesizer can do much more than give a voice to a machine.

Let me tell you about an Englishman named Dick Boydell. He was born with CP. His mother comments "Dick couldn't do a thing for himself physically. He was in a wheelchair. He couldn't keep still; he had athetoid movements. He could hardly hold his head up. He couldn't use his hands at all. He couldn't stand. Well, with all those terrible disabilities, that was nothing to compare with a lack of speech. That was his greatest handicap."

Today Dick can communicate sentences as well as any intelligent TAB can. His tool is a microcomputer with a keyboard input and a voice synthesizer for output. Lengthy or frequently-used messages can be stored for later retrieval. Since Dick cannot control his fingers he has mastered typing with his toes. Although his communicating system is tailor-made to his disability, its components are accessible to people with limited funds.

Microcomputers are helping paraplegics to walk. Electrodes which receive natural electrical signals are placed on a person's back. A microcomputer interprets these signals and sends amplified signals to the legs. Electrodes on the legs then deliver signals to stimulate paralyzed muscles.

Not only can microcomputers give people speech and mobility, they can teach finger spelling to aid the deaf, provide basic living skills instruction to the learning disabled and evaluate speech or gross motor performance. The disabled can also enjoy fighting off aliens and hitting gophers with shovels on video screens.

Many disabled people are aided by the microcomputer. I use it not only as a word processor but core resource in Al Mann Associates. The greatest single problem in my business, and many others, is keeping abreast of current information. I could try to do this with my own memory, but a human memory has limitations. The microcomputer's memory has virtually no limits. I take advantage of this limitless memory by utilizing data bases. Some data bases I prepare myself. I gather information from magazines, books, journals, brochures etc. I store references to specific topics in the microcomputer forming a data base. I can use the microcomputer to recall ALL the stored information on a given subject. I also rely heavily on data bases produced by others. I can obtain the information stored in these "on-line data bases" when I connect my microcomputer with another computer via the telephone.

There are over 1,000 on-line data bases available to the public. The information they contain ranges from Aquaculture to ZIP codes. They are used by business planners, engineers, educators, chemists, economists and others. NARIC (National Rehabilitation Information Center) provides me with information to research technology useful to persons with disabilities. BBIP (Bowker Books in Print) give me the latest on 600,000 books in print and 60,000 soon-to-be published books. On THE SOURCE I read news from UPI, receive letters by SourceMail and attend conferences through Participate. I am currently designing DOIT (Disability On-line Information Tool). I am not the only disabled person using on-line data bases.

Georgia Griffith is a contemporary Helen Keller who lives and works in Lancaster, Ohio. She works for the US Library of Congress which is located in Washington, DC. Georgia has established a career which lets her break free from silence and darkness. She has achieved this success living 800 miles from her office. Her tools are a microcomputer and a VersaBraille system. VersaBraille is a small machine which prints computer braille.

Utilizing CompuServe, a nationwide data base system, Georgia has made many friends. She can communicate with anyone anywhere in the world who is a subscriber to CompuServe.

Georgia's communication tools, her microcomputer and VersaBraille system, combined with her determination have made it possible to be independent. As Georgia puts it, "Can you imagine someone who never hears the news, never reads the paper or seldom talks with people?"

The microcomputer isn't revolutionary in what it can do. What is revolutionary is its versatility, low cost and the ease with which anyone can use it. The problem is that not enough people with disabilities and people who work in rehabilitative medicine are aware of the availability of this tool. What is needed for the miracle to work is an awareness of the availability of the tool and the determination to use it.

Using the Computer in the Special Education Classroom: The Possibilities and the Courseware

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Abstract

One of the most exciting areas for microcomputer use is in special education. Increasingly, teachers are utilizing the capabilities of this technology to assist them in providing the one-on-one teacher/student contact which is so essential for special needs students. This article will outline specific areas in which the microcomputer can be used with special education students. More specifically, it will outline selected programs applicable to their needs.

There are numerous reasons why teachers should be examining the microcomputer for use in their instructional programs. Hardware (machine) adaptations enable handicapped students to communicate with the computer using methods other than the standard keyboard. Devices such as game paddles and foot pedals take emphasis off typing skills and finger dexterity. Students may instead interact with the computer by turning a dial on a game paddle, or by pressing down with their foot on a foot pedal. MECC Special Needs, Volume 1, exemplifies a program that enables students to select answers using a game paddle. In this program the student must select the correct spelling of a word to fill in the blank. Each possible choice is highlighted in sequence by a moving box. When the appropriate choice is highlighted, the student may or may not respond; the box continues to highlight each choice until the student is ready and able to respond. This capability then, not only compensates for physical disabilities, but it eliminates any added pressures brought on by time limitations as well.

John went to the
__________ of the line.

1 head
[2] hed
3 hade

Figure 1. MECC special needs volume 1.

Other hardware devices assisting handicapped students include speech synthesizers and printers. Speech synthesizers enable many nonvocal students to talk for the first time. Programs under development use speech synthesis for verbal output making it possible for the visually impaired to interact with a computer. Using printers and keyboards adapted for braille, visually impaired students can use word processing to create and revise their writing activities.

Telecommunication systems facilitate learning experiences for the handicapped in ways that would have been difficult if not impossible before. Hearing impaired students can be involved in on-going conversations with other students that exercise language skills through continuous reading and writing.

The MECC Blissymbolics courseware allows nonvocal students to "talk" with others using Apple computers. Students may work individually or in small groups to learn the meanings of the symbols, or to communicate with them if they are known. Using game paddles, two children can talk together. Students may also take turns if they do not have game paddles. A printer may be used so that students have a printed copy of their communication. Printed copies can then be shared with friends, parents, teachers and others. Students may use the blissymbol packages to complete letters, stories, and other creative writing activities that might otherwise be impossible. The following is a sample printout of a letter created using MECC Blissymbolics:

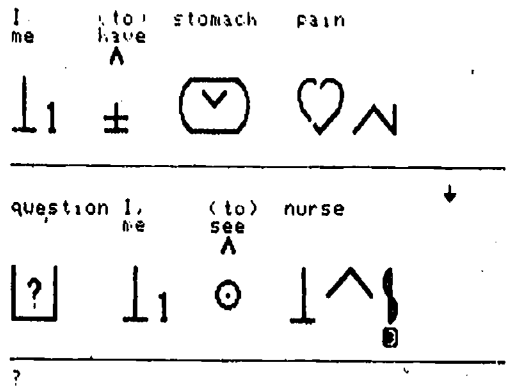

Figure 2. MECC blissymbolics (blissboard).

The state of the art in technology fosters independence in special needs students. Because they are allowed to and have success at functioning on their own they develop an enthusiasm for and a motivation for learning in the autonomous environment the computer provides.

Many teachers in the field of special education are just beginning to explore the potential of technology, in particular the use of the microcomputer. Those looking for software labeled "handicapped" will have a difficult time finding any material. There is very little if any so labeled. The special education teacher must look at courseware designed to be integrated into the standard educational curriculum. Surprisingly, much of the material is applicable to students with special needs. It is crucial however that the teacher take time to review software as carefully as possible. One word of advice: test the programs out on students prior to purchase. Often a program teachers find "... or boring" may be just the program students really enjoy. Conversely, a program teachers find cute and enjoyable, students may find "childish and dull!" Therefore, if at all possible, software review should be a student/teacher process.

Drill and practice applications have tremendous uses in the special education classroom. The computer is a perfect tool for delivering practice problems over and over again. It never tires, or looses patience, and it is a stickler for demanding a "perfect" response. In situations requiring extensive drill and practice exercises, the computer provides a time-saving outlet that enables teachers to work with other students who require more specialized attention.

The most powerful software applications available today are those that allow the teacher to modify parameters within the program, or to create individualized exercises and lessons. These types of programs make it easy for the non-technical, non-programming teacher to adapt software for "special needs."

On a simple level a program such as "Words" from MECC Elementary Volume 7 (pre-reading) allows teachers to enter words behind the blocks of a concentration board (shown below). These words may relate, for example, to a basal reading series, a spelling series, a science or social studies lesson. Instructions for changing words are provided on the screen making it simple to enter words (see illustration). In addition, written support materials, available to supplement the diskettes, answer just about any question teachers might have about the program and its use in the instructional setting. Once the words are entered into the program, students may use the concentration board as an exercise in matching those words, ideas, or concepts teachers want reinforced.

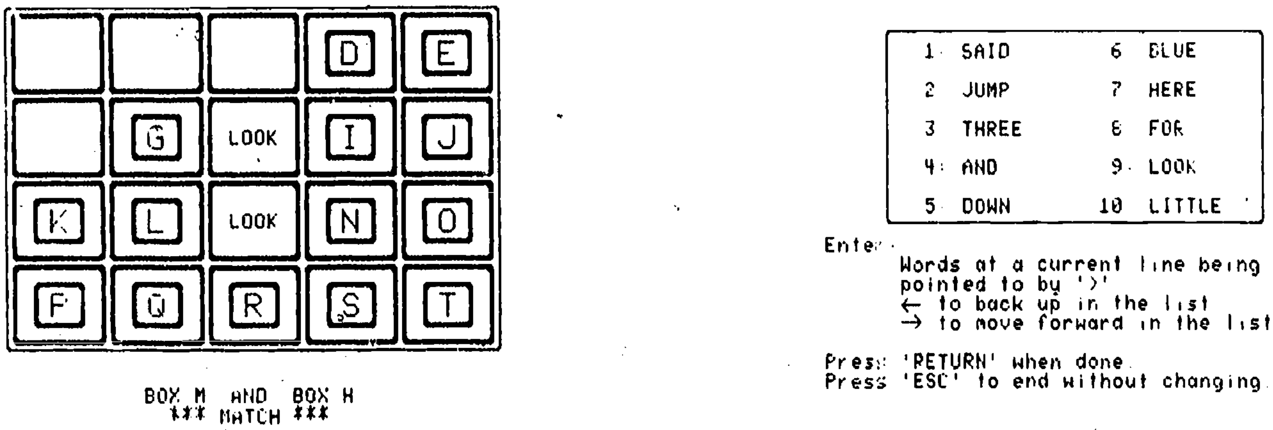

Figure 3. MECC elementary volume 7.

MECC Elementary Volume 2 (language arts) contains programs which allow the teacher to create vocabulary activities such as spelling recall, spelling recognition, and spelling discrimination. Words entered into these programs can also be sent to a printer where word find puzzles, crossword puzzles and other activities assembled by the computer can be placed on paper. This copy may then be duplicated for the class to use. The beauty of all this is that the computer does the hard part, it figures out the puzzle format. All the teacher needs to do is supply the words.

More sophisticated adaptive software packages allow teachers to create question and answer lessons. MECC Teacher Utility Volume 1 is one example of this type of program. Objective numbers may be set to each question item. Students may be drilled on particular objectives or a random sampling of objectives. The computer will keep track of student progress. A "report" option makes it easy for teachers to examine results. In addition, questions may be sent to a printer to be duplicated and used for review activities or final tests. Other MECC Teacher Utility programs (2,3,4) allow the teacher to create true and false, multiple choice and fill-in-the-blank questions.

With creativity and time, the applications for these programs are unlimited. The teacher is in control of the design and the instruction becomes individualized according to the students' needs. Some school systems have initiated incentive programs where teachers who contribute the most lessons using authoring programs may take a computer home during vacations as a reward. Programs of this type are tremendous. They involve teacher participation and cooperation, and they give students numerous instructional activities to choose from.

Beyond the teacher utility packages more sophisticated authoring systems exist that give the teacher even greater design freedom. Initially, lesson development using an authoring system takes more time than using teacher utility programs because teachers must learn an "authoring language" in order to do the design. However, once the teacher has mastered teacher utility applications, the move toward true "authoring system" software may become challenging and fun!

A reference sheet is provided listing software that this author is aware of for use with special education students. It is by no means a complete list but rather something to get one started in exploring the use of microcomputers in special education.

References

MECC Adaptive Software Applications:

MECC Elementary Volume 2 (language arts)
MECC Elementary Volume 7 (pre-reading)
MECC Spelling Volume 1
MECC Spelling Volume 2
MECC Special Needs Volume 1 (elementary spelling)
MECC Special Needs Volume 2 (music, mathematics, science)

MECC Software for Special Needs:

Special Needs Volume 1
Special Needs Volume 2
Guessing and Thinking (elementary mathematics)

MECC Teacher Utility Applications:

Teacher Utilities Volume 1
Teacher Utilities 2,3,4

MECC

3490 Lexington Avenue North
St. Paul, MN 55112

Commercial Authoring System Software

TIES Word Wise

TIES Electric English

TIES
1925 W. Country Rd. B2
Roseville, MN 55113

EZ PILOT
Teck Associates
P.O. Box 8732
White Bear Lake, MN 55110

Apple PILOT

Apple Corporation
(available through local Apple dealers)

The Center for Independent Living of Greater Bridgeport: Computerized Coordinated Service Center

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Abstract

Computerized Coordinated Service Center (CCSC) is a newly created, innovative component of the Center for Independent Living of Greater Bridgeport (CILGB), an independent living center established to facilitate the independence of disabled persons, including adult and aging developmentally disabled adults, who live in Fairfield County, Connecticut. Through utilization of an IBM personal computer system and related software, CCSC has developed a needs assessment and information resource center. Presently, 100 existing categorical and generic agencies and programs are being surveyed. CCSC's computerized Information and Referral (I & R) services will coordinate referrals, promote multi-agency cooperation and reduce unnecessary duplication of services.

The Center for Independent Living of Greater Bridgeport (CILGB) is a consumer-oriented program established to promote the independence and civil rights of adults with disabilities, including adult and aging developmentally disabled persons living in the Fairfield County area of Connecticut. CILGB provides services in an area covering 16 cities and towns, with a total population of over 468,000 people. CILGB has four program components: (a) the Coordinated Service Delivery System (CSDS) provides comprehensive case management and independent living services; (b) the Community School for Living (CSL) provides peer counseling, recreation, support, volunteer and education programs; (c) the Transitional Living Program (TLP) provides intensive Independent Living Skills instruction and housing assistance; and (d) the Computerized Coordinated Service Center (CCSC) provides technical assistance and Information & Referral (I & R), and is responsible for CILGB record-keeping and program evaluation.

In 1982, seeking to expand Case Management and Information & Referral (I & R) services within the greater Bridgeport and Danbury areas, CILGB established the Computerized Coordinated Service Center (CCSC), a federally-funded program cited as "a developmental disabilities project of national significance."

CCSC's Function within CILGB

CCSC's function within CILGB is many faceted. Initially, it is a community-based needs assessment and case management center; yet, it also functions as an innovative resource component. Computer technology is an integral part of the project. One of the principal goals of CCSC is to develop a computerized needs assessment and information resource center. Utilization of an IBM Personal Computer (IBM/PC) and related software significantly enhances this capability. Any information gathered on community services available to people with disabilities, and subsequently stored into the computer's memory, can be easily accessed, and is readily available to consumers and professionals alike. In addition, individual consumer case records create a data base for use in case tracking and internal program evaluation.

How CCSC Developed

The initial set-up phase of the project, which ended in June, 1983, focused primarily on creating a computerized information data base. Presently, all stored information is continually updated, and any new information can be added, when appropriate. The initial period resulted in the creation of an extensive data base whose contents presently include: (a) a comprehensive file containing individual Case Management program statuses (CSDS uses a "status system" to track clients' progress through their Individual Independent Living Plan); over 205 records are currently stored; (b) an alphabetical roster, presently containing over 670 records, referencing initiation of CILGB service provision to individuals; (c) monthly statistics, summarizing the number of sessions and units of service provided to over 160 non-duplicated participants in CILGB programs since January 1st; (d) pertinent demographic information on over 235 CILGB participants. The contents of this extensive information library enhances CCSC's capability to establish the baseline data base necessary for program evaluation and projected dissemination and utilization purposes.

Recently, computer utilization has focused on creating an innovative needs assessment and information resource file. Presently, comprehensive information on over 100 existing federal, state, and local agencies and programs serving Fairfield County is being gathered. This computerized I & R resource provides facilities and programs with an avenue for informing consumers about services, for identifying services for clients, and for facilitating appropriate referrals. Case Managers and consumers can accomplish a preliminary needs assessment and identify appropriate community-based resources.

How CILGB Utilizes CCSC

Although all of the computer's capabilities have not yet been fully utilized, the many technological functions permitted are quite extensive. In particular, use of a personal computer has facilitated service expansion capabilities. For instance, computerization has greatly increased the efficiency of both case management and administrative procedure. The design and implementation of the user-created files allow for quick and easy access to general client demographic information, individual program achievement reports, and all statistics necessary for processing monthly, quarterly, and annual reports. If desired, all information entered into the computer is automatically updated, allowing for fast and efficient access to simultaneous monthly and year-to-year figures. Tables 1, 2 and 3—printouts of sample files—provide an illustration of the information a CILGB Case Manager can visualize on the computer's screen, all at the touch of a couple of buttons.

Table 1

Case Record of Participant John Doe

Record # 3 Delete flag = N

1	NAME:	:JOHN DOE
2	ADDRESS:	:1736 GREEN STREET
3	CITY, STATE	:BRIDGEPORT, CT
4	ZIP:	:06606
5	NUMBER:	:82 003 C
6	TELEPHONE:	:555-0000
7	SOC SEC #:	:234-09-5656
8	BIRTHDAY:	:10 21 64
9	MSTAT/R/SEX HH:	:NEVER MARRIED/WHITE/ MALE
10	ED/EMPLOY STAT:	:HS 10 NEVER EMPLOYED
11	NSA/INCOME L-M:	:YES
12	INCOME SOURCE $	:
13	INCOME SOURCE $	.
14	TRAVEL ABIL.:	:F:
15	MAILING LIST:	:NEWS REC
16	PRIM DISAB RSA:	:CP 300
17	SEC DISAB RSA:	:DEAF 200
18	DEV/SEV WHEEL:	:DEVELOPMENT SEVERE/ WHEEL
19	REF SOURCE DATE	:OHS 08 62
20	REFERRAL AGE:	:18
21	LIV SIT @ REF:	:F:
22	LIV SET @ DISCH	:
23	DVR SERV COUNS:	:NO
24	ILP DATE:	:08 31 82
25	DISCH-ACT STAT:	:99 99 99
26	DISCH FROM CIL:	:99 99 99
27	SERV REC'D:	:CSDS, CSL
28	RED IN PUBL AS:	:

29	MED/DOSE/FREQ:	:VALIUM = 300 MG/D
30	MED/DOSE/FREQ:	:
31	EMERG #/DR.:	:D = 846-1695 N = 374-7628 DR NORMAN WEINSTEIN
32	# PEP AREAS:	:03
33	# PEP ITEMS:	:17
34	# PEP ACHIEVED:	:04
35	% PEP ACHIEVED:	:.24
36	PEP STATUS QUO:	:0
37	PEP REGRESS:	:0
38	PEP DISCONT:	:04
39	LAST ENTRY:	:02/01/83
40	COMMENTS:	:

Table 1 provides an example of the information contained in a participant's case record. The information can include demographics such as, address, race, sex, etc., or more confidential data such as, type of medicine or referral source.

Table 2 provides a different type of information: a comprehensive summary of ALL services received and the number of units of service delivered since Janaury 1st:

Table 2

Monthly Statistics on John Doe

Record # 9 Delete flag = N

1	NAME:	:JOHN DOE
2	PROGRAM:	:HHS
3	CM MONTH:	:9
4	ILS MONTH:	:6
5	OT MONTH:	:4
6	ADV MONTH:	:3
7	HOUS MONTH:	:0
8	EVAL O MONTH:	:0
9	FOLL-UP MONTH:	:0
10	LIV-SIT MONTH:	:2
11	CM PREVIOUS:	:20
12	CM YTD:	:29
13	ILS PREVIOUS:	:6
14	ILS YTD:	:12
15	OT PREVIOUS:	:2
16	OT YTD:	:6
17	ADV PREVIOUS:	:2
18	ADV YTD:	:5
19	HOUS PREVIOUS:	:2
20	HOUS YTD:	:2
21	EVAL O PREV:	:0
22	EVAL O YTD:	:0
23	FOLL-UP PREV:	:0
24	FOLL-UP YTD:	:0
25	LIV-SIT PREV:	:1
26	LIV-SIT YTD:	:3
27	TOT MONTH UNITS	:24
28	TOT YTD UNITS:	:57
29	1ST MONTH LIST	:01/31/83

Notice that all data is maintained on a monthly basis, with an automatic year-to-date summary also readily available for quick reference. The CILGB Case Manager can immediately receive information covering eight areas of services, including: Case Management (CM), Independent Living Skills (ILS), Occupational Therapy (OT), Advocacy (ADV), Housing (HOUS), Follow-up (FOLL-UP), Living Situations (LIV-SIT), and Evaluation Only (EVAL O). In this particular case, "John Doe" received 9 units of CM during the past month, for a year-to-date (YTD) total of 29 units of CM. The monthly total for combined units of services received was 24, with a YTD total of 57 units.

Most of the other files stored on the computer are similar in nature; all are readily accessible to CILGB Case Managers.

CCSC's Computer System

CCSC's computer hardware consists of an IBM Personal Computer equipped with a double disk drive and a NEC 3550 Printer. Current storage capabilities for the IBM consists of 64K RAM with additional disk capacity of 360K RAM.

Additional expansion capabilities are attainable, if desired. The IBM's double disk drive component permits enough flexibility for simultaneous insertion of systems application software packages and data base diskettes, one in each drive. The NECX letter quality printer provides CCSC with the ability to produce letter-like reproductions of impressive quality.

Software that CCSC Uses

Systems programming on the IBM/PC is quite flexible. Presently, CCSC uses three software packages designed for adaptability and efficiency: Total Information Management (TIM), Wordstar, and Supercalc.

TIM.

Innovative Software's TIM program is a popular, user-friendly (i.e., it is designed for a person who is not particularly familiar with how a computer works), data base management, software package, whose functional capabilities allow for easy manipulation of information.

As a filing system, TIM maintains custom-designed records in a format that is readily accessible to user, according to their needs, Initially, the program supplies handy instructions in the form of "Menus" and "Sub-Menus"—helpful segments that appear on the computer's screen. The user simply presses the key that corresponds to the desired mode as displayed on the menu. For example, the letter "A" on the keyboard is used to reference further instructions for adding, updating, or inspecting a previously created record. The letter "C" designates the mode for designing a custom made file. The number of records per file that can be stored on a double-sided, double-density diskette (360K) generally fluctuates inversely with the amount of space the operator allots to each record. For instance, a file consisting of 200 records, with each record allotted 1000 characters (letters) of total storage space, would utilize approximately 200K on the diskette, about two-thirds of the available disk capacity. Approximately 100 more records could be added to this diskette before it reaches full storage capacity. Another file might contain over 650 records because each record is allotted only 152 characters of total storage space. This file utilizes 120K of disk storage. Almost 1000 additional records could be added to this file before full diskette capacity is reached. Although this may sound somewhat complicated, in actuality, it is not.

Records are capable of holding up to 40 fields of information. Data can be organized so as to accommodate alphanumeric characters, numeric characters, or both. Formats are available for adding, subtracting, dividing, or multiplying data automatically. Furthermore, if more information is needed, fields can be combined to include multiple entries of data. For example, CCSC's file on "John Doe" combines race, sex and marital status into one multiple entry field (see Tabl 1).

Data can also be stored in sev... separate files, each one somehow related. Complete information involving over 100 pieces of select data may have to be divided and placed in multiple files. CCSC's complete data on "John Doe", for instance, consists of the 117 fields on informaton contained in 4 files, as follows: (a) demographic data (40 fields); (b) dates of service provision (17 fields); (c) summaries of services received (29 fields); and (d) individual program achievement (31 fields).

These user-created files can then be sorted, printed, added, deleted, or updated in a manner that is easily understandable.

By far, for our purposes, the most useful function of TIM is its select mode which allows the operator to sort and select data in the user-created files according to certain criteria that the user defines. The needed specifications are chosen by the user using simple formulas which tell the computer exactly what to look for. Subsequently, these formulas are then stored, if desired, for further use in the program's library. Table 3 shows an example of a select mode operation.

Table 3

How Computer Searches for Select Information from a File

ALL PARTICIPANTS WHOSE DISABILITY IS DEVELOPMENTAL

Rec #	Name:	Dev/Sev/Wheel:
8	Wanda Blake	Developmental/Severe
3	John Doe	Developmental/Severe Wheel
4	Theresa Drake	Developmental Severe Wheel
2	Gloria T. Freed	Developmental Severe/Wheel
6	Andy Gordon	Developmental
10	Don S. Moore	Developmental Severe
9	Jan Turner	Severe Developmental/Wheel

7 records conform to search criteria

The operator instructed the computer to select all clients whose primary disability is developmental. Out of a total of 10 records, 7 met the pre-set criteria and were selected by the computer. Additional TIM capabilities include the ability to: (a) generate reports and lists, including mailing lists; (b) perform maintenance functions such as deleting files, changing file names, etc.; (c) create and design new files, copy old formats, etc.; (d) link two files together for a joint report; and (e) interface the TIM software package with Wordstar.

Wordstar

Micro Pro's Wordstar program is a functional software applications system designed to perform word-processing procedures. It is a versatile program that combines the capabilities of a computer, a word-processor, and an electric typewriter into one handy package. Words, sentences, paragraphs, or even complete chapters can be moved throughout any user-created files. Changes, deletions, or insertions can also be made at any time, even after a document has been established. CCSC utilizes Worstar for a variety of purposes including, amongst others: (a) writing and storing documents of an extensive nature, such as grant applications and manuals; (b) elaborating on and retrieving detailed information on CCSC's facilities surveys; and (c) establishing and updating frequently used materials, such as CILGB mailing lists, form letters, etc.

Supercalc

Supercalc, a software applications program produced by Sorcim Corp., is another popular package that CCSC uses. Supercalc utilizes a two dimensional grid arranged in a spread sheet format which may range in size from 1 to 254 rows in length, with up to 63 columns in width. Its main focus is geared towards financial applications. It is particularly useful in solving everday financial problems such as budgeting and projections which require both simple and complex calculations. The program is designed with the user in mind; its functions emphasize clarity and simplicity, with easily understandable messages available on the screen. The user can examine and alter numbers and text easily within the spread sheet's lettered columns and numbered rows; formulas can be created, cross-referenced and duplicated with particular ease.

How the Facility Surveys are Utilized

All the information gathered on the 100 agencies, facilities, and programs included in the surveys is stored on the computer in two forms. Initially, a concise, index-type file, geared towards quick and easy access, is utilized and accessed through the TIM software program. This concept provides CCSC with the necessary flexibility a versatile resource center needs.

Inquiries from consumers or professionals seeking general information, collated in a brief, synopsis-type format and classified, either by type of agency or program, location, services available, population served, etc. are handled this way. TIM provides the versatility needed to search through and sort the selected data in a few moments; all information is available in a cross-indexed, cross-referenced form.

Requests for more specific, detailed information on particular agencies or programs require a second, more comprehensive file designed, in many ways, similar to a library format. Wordstar, provides the necessary capabilities. Information is classified in categories that include, but are not limited to: agency name and address, working hours, agency director, telephone and TDD numbers, program objectives, type of agency, funding sources, current facilities, planned programs, services provided, eligibility requirements, ages served, area served, disabilities served, client capacity, transportation, accessibility, fees, application procedures, referral sources, appeal processes, etc.

How Anyone can Use CCSC

CCSC's potential as a viable resource center is particularly relevant for professionals associated with agencies, programs and facilities. CCSC's unique association with CILGB provides professionals with an excellent referral source for independent living services. In addition, by registering programs with CCSC's computerized Information and Referral system, agencies can: (a) increase exposure within the surrounding communities, (b) receive up-to-date information on services available, (c) experience an increase in potential referrals and (d) share community resources and identify partners in multi-agency collaborative projects.

Consumers can also benefit from CCSC. Individuals with disabilities can now receive information on existing service available within Fairfield County. Information on CILGB service provision is also readily available. At present, CSDS services include: (a) advocacy services, (b) needs assessment, (c) independent living skills instruction and independent living counseling, (d) occupational therapy, and (e) coordinated case management services. In addition, the Community School for Living provides a wide array of consumer-based education, recreation and support groups.

How to Obtain all this Information for CCSC

The procedure is actually quite simple. Initially, all it takes is a routine phone call. Any information that is readily available will be provided immediately. For example, you may just want to know the names of all the agencies in Danbury serving individuals with physical disabilities.

Inquiries of a more comprehensive nature can also be handled over the phone. Or, we can send the information in a printed format. Requests dealing with in-depth procedures on selected agencies are handled in this manner. Either way, the procedure is designed to accommodate you, at your convenience.

How Agencies can Develop a Resource Center Similar to CCSC

Agencies, programs and facilities are all capable of developing projects similar to CCSC. If your goal is (a) to coordinate case management services, (b) to produce needs assessment efficiency, (c) to provide fast and accurate I & R, or (d) to just streamline adminstrative and office procedures, CCSC can assist you. Our staff can provide the technical assistance and expertise necessary for developing a logical plan to achieve both immediate and long range goals. Step-by-step instruction will assist you in understanding and implementing the entire program. If you would like more information on our program, or if you are interested in seeing a demonstration, please contact us at CILGB, P.O. Box 3366, Bridgeport, Connecticut 06605 or call (203) 336-0183.

Tactile Graphics Display

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Abstract

The American Foundation for the Blind has designed and developed a new tactile graphics display, which is capable of selectively lifting up to 16,000 pins in a symmetrical mechanical matrix. Under electronic control, the display can be used to generate graphics, large print, or braille. Its unique design significantly reduces the number of drivers required, resulting in a low-cost device.

The Tactile Graphics Display was developed under a grant funded by the National Science Foundation. It can be configured in single-line, multi-line, or full-page displays (Library of Congress standards). Because of its symetrical dot configuration, multiple alphanumeric fonts, conventional six-dot braille, computer braille and graphics can be generated. Black pins on a white background provide a sharp contrast which enables the partially sighted to use the display, as well as the blind.

Background

The present process of generating braille material is bulky and expensive for the following reasons:

1. One page of printed material generates approximately three pages of braille.
2. Heavy-duty paper must be used to prevent the raised dots from being compressed by the finger.
3. Thermoform copies are expensive because of the high cost of reproduction paper (up to 10¢ per sheet).
4. A high percentage of braille material requirements is for limited quantities (less than 100 copies), which makes the automation process impractical.
5. Present high-volume techniques utilizing zinc plates are costly.

The Library of Congress is one of the organizations attempting to reduce these costs, some of which are inherent in the reproduction process and therefore extremely difficult to impact upon these costs. One solution to the problem of cost and bulk is a mechanical device which lifts pins on a single line to generate braille. The braille information is then stored on magnetic tape in digital form and used to control the mechanical display. Companies such as Telesensory Systems, Triformation System, Clarke & Smith Industries, F. H. Papenmeier and Maryland Computer Services have attempted to solve this problem by means of computer terminals. Some of the devices provide voice output of computer information as an alternate output.

A major disadvantage of these devices is cost from $5,000 to $12,000. Mechanical devices used to lift pins range in price from $10 to $20 each, utilizing bimorph drivers (a quartz crystal structure that moves mechanically). A one-line display (40 characters as defined by the Library of Congress) requires 40 x 6, or 240 actuating devices, at a cost somewhere between $2,400 and $4,800.

Method

The display is an electro-mechanical device. The latch bar moves horizontally and latches or unlatches pins. The pins rest above or below small protrusions on latch bars. When they rest above the protrusions, they are in the "up" position; when below, they are in the "down" position, providing the latching function. A second group of pins, which also moves with the latch bars, slides into the grooves of the first pins. By moving in the latch bars, these pins engage a lifting mechanism (lift bars and lift bar actuators) which will either lift or lower the pins only in the unlatched row. The following are design features:

1. All raising and lowering actions are positive, driven by the external mechanism.
2. All parts are captive.
3. No return bars are required because the pins are driven either upward or downward.
4. No gravity return is required.
5. No springs or other mechanism are necessary, thus reducing complexity.

For a 128 x 128 square matrix, 256 drivers are required. Competitive designs require one driver for each pin, or 16,000 actuating devices for a similar display.

Implementation

An analysis was made of the construction of the device in both horizontal and vertical rows. Tolerance analysis indicated that 6-inch lengths of horizontal molding, placed in tandem, would be a superior configuration. The slide bar mechanism was designed to be screwed into the block, utilizing a jeweler's screw, so that individual rows could be assembled and tested before subassembly. A module of 16 x 64 pins was selected to permit ease of repair. Modules of 16 x 64 can be ganged horizontally and vertically to a maximum of 128 x 128 display.

The machining of just one block required 400 cavities, each of which was complex in shape. Breadboard parts were fabricated using a numerically-controlled milling machine. Analysis of a few finished parts resulted in improvements in the pin and latch bar design and increased the horizontal pin movement. It was not practical to machine a complete display because at least 5,000 hours of machine time was required.

The display parts were injection molded. Injection molded parts shrink during fabrication and the amount of shrinkage is difficult to predict and control. Factors contributing to this are:

1. Type of material selected
2. Mold pressure
3. Mold temperature
4. Pressure at which the material is injected
5. Cycle time of injection molding machine
6. Configuration of the part

The design dictated that the match between the block and the slide bar be maintained within .005 inches in 6 inches, although the actual length of these parts did not have to be maintained precisely.

UFE inc., Stillwater, Minnesota, fabricated the components using molding machines which were computer-controlled, resulting in parts which were within tolerance and repeatable.

Drive Mechanisms

Changing one row of the display is done in the following sequence:

1. Unlatch the row.
2. Raise or lower each individual pin in the row.
3. Latch the row.

The horizontal and vertical displays have different requirements for the drive mechanisms. The horizontal display requires single movement to unlatch a row and single return movement to latch a row. Only one row in the entire display should be activated at a time. The vertical drive mechanism requires a more complex motion. From the neutral position the mechanism is driven forward to lift a pin and backward to lower a pin. This forward and backward motion cams the lift bar actuator either up or down.

Horizontal Drive

Numerous configurations could be utilized for the horizontal drive mechanisms. The least expensive would be a sequential drive, similar to that used in printers, typewriters, etc., where an individual character is printed using a moving belt or a lead screw. Many types of sequential mechanisms would work effectively. Sequential operation would reduce the overall speed of operation but would be by far the simplest and least expensive.

The second technique would be direct drive, i.e., each row or column would have a power solenoid with sufficient energy to latch and unlatch a row. For small displays (single and multi-line) this would be the most cost-effective solution.

For full-page displays, small interposing solenoids could be utilized. These interposing solenoids would lift an interposer and a bar would drive only the horizontal row with the engaged interposer. This technique would permit the use of low-power solenoids. Interposers could also be driven by bimorphs for low battery drain. The drive mechanisms designed for the display were of the former type (solenoid interposer). Depending upon application, the other two types of drive may be implemented at a later date.

Vertical Drive

Vertical drive requires a more complex mechanism. One of the paramount requirements is that only one interposer mechanism be used to translate two motions—either forward or backward from neutral. To accomplish this, two counter-moving bars are moved in opposite directions and the interposer engages one of the bars.

Electronics

The electronics necessary to drive the display and interface it to a computer system, or as a stand-alone device, are presently being designed. The implementation utilizes a microprocessor. This report concerns only the mechanical aspect of the display.

Conclusions

We have constructed and tested an inexpensive display capable of full-page tactile graphics, with dramatic reduction in cost over existing display mechanisms. This low-cost device permits single-line, multi-line or full-page braille, or graphics display.

Acknowledgement

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VersaBraille Applications in Education

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Abstract

During the 1982-83 school year, a program was conducted in a residential school and in public schools in Pittsburgh, Pennsylvania, and at the University of Pittsburgh to demonstrate the utility of the VersaBraille in education. Eight students in high school and four University students used VersaBraille in classes and at home for note-taking, preparation of assignments and for a variety of personal uses. Students and teachers devised procedures for using the VersaBrailles. Students' class work was translated and printed in regular type for teachers; students accessed the University mainframe computer for programming; and students accessed data banks for literature review. The program clearly demonstrated the effectiveness of the VersaBraille for education.

Blind students, especially those who attend schools with sighted students, are handicapped by the lack of efficient procedures for processing written information. Taking notes in braille with a slate and stylus or on a Perkins Brailler is slow; teachers' hand-outs must be transcribed into braille or read to the students; all of the students' work must be transcribed into print for sighted teachers. During the past decade, the application of computer technology has enabled the development of sophisticated devices to overcome this handicap. These devices have been primarily developed for vocational application, however, and their uses in education have not yet been widely demonstrated. One such device is the VersaBraille®, a paperless braille machine produced by Telesensory Systems, Inc., Mountain View, California.

The VersaBraille System is a portable instrument measuring 9¼" x 14" x 14" and weighing approximately ten pounds. As a stand-alone machine, it functions like a braille analogue to a word processor. Braille is typed on a six key-space bar keyboard patterned in size and position after the Perkins Brailler; the keys have a much lighter touch than the Perkins Brailler and, since they operate electronically, the writing is much quieter. Braille is displayed on a display of 20 cells, each with six holes through which rounded pins project to form the braille characters. Braille information is recorded on an ordinary audio cassette tape which is formatted into "chapters" and "pages" for ease of retrieval. Each side of the cassette tape will hold 200 pages of 1000 braille characters per page, the equivalent of four large volumes of braille. A rapid search feature permits the user to retrieve a specific chapter and page within seconds; a word search will find each occurrence of a word on a page.

Educationally, a particularly useful feature of the VersaBraille is its editing capability. Passages and words may be corrected, inserted or deleted through the braille keyboards; when insertions or deletions are made, the information on the tape is spread apart or put together with normal spacing so that the finished tape is perfect.

The VersaBraille can also be used as a tape recorder, the user selecting either a braille mode or an audio mode. The audio feature can be very helpful vocationally, for example, to a business or professional man who needs a record of meetings, but, since switching from the braille mode to the audio mode involves some delay and students really do not need to tape lectures but need to be able to take notes just as sighted students do in class, students have not found the audio features particularly useful for classes.

In addition to the reading, writing, searching and editing stand-alone functions, software programs which are entered into the VersaBraille's memory from a cassette tape enable the VersaBraille to interface with a variety of external devices. Adapter cables which permit the VersaBraille to drive a printer or to act as a computer terminal are easily connected. The VersaBraille can be directly interfaced with a printer and braille information on the cassette tape can be sent to the printer which automatically will print the information in inkprint for sighted persons. The VersaBraille can also be directly interfaced with a variety of microcomputers and, through a modem, to a larger mainframe computer, thus enabling the blind person to use the VersaBraille as a terminal; information entered into the computer is presented in braille on the VersaBraille's braille display.

A program, funded by the Richard King Mellon Foundation, Pittsburgh, Pennsylvania, and administered through the University of Pittsburgh was conducted, during the 1982-83 school year, in a residential school and in public schools in Pittsburgh and at the University of Pittsburgh to demonstrate the utility of the VersaBraille in education. Five junior and senior high school students who were mainstreamed in public schools, three students in a residential school, and four university students used VersaBrailles in their classes and at home for a wide variety of activities: preparing for classes, taking notes in classes, preparing papers and other homework assignments, and editing them in preparation for submission to teachers. They also used VersaBrailles for personal uses such as recording homework assignments, recipes, daily diaries, addresses and telephone numbers.

At the junior and senior high school level, students developed procedures for using VersaBrailles each day for taking notes in classes. For example, at the beginning of the week, a student opened a chapter for each subject and reserved enough pages in the chapter to write class notes for a week. As she finished the notes for each class each day, she entered her name on to the tape; the next day, with the word search function, she found her name within seconds and was prepared to continue with notes. Tests and worksheets were prepared on tapes by each teacher; the student read the question and, using the insert function of the VersaBraille, put in her answer. After the test or worksheet was completed, the VersaBraille was connected to a printer—in many cases, a school printer which was used in the computer lab—and, again within seconds, the braille was translated and a print copy was ready for the classroom teacher. If the printer had the capacity to send and receive, the teacher put the test on a cassette tape in braille by typing it on the printer keyboard. One teacher found she could prepare students' work on a microcomputer typing on the keyboard, then she downloaded to that student's VersaBraille. Long assignments such as research papers or science reports were written by students on their VersaBrailles, corrected and edited until copies were perfect, and print copies were quickly prepared for classroom teachers on the printer; this saved an enormous amount of time for the student and for the special teacher.

Students have been preparing to take computer science with their sighted peers. VersaBrailles can be very easily interfaced with Apple computers so that the VersaBraille can enter programs on the Apple and the run will be translated back to the cassette tape to be accessed in braille by the student. With other microcomputers it is a bit more complicated, but not completely impossible.

The university students made more sophisticated uses of the VersaBraille. Using a telephone modem in his own apartment, a student studying computer science called up the university's mainframe computer and independently without the help of any reader, developed programs and ran them. All of the interaction was recorded on the cassette tape for review by the student off-line. Students who had never been able to submit programs for courses on time found they could produce equal work at the same rate as their classmates. Students who were not studying computer science used VersaBrailles and telephone modems to access data banks and review the same literature as their classmates. With this information and the VersaBraille, they could write research papers, correct and revise them until they had a final copy to be submitted, and have the paper printed for submission. One student in law school used his VersaBraille in class where he could read cases as the teacher was discussing them; many cases could be recorded on a single cassette tape which could be accessed quickly. One student, studying chemistry, used the VersaBraille to take notes from her taped textbooks. She devised her own Braille system for denoting complex chemical symbols such as single, double and triple bonds. In her notes she entered clue words, for example, "amide"; when she studied she simply searched through the notes for the clue word and quickly had a list of all involved reactions.

For the VersaBraille system to be used to its maximum potential, adequate training for teachers and students is necessary. The teacher/participants in the program at first attended a two-full-day training seminar which included demonstration and some hands-on practice. On first acquaintance, the teachers were bewildered and frightened of the machine; since none of the teachers had experienced with computers and had no knowledge of basic computer science, such terms as "chips", "interface", "ASCII", and "download", were almost incomprehensible. Additional explanation and practice was necessary before they felt comfortable with teaching students to use the machine. At the end of the year, they expressed their need for a computer literacy course and training in the use of computer braille. The students were not as fearful of working with the machine and they devised many procedures on their own; nevertheless, it was clearly demonstrated that those students who had been formally instructed in the mechanics of the machine and had time to practice with it before they used it for their academic work, used it more flexibly and effectively than those who had just learned procedures as they needed them for classwork.

The program in Pittsburgh in one year clearly demonstrated the utility of the VersaBraille for blind students. This instrument could make a tremendous difference in the education of the blind. It is conceivable that tapes could be produced by transcribers, directly from the publisher's computer tapes, or from a print reading machine such as the Kurzweil. Central libraries, could store the tapes easily; students could access the library tapes through the telephone modem in their schools and within minutes have a copy for their use. Removing the tedious time consuming hassle of transcribing and typing papers to be submitted to sighted teachers could allow blind students time for extra studying, or for leisure time activities with their peers. Teachers could have time to teach the daily living skills which have been so neglected in the curriculum of mainstreamed blind students. All blind students could become computer literate while in school and those who wished to pursue computer programming as a vocation could do so.

In the past, the development of machines—some very simple—has had a dramatic effect upon the education of the blind. The braille typewriter forced the standardization of braille and made the mass production of braille textbooks feasible; the Thermoform machine greatly enhanced the effective mainstreaming of blind students by making single textbooks more readily obtainable; the talking book machine made more literature available. The VersaBraille could have an equal effect in the future.

Applications of Microcomputer Technology in a Comprehensive Rehabilitation Center

B. Rizer

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Abstract

Microcomputer technology is having a tremendous impact on the lives of the disabled. Applications range from microcomputer based augmentative communication systems for the vocally impaired to special text to braille conversion programs for the visually impaired. Applying this technology on a widespread, systematic basis to benefit large numbers of disabled persons is becoming a challenge to every facility which provides services to the disabled. The Maryland Rehabilitation Center with assistance from The Johns Hopkins University Applied Physics Lab is taking on this challenge and finding promising results. A microcomputer center has been formed and functions as a resource for all client service departments within the center. In addition, special interface systems are developed for individual clients to assure their ability to function in the center and beyond. The following paper is not a model but a summary of an operating system which for one special facility is proving productive.

The Maryland Rehabilitation Center provides comprehensive rehabilitation services to the mutiply and severely disabled population of Maryland. The center is one of only ten nationwide and serves over 1400 disabled persons each year. The growing number of severely disabled persons referred to the center is on the increase primarily for two reasons: First, the victories which have been won by the special education groups are resulting in more developmentally disabled young people being introduced to the mainstream of education with an eventual need for a continuation of services beyond the twenty-first birthday. These individuals are being referred to state vocational rehabilitation agencies and facilities in large numbers and create a new challenge for the rehabilitation system to absorb. Secondly, medical science is advancing at a disproportionate rate when compared to the social, educational and rehabilitation professions and these advances result in many more individuals surviving serious illness and trauma only to live restricted lives in a society which is not prepared to help and deal with them.

Facilities specializing in the provision of rehabilitation services to the severely handicapped are faced with a new "breed" of clientele. Most facilities are not equipped to meet the needs of such large numbers of individuals requiring multiple and specialized care. In many cases modifications to present procedures are necessary while in other cases an entirely new service is required.

Fortunately, these new trends come at a time when other changes are taking place which offer a partial solution to the problems at hand. (Improvements are taking place in technology, particularly microcomputer technology, at an even faster rate than improvements in medicine or in the educational rights movement.) Technology and microcomputers are no longer confined to research and development laboratories and to "high-tech" industries but are now available for the common work place, the school, the home, and of course, the rehabilitation facility. Affordable microcomputers are changing the way in which many jobs are performed. Rehabilitation centers certainly follow this principle and go on to take it a step further. The Maryland Rehabilitation Center applies many of the "traditional" uses of microcomputer technology but specializes in unique, "non-traditional" uses.

It is difficult to conceive of something as being traditional when it has only been around between two to five years, but "traditional" and "non-traditional" appear to be the best terms when defining what the majority of the world does with microcomputers as compared to what a comprehensive rehabilitation center does with microcomputers.

Traditional uses include the use of microcomputers in word processing training, electronic spreadsheets in business education, computer-assisted diagnostics in automobile mechanics' training, computer-assisted design and layout in drafting training, Computer Assisted Instruction (CAI) in remediation and supplemental education programs, recreation and entertainment and, finally, the use of microcomputers in the training of computer programmers. These applications currently exist in a large number of training facilities, including those dealing with special populations such as rehabilitation centers. These applications certainly are not unique and do not require further description here.

The non-traditional applications of microcomputers in a rehabilitation setting result not necessarily from specially dedicated devices and efforts but from the application of "off-the-shelf", affordable technology which has been slightly modified to provide a benefit to the severely disabled user, a use for which the device was never initially intended. Most rehabilitation facilities have neither the funds nor the expertise to develop custom applications of technology for each disabled user. This approach would not prove effective as few disabled persons would be served, and a disproportionate amount of time and energy would be spent on follow up and maintenance of the custom devices.

Applications

Before proceeding with a list of the unique applications of microcomputers in a comprehensive rehabilitation center, it is important to understand the basis under which such a facility operates and the changes which have made tremendous impact or such a facility's ability to perform its function. Until very recently, if a disabled individual referred to a vocational rehabilitation center lacked a communication system and was unable to complete at least a portion of his evaluation independently, he probably would have been refused entry into the evaluation programs, or he would have been admitted with great reservations on the part of the evaluation staff and with the resulting probability that the evaluation would be terminated in a very short period of time. This type of referral is increasing at an alarming rate, and there is every indication that the trend will continue and will indeed increase due to expanding educational rights and medical gains.

Each of the following applications is followed by a brief program description.

Augmentative Communication Devices

Many custom or dedicated speech-generating or text-generating devices are now available commercially for the vocally impaired or nonvocal. Being dedicated, the device performs that function for which it was designed and developed. These devices are not suitable for all individuals who could benefit, simply because they are not accessible to the severely physically impaired who are also vocally impaired. Dedicated devices tend to be expensive due to the very nature of their being a device marketed for a limited audience.

Adding the component of speech to a severely disabled person's capabilities before he proceeds in a rehabilitation program is vital to the success of the individual's program. This component can now be added by use of a microcomputer. Portability is still another dimension added by utilization of a portable microcomputer such as the Radio Shack Model 100 or the Epson HX-20. These computers, coupled with a voice synthesizer and proper software, operate reliably and efficiently as communication devices. In addition, portable computers can be used for nearly the same purposes as the stationary microcomputers, including word processing, data base management, educational activities and recreation. Also, with the addition of a phone modem, the world of telecommunications becomes available for everything from sending phone messages to another user to accessing large data bases for current information.

Alternate Text-Generating Devices

Probably the biggest barrier to a severely handicapped person's completion of a thorough evaluation is the person's inability to respond to objective test questions or to work independently of the evaluators. The microcomputer with alternative control devices enables even the most severely disabled to complete many of the testing procedures which would have been all but impossible previously.

Alternative input devices employed at the Maryland Rehabilitation Center include:

a. Voice Activiation
b. Morse Code
c. Stepping and Scanning

The morse code as well as the stepping and scanning approaches allow for a wide range of switch activation possibilities from chin switches to foot control.

Environmental Control

Many severely handicapped individuals become easily frustrated by their inability to control their immediate environment. The simple tasks of turning on a light, the television or a radio are not possible or require so much effort that the activity is not attempted. The microcomputer, coupled with a home control program, is capable of allowing the individual to control many features of the environment, thus saving much time and energy previously wasted performing a simple task. This type of control is possible using any of the previously mentioned interface systems, including voice input or single switch control.

Alternate Learning System

The appearance of microcomputers in special schools and rehabilitation facilities has revealed that many severely handicapped, developmentally disabled young adults are not functioning at or near their chronological or mental ages simply because they lack the ability to fully participate in the educational environment. The provision of educational services to handicapped students is improving, but certain environmental, personnel and functional limitations continue to prevent many of the more severely handicapped students from reaping the benefits of the time spent in the educational setting.

Appropriately designed hardware and software can eliminate the last barrier experienced by the severely handicapped student and, in some cases, give the students the upper hand due to the quality and quantity of material which can be presented through Computer Assisted Instruction. Many tests administered by the Maryland Rehabilitation Center are now administered on microcomputers to eliminate any existing barriers to the testing process.

Cognitive Rehabilitation

One of the most recent developments, and one which shows promise and appears to be gaining in popularity, is the use of microcomputer programs as a cognitive retraining tool. Studies are now being conducted in the use of microcomputers for aiding in the improvement of memory, reading speed, spatial relations, eye-tracking and attention span. The field of cognitive rehabilitation is relatively new and will be expanding as a result of the large increase in the number of brain-injured persons referred for services.

Diagnostic and Review Process

The process of determining the usefulness and extent of application of microcomputer technology to the disabled is a new one. Many fields and professions are involved and each plays a specific and vital role. The process of coordinating these activities and providing such helpful support as (1) software applications, (2) interface procedures, (3) review of new developments on the market, (4) development of systematic evaluations and application processes and (5) the decision of the all-important question of when microcomputers are applicable to the problem at hand must be handled, at least in a large scale rehabilitation center, by a common source. In the case of the Maryland Rehabilitation Center, that common source is developing as a microcomputer center manned by a rehabilitation professional.

The creation of a microcomputer center for all aspects of microcomputer technology, including the evaluation for interfacing of the severely handicapped, has added a new dimension to the Maryland Rehabilitation Center. The center's ongoing goal of serving more disabled persons and serving an increasing number of the severely handicapped is becoming more of a reality thanks to the new approaches being taken with computers. Immediate benefits have become obvious and the anticipation of new developments keeps the excitement and anticipations at a high level.

Unique Microcomputer Problems in a Rehabilitation Center

New programs and advances are not without growing pains. In the case of technology and the handicapped, the following concerns are making themselves known:

Client Rejection

Because something works and perhaps works well does not mean that the client for whom it was intended will accept it. These problems range from the female client who does not accept the voice prostheses because of the male robotic voice to the cerebral palsy or spinal cord injury client who does not accept the use of a mouth stick or a head stick mounted to a helmet or head band.

Partial Meeting of Needs

The tremendous variety of interface equipment available today results in few severely disabled individuals who are unable to be successfully interfaced with a microcomputer system. The physical and technological components are advancing rapidly. However, there are other components to be considered before a successful interface can be completed, including the individual's educational background, study and/or work habits, and emotional and psychological adjustment to the disability as well as the need for the intellectual process to be on par with the client's new ability to communicate.

Too Much . . . Too Late

In the case of some of the older developmentally disabled, current technology came too late. The lack of education, social and personal developments is so great that progress can only be measured in tiny steps. Unfortunately, such facilities as the Maryland Rehabilitation Center are not equipped or even intended to work with cases that do not show some promise of improving to the point of making significant change in the disabled individual's life. Many severely disabled persons will be falling through the cracks and will not have an opportunity to test their own abilities to succeed with a tool which could make success possible.

Summary

The introduction of microcomputer technology to the wide variety of needs of the severely handicapped is still very much in the early stages. At this point in time there simply are not many proven approaches to follow.

Creativity, a sense of determination, both in the severely disabled person and in the rehabilitation professional, and trial and error coupled with hard work are the ingredients of success.

The Connecticut Special Education Microcomputer Software Evaluation Project

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Abstract

This presentation will describe the activities of the Connecticut Special Education Software Evaluation Project. The overall goal of the project is to develop and field test a statewide model to evaluate the effectiveness of special education micorocomputer software and to disseminate the results on a statewide basis and beyond. To achieve this objective the project is developing a software evaluation model and instrument, conducting a software needs assessment, training teachers and administrators to evaluate software, evaluating microcomputer software, developing a dissemination model, serving as a resource to school districts regarding software and hardware concerns, encouraging in-depth field studies, and developing a special education microcomputer users group.

The microcomputer revolution will have dramatic and irreversible effects on the way in which we do business, educate our children, and, ultimately, live our very lives. A recently completed nationwide survey by Market Data Retrieval (1982) indicates that over 24,000 U.S. public schools now use microcomputers in instruction, and that more than 60 percent of public school districts contain at least one school using a microcomputer for instruction.

Concerning the availability and use of microcomputers in Connecticut, a recent report issued by the Connecticut State Department of Education reveals that 54 percent of the school districts have microcomputers available at the elementary and junior high levels, while 62 percent have them available at the high school level (Glass, 1983). The report shows that Connecticut is just beginning to use microcomputers for instruction of the handicapped and for generating individualized Education Programs (IEPs).

Despite the impressive statistics concerning hardware availability, many experts are concerned about the quality of software available for school use. Burns (1981) indicates that with the dramatic fall in the price of equipment, the single most important barrier to instructional computing is the lack of high quality curriculum materials. The Educational Products Information Exchange (EPIE), is even more emphatic. They state that the production of "educational" software is a fractured cottage industry dominated by enterprising programmers, not educators. Instructional design concerns are only occasionally addressed in the single-concept tapes or disks (1981).

These findings relate to general applications of educational software. Although the literature is somewhat silent about the quality of special education software, there is reason to believe that it is just as bad as, if not worse than, software developed for the general population.

The need to provide technology for the handicapped can be sensed throughout Connecticut. Connecticut's Superintendent of Schools recently made technology a major priority for the state. Our State Director of Special Education has urged Connecticut to become a leader in terms of microcomputers and the education of the handicapped (Gillun, 1983). The handicapped need equal access to microcomputers. More importantly, we must insure that this new technology is appropriately evaluated and modified for them. Hopefully, this project will be a major step in this direction.

Project Design

General Design

The overall goal of this project is to develop and field test a statewide model to evaluate the effectiveness of special education microcomputer software and to disseminate the results on a statewide basis. To achieve this overall goal the project will develop a software evaluation model and instrument, conduct a software needs assessment, train teachers and administrators to evaluate software, evaluate microcomputer software, develop a dissemination model that can be utilized by the Connecticut Special Education Resource Center, assist the Connecticut SERC in becoming a repository for special education software, serve as a resource to school districts regarding software and hardware concerns, encourage in-depth field studies, and develop a special education microcomputer users group. Details on these activities follow.

Special Education Software Evaluation Instrument

A number of approaches have been proposed for the evaluation of educational software. However, only a few have been developed with the specific needs of the handicapped in mind. Consequently, the first activity of the proposed project is to develop a model and an instrument for the evaluation of special education software. This model and instrument will be sensitive to previous work in the general area of software evaluation, to the specific needs of handicapped children, and to the needs of school districts throughout the state.

The developmental work on the evaluation instrument has already begun. The project staff has reviewed existing software evaluation instruments, such as the ones from Microsoft, MCE Inc., and a variety of other sources. Although these tools have utility for general applications, they do not seem very sensitive to the needs of the handicapped.

In terms of general software concerns, two sets of information will be required. Consistent with the procedures designed by Microsoft (1982), these include (a) descriptive information for the documentaion of software; and (b) criteria for the evaluation of software quality. Descriptive information includes general concerns, hardware concerns, type of support available from the publisher, instructional aspects and management aspects. Criteria for the evaluation of quality includes content validity, instructional strategies, and operational concerns. Each of these has a number of sub-categories, thereby yielding a total of 16 quality concerns. Francis Archambault, from the project staff, is in the process of adapting these criteria to the needs of the project.

The software to be considered by this project can be categorized as either management software (e.g., IEP development, record keeping, etc.), or courseware. Further within each of these two groupings, is material designed for most children or for "regular" education, and material that publishers advertise as being specifically designed or modified for handicapped children. It is this "special education courseware" that will be the major concern of this software evaluation project. Rucker and Vautour (1978) have proposed a rationale for modifying IEPs for handicapped children that may have utility in terms of software modifications for handicapped children. These modifications fall into four broad classifications, i.e., modifications of presentation, performance, content, and time.

Modifications of presentation could include enlarging the print size in the instructional frames of a program for a visually impaired child, presenting material via a speech synthesizer to a child with a severe reading disability, or deleting distracting graphics from a program for a hyperactive child.

Performance modifications address ways a student is allowed to display mastery of a specific skill or concept. For example, the TETRAscan II is a keyboard emulator that allows severely disabled children to operate all standard software even though they may have control of only a single muscle (Closing the Gap, 1983, Vol. 1, No. 6). Another example would be an orthopedically disabled child using a voice activator to interact with the microcomputer.

Rucker and Vautour point out that curricular content is an area in which modifications are often required for handicapped children. What is taught and the appropriate sequence to be followed must be resolved if we expect a child to perform successfully. The type and extent of curricular modification is directly related to the degree of severity of the handicapping condition and the age of the child. Modifications of this sort are incorporated in courseware by branching programs that lead to different levels of instruction. Certainly a program designed for handicapped children must have this capability and a software evaluation instrument must address it.

The final program modification deals with time. We all can cite examples of handicapped children who are capable of performing a certain task, but because of insufficient time fail to do so. Software modifications regarding time will be relatively easy to deal with since the microcomputer can be programmed to have infinite patience. The software evaluation instrument developed for this project will be innovative in that it will take these four modifications into account.

During the present phase of this project, the 16 quality concerns mentioned earlier and the four modification criteria are being reviewed, modified, and then "mapped" onto an instrument. This instrument will be reviewed by a management review team made up of project staff plus University of Connecticut special education faculty members with specific content expertise in such areas as LD, MR, ED, and S/PH.

The instrument will be field tested at the University of Connecticut, revised, and then field tested with the cadre of software evaluators. Questionnaires will be designed to obtain feedback on the evaluation forms. Concerns addressed will include, but not be limited to, the appropriateness of language and definitions, the comprehensiveness of the items and categories, and the ease of use. Interviews around these same themes will also be conducted. Based on the data obtained in these trials, appropriate changes will be made. The combination of a thorough literature review, expert analysis, and field testing should yield high content validity for the instrument.

The major reliability concern centers on the issue of interrater agreement. To obtain data to address this statistical concern, a variety of software packages will be evaluted by our cadre of evaluators during their training sessions. Standard analysis of variance procedures will be used to obtain the required index.

The evaluation instrument will provide the project staff with the data needed to write software evaluation reports. These reports will be disseminated throughout the state of Connecticut, and, based upon them, teachers and administrators should be able to make more informed selections of microcomputer software.

Evaluate Connecticut Special Education Microcomputer Software Needs

The project will seek to evaluate Connecticut special education microcomputer software needs based on several data bases (i.e., a review of the literature, Connecticut State Department of Education study, and the results of the needs assessment questionnaire developed as part of this project). The review of literature has revealed that (a) educationally effective software is limited, and (b) most software available today is machine specific.

The Connecticut State Department of Education survey (Glass, 1983) revealed that Apple and Radio Shack constitute 79 percent of the hardware presently in use in Connecticut public schools. These data have a direct bearing on this project. That is, a given program can only be used on the particular computer it was created for. If the State Department figures hold for the special education microcomputer users within Connecticut it will mean that the majority of software to be evaluated needs to be operable on these two machines.

This project will develop a needs assessment questionnaire specifically designed to measure microcomputer software usage throughout the state. We will attempt to determine (a) the kinds on instructional and management software now in use, (b) which seem most popular for particular types of handicapped children, and (c) which vendors and publishers have gained the respect of the school districts. Also, particular areas where software is not available will be explored. Finally, particular problems with instructional and management software will also be included.

Select and Train a Cadre of Special Education Evaluators

The Special Education Resource Center will announce the project in a Fall 1983 publication. This will describe the nature of the Project and will solicit special education teachers and administrators actively using microcomputers who would like to be trained in using our software evaluation instrument. A similar request for volunteers will be in the first project Newsletter. We will select a cadre of about 20 people to train from those that respond.

The project will bring together the cadre of special educators for training in our software evaluation procedures. The training will involve a thorough description of the instrument, trial use of the instrument to evaluate selected software, writing narrative reports based on evaluation instrument results, and comparing results in terms of interrater reliability.

Obtain and Evaluate Special Education Microcomputer Software

The project staff will write to software producers to request their cooperation in our evaluation effort. The initial list of companies will be drawn from the LINC Resources list. As soon as software begins arriving at the project the project staff will review it to determine whether (a) it is relevant to special education instruction or management, (b) it is in an area that fits established Connecticut special education microcomputer needs, and (c) it is free of major technical errors. If the software meets these criteria, it will be sent out for evaluation by at least two of our cadre of special education software evaluators matching the area of expertise required. The returned reports will be assembled into an overall evaluation report by the project staff. A summary of the report will be prepared for the next project Newsletter.

Dissemination Model

The project will assist the Connecticut Special Education Resource Center in the development of a dissemination model for the results of software evaluations across the state. A project Newsletter, mentioned earlier, will be a major component of the dissemination model. The project and the Newsletter will be announced in SERC publications soon after the project begins. The first mailing will be to (a) special education administrators and supervisors, (b) others who may have attended the first Connecticut Microcomputer Conference on Special Education (10/82), and (c) those who respond to the SERC announcement. The aim will be to disseminate the Newsletter to all special education administrators, supervisors, teachers, pupil personnel workers, and others interested in special education microcomputer software.

There will be at least three issues of the Newsletter during the 1983-84 year. The content of the first has been described above. The second Newsletter will describe the results of the needs assessment questionnaire and provide insights on special education hardware and software usage in Connecticut. It will also include evaluative comments received regarding the more popular education software. Finally, in this and the following newsletter, the readers will be encouraged to consider attempting in-depth field studies in their school district. Such studies could be published in later newsletters.

A third issue in May will provide the first feedback in terms of the evaluation of special education software by our cadre of trained evaluators. It will contain reviews of special education software, and will provide directions on receiving full reports if desired.

The newsletter mailing list will constitute a users group of those concerned about special education hardware and software usage in Connecticut. The project will support at least one meeting of the group. This will offer an additional opportunity to disseminate evaluation results. Users from across the state will be encouraged to make presentations at the meeting(s).

Anyone interested will be welcome to visit the project to try out the software of interest to them, talk with the project staff, and pick up copies of the project Newsletter and evaluation reports. They can also try out the software by visiting the Connecticut Special Education Resource Center in Hartford. The SERC will maintain a collection of journals and books on microcomputer hardware and software. Copies of the Newsletter and evaluation reports will also be available at SERC.

Finally, the project final report will contain a discussion concerning a statewide computer network. That is, the project staff will present a working plan for establishing a network system The discussion will include advantages, disadvantages, costs, and so forth. Kansas and Florida are already well underway in this process. Kansas is attempting to get each school district into the Special Net computer network. It is our feeling that such a network would have many advantages for school districts in Connecticut. Such a network would provide the state with the greatest possible dissemination model.

The project will be linked to Special Net and we will encourage our users to do the same. This will provide many advantages. For example, copies of the Newsletter, full evaluation reports, or other materials could be sent out via the network by the project when requested. Anyone in the network can communicate with the Connecticut State Department of Education, the National Association of State Directors of Special Education, the project staff, and everyone else in Connecticut and other locations within the Special Net network. Bulletin boards on federal and state concerns, computer applications for handicapped children, litigation, promising practices, new product, new publications, etc. are available.

Develop Software Repository

The software that is evaluated will reside at the Connecticut Special Education Resource Center. The project staff will help the SERC establish this repository. Those interested would be able to come to the SERC and try out the software of interest to them.

Serve as a Resource to School Districts

The project staff will serve as a resource to school districts on special education software acquisition, evaluation, and development as well as hardware evaluation and acquisition. The staff will refer those interested to articles, books, the project Newsletter, and software reviews of interest. The staff will also accumulate a listing from the software needs assessment of particularly successful practices with specific types of (a) handicapped children, (b) hardware, and (c) software. Thus the staff will be able to offer solutions to problems or match a request with a practitioner in the field who will be able to help them.

The project will also sponser a special education microcomputer users group. The users group, which will be described in the project newsletter, will act as an additional resource for Connecticut special education. The project will sponser at least one meeting of the users group on the University of Connecticut campus in the Spring 1984.

The users group and others will be encouraged to join the Special Net network. This will put them in touch with an immense resource. The project staff will have the Special Net resource at its fingertips, as an aid in addressing concerns that arise regarding microcomputers and handicapped children in Connecticut.

Encourage In-depth Field Studies

The project will encourage in-depth field studies on special education microcomputer software. Although the project will only be able to encourage such studies through the Newsletters, it is deemed to be very important by the project staff to begin these studies. The project staff will willingly offer assistance to any school district interested in such studies.

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The Executive Secretary Word Processing System: An Aid to Those Servicing the Disabled

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Abstract

The Executive Secretary is a low-cost word processing program. It is designed to run on the Apple II microcomputer, IBM personal computer, Olivetti M-20, and Franklin ACE computers. The Executive Secretary permits the user to perform a variety of tasks simply and efficiently.

With the ubiquity of microcomputers and associated software, practitioners in rehabilitation-oriented fields should strive to determine the applicability of computer technology to their own practice. Indeed, this conference is a testimony to the variety of applications now available to the practitioner dealing with the disabled. Though it is only natural for users of current technology to focus on the truly exciting diagnostic and therapeutic applications, one other very important aspect of microcomputers is their ability to manage efficiently many administrative functions. Of course, numerous software packages are available that support accounting, spreadsheet application and word processing. But one program—The Executive Secretary—is a low-cost word processing program that can manage many of the busy practitioner's administrative responsibilities.

Word processing systems shouldn't be limited to text entry and text modification. Rather, they should permit users to perform a variety of tasks simply and efficiently so that minimal time is spent in repetitive tasks (such as re-typing portions of documents), designing special forms, printing on pre-printed forms, customizing documents, conducting mailings, or whatever. Briefly, the system should be powerful and flexible enough to meet a wide range of needs.

The Executive Secretary represents such a system. Designed to run on the Apple II family of microcomputers, IBM personal computer, Olivetti M-20, and Franklin ACE computers, this system is relatively inexpensive, is a powerful management tool, and should be considered seriously by all who have a compatible microcomputer. Nevertheless, becoming proficient with such a system does necessitate a major time commitment, and many potential users' applications remain limited.

This presentation will focus on how The Executive Secretary can assist virtually anyone involved in teaching or servicing the disabled with the administrative aspects of their vocation. The examples presented below were developed for use on a Apple II + with 64k RAM or Apple IIe with two disk drives. I will begin with some simple word processing applications and end with more sophisticated programs that will highlight several possibly unique applications of this package.

Keyboard Commands and Libraries

Clearly, some of the most obvious word processing applications include such things as resume production, articles, letters, and memos. The first example represents an application familiar to everyone: a client report. To print a report with the relevant client information formatted, the user must first create and store two separate files—one for the heading and one for the report closing (e.g., the practitioner's name and credentials). The third file, which consists of the body of the report, is prepared as a separate file and includes commands that call up the report heading and closing files for execution. Also, the system can be programmed to request information from the operator while the report is printing. Thus, for each report to be produced, appropriate information is requested by the system, entered by the user at the keyboard, and then printed and formatted as programmed. The program below shows the first document file labeled. REPORT HEAD which is used for printing the report heading. The line numbers are not a part of any file discussed in this paper; they are only included to aid in discussion.

```
1 >cr 2
2 >tm 10
3 >bm 10
4 >KD 1, CLIENT NAME?
5 >KD 2, STREET?
6 >DK 3, CITY, STATE, ZIP?
7 >KD 4, PHONE?
8 >KD 5, DATE?
9 >KD 6, PARENTS?
10 >KD 7, REFERRED BY?
11 >KD 8, REASON FOR VISIT?
12 >cn
13 OHIO UNIVERSITY]
14 SCHOOL OF HEARI'    SPEECH SCIENCES]
15 CLINICAL SERVICES DIVISION]
16 >co
17 ]
18 Name: &01
19 >ah 40
20 Date: &05]
21 Street: &02
22 >ah 40
23 Parents: &06]
24 City: &03
25 >ah 40
26 Referred by: &07]
27 Phone: &04
28 >ah 40
29 Reason for visit: &08
30 ]
```

Line 1 of this file is a command to enact a carriage return on the printer while lines 2 and 3 set the top and bottom margins. Lines 4-11 define "keyboard" commands (identified by the ">KD"). These commands temporarily halt printing of a document and reguest specific information to be entered from the keyboard. For example, when the program reaches line 4, the phrase "CLIENT NAME?" appears on the monitor. The user then types in the name to be printed, presses RETURN and the system responds with "STREET?". This sequence continues until all keyboard commands are executed. Line 12 commands the next three lines to be centered, while line 16 turns centering off. Line 17 forces a carriage return; its effect is to produce a blank line.

Once the keyboard commands are defined, they can be used as shown in lines 18-29. Using the ampersand (&) followed by the keyboard command number, the various items that were entered earlier at the keyboard can be formatted and printed as the user wishes. Line 18 instructs the printer to print the name that the user entered in response to the prompt "CLIENT NAME?". Then the printer moves over 40 spaces (line 19; >ah 40) and prints the date (line 20). The right bracket after the "&05" commands the printer to move to the beginning of the next line and print the client's street address. This process continues until all information entered at the keyboard is printed as requested in lines 18-29.

The next file prints a standard report closing:

```
]
]
]
>UL 20
```

```
5 William H. Seaton Ph.D., CCC-A
```

After the report is printed, three lines are skipped (lines 1-3), and the practitioner's name and credentials are printed. The ">UL 20" command underlines 20 spaces for the signature.

Once these two files (REPORT HEAD AND REPORT CLOSING) are defined, they can be used to print any report. To use them, they must be on the same document disk as the report and they can be "called up" from within the report to be used during the printing. This is done as shown below:

```
>XT REPORT HEAD
(body of report)
>XT REPORT CLOSING
```

The first line shows how to call up a file from within a file. The >XT REPORT HEAD command instructs the system to call the external file named REPORT HEAD for execution before printing the report. As a result of this command, the report head file is called up, executed as explained above, and then the report is printed, followed by the report closing, which is called up with the >XT REPORT CLOSING command. The final result is shown below:

```
                    OHIO UNIVERSITY
          SCHOOL OF HEARING & SPEECH SCIENCES
               CLINICAL SERVICES DIVISION

Name: John Smith                 Date: September 12,
                                   1983
Street: 1 Paris Lane             Parents: N/A
City: Anywhere OH 44444          Referred by: Self
Phone: 555-1212                  Reason for visit: Diag-
                                   nostic

John Smith was seen at the Ohio University Speech and
Hearing Clinic etc.

__________________________________
William H. Seaton, Ph.D., CCC-A
```

Though it may take a short time to write the programs shown above, once they are written they can be used repeatedly for any report.

Another nice feature of The Executive Secretary is that it permits one to build a library of frequently-used terms which can be used to save typing time. "Libraries" are created as shown below by using the "greater than" (>) symbol followed by a period and two-character code or descriptor of the term or phrase followed by the phrase itself:

```
1 >.OU Ohio University
2 >.SH Speech and Hearing Clinic
3 >.HA hearing aid evaluation
4 >.ME medical examination
```

Once these "libraries" of terms are defined, they can be used in printing documents by inserting the three-character codes (i.e., the period and the two-character descriptor) in place of the phrase itself. When the document is printed, the library of terms is called up with the >XT command and the appropriate phrases are inserted wherever the codes appear. The use of these codes is demonstrated below:

```
1 >cc 2
2 >XT LIBRARY
3 >XT REPORT HEAD
4 John Smith was seen at the .OU .SH for a .HA follow-
  ing a
5 .ME etc.
.
.
.
12 >XT REPORT CLOSING
```

The report resulting from this program is shown below:

```
(heading information)
John Smith was seen at the Ohio University Speech and
Hearing Clinic for a hearing aid evaluation following a
medical examination, etc.
(signature and credentials)
```

It is clear that substituting brief codes for long phrases such as this saves one considerable time as various libraries can be constructed and used as needed. It should also be clear that this is an excellent approach for building libraries consisting of a user's professional terminology such as medical terms, treatment or diagnostic terms, etc.

Card Files

The Executive Secretary electronic card filing system is another flexible and powerful feature of this program. Not only will it permit printing of personalized form letters and mailing labels, but it will also do some budget management, and other straightforward accounting functions. Each card in a file holds up to 13 lines and an entire file holds up to 999 cards. The more lines one defines on a card, the fewer cards one can place in the file. For example, one 13-line file we have used holds up to 417 cards.

As one example of a card file application, consider the personalized form letter. That is, an individual wishes to send out multiple copies of the same letter but each letter has a different name and address. This is simple to do with The Executive Secretary as the names and addresses are merged and printed with the letter. However, with one pass of the card file you could produce "customized" form letters depending upon certain conditions you set up with your card file. Suppose you manage a speech-language-hearing clinic and regular requests about services are received in your office. To handle these requests, you would set up a card file and, for each request, a card is added to the file with the following information on each card:

```
1 NAME
2 ADDRESS
3 CITY, STATE, ZIP
4 GREETING NAME
5 SERVICE TYPE
```

On line 5 of the card file might be included the code "spl" for speech-language-pathology services and "aud" for audiology services. Then, a paragraph which serves as an introductory paragraph to each letter, and two separate paragraphs—one for responding to speech-language services requests and one for audiology services requests—are stored on the document disk. The file to print these letters is shown below:

```
 1 >cr 2
 2 >KD 99, TODAY'S DATE?
 3 >MN SERVICE REQ
 4 >RN
 5 >tm 10
 6 >bm 10
 7 >cf
 8 >ah 50
 9 &99]
10 &01]
11 &02]
12 &03]
13 ]
14 Dear &04:]
15 ]
16 >XT INTRO
17 >IF 5 spl
18 >XT SPL SERVICES
19 >GO 22
20 >IF 5 and
21 >XT AUD SERVICES
22 >XT LETTER CLOSING
23 >IF
24 >np
25 >GO 3
```

This document file would permit different letters to be sent to potential clients requesting information about either speech-language pathology services or audiology services, all in one pass of the card file. By now lines 1 and 2 are familiar to you. Lines 3 (>MN SERVICE REQ) and 4 (>RN = "run") call up and run the card file SERVICES REQ, while lines 5 and 6 set the top and bottom margins of the letter and line 7 sets the system for continuous feed paper. The next line prints the date and lines 10-15 print the first four lines of the card file. Then the introduction to the letter is printed with the >XT INTRO command (line 16). Line 17 tells the system that if the term "spl" is on line 5 of the card file, print the file called for by the >XT SPL SERVICES line, go to line 22 and print the letter closing. Now if line 5 of the card file does not have "spl" on it, the computer skips the commands following the ">IF 5 spl" line (i.e., it skips lines 18 and 19) and checks to see if line 5 has "aud" on it. If so, it will then print the file called for by the >TX AUD SERVICES command and then prints the letter closing. The last two lines start a new page, "cycle" the card file and print the next letter depending upon the contents of line 5 of the card file. Without these last two commands, the program would recycle, start at line 1, and the user would have to type in the date each time. Using the >GO 3 statement avoids this as the line with the keyboard command is bypassed.

Still another use of the card file is information retrieval. Anyone who has used the large information retrieval systems such as MEDLINE or ERIC knows how helpful these systems can sometimes be for retrieving citations. On a small scale, one can build a similar information retrieval system with The Executive Secretary electronic card file. For example, could manage a reprint file and individual citations ...d be stored as follows:

```
 1 AUTHORS 1
 2 AUTHORS 2
 3 TITLE1
 4 TITLE2
 5 CITATION
 6 YEAR
 7 KEYWORD1
 8 KEYWORD2
 9 KEYWORD3
10 Abstract1
11 Abstract2
12 Abstract3
13 Abstract4
```

Lines 1 and 2 are designed to handle articles with multiple authors, authors with long names, or both. The same logic holds for the two title lines (3 and 4), while line 5 is for the journal, volume, and page numbers. Line 6 is reserved for the year the article was published, while lines 7-9 permit entry of up to three key words. Lines 10-13 permit the user to enter a brief (about 15-20 words) abstract.

Suppose you had a file of articles on microcomputer applications and wanted to select only those articles dealing with word processing. A document file to do this might look like this:

```
 1 >cr2
 2 >MN REPRINTS
 3 >RN
 4 >IF 7 word processing
 5 >OR 8 word processing
 6 >OR 9 word processing
 7 &01 &02 &03 &04. &05 &06.]
 8 &10 &11 &12 &13
 9 ]
10 ]
11 >IF
```

A portion of the output from such a program would look like this:

Gabel, D. Word processing: Finding the right software. Personal computing, 7, 110ff, 1983.
Tables summarize features of most commercially available word processing programs.

McWilliams, P.A. The word processing book: A short course in computer literacy. Prelude press, 1983.
Who can benefit from word processing, features summarized, hardware/software reviewed.

One could write document files which would select relevant articles in numerous ways. For example, one could select on the basis of an author's last name, year of publication, journal, etc. One could also narrow a search so it was very selective. That is, if an author publishes in several areas and you wanted only the articles published in one area, the portion of the document file to do this might look like this:

```
1 >cr2
2 >MN REPRINTS
3 >RN
4 >IF 1 McWilliams
5 >OR 2 McWilliams
6 >AN 7 literacy
7 &01 (etc)
```

This file would select and print out all citations having an author whose last name is McWilliams, and that also have a keyword "literacy" on line 7 of any card in the card file. This example assumes that the user would place the keyword reflecting the primary emphasis of the article on line 7.

It may be of interest to note other uses of the card file system. We manage the client billing process with The Executive Secretary. Six lines are defined for the client billing file:

```
1 CLIENT NAME
2 CASE NUMBER
3 SERVICES
4 DATE OF SERVICE
5 SESSIONS
6 FEE
```

Then, using a separate document file this information is formatted and printed precisely as needed on preprinted forms.

But in addition to managing our billing, we can also print reports based on the information in the client card file. At the end of an academic term we can print out a report that will summarize the billing activity and give us a total of all fees we had charged that term:

CLIENT NAME	CASE NUMBER	SERVICES	FEE
John Jones	11122	therapy	100
Mary Jones	33223	hear eval	25
Bobbi Doe	43234	therapy	100
TOTALS			225.00

This table was generated by The Executive Secretary using its "PRINT REPORT" function which is one of the card file management options that comes with this word processing program.

One final example will demonstrate two other useful features of the card file system: sorting and obtaining subtotals. Consider the case in which an individual needs to maintain a history of all budget transactions as well as obtain budget summaries at various times during the year. Moreover, the budget summary must contain a subtotal of funds spent in each budget category as well as a grand total that has been spent. The Executive Secretary permits this kind of budget management by using the "PRINT REPORT" function of the card file system.

To begin with, one might enter the following items in a card file to manage a budget:

```
OBJ CODE
ITEM
QUANTITY
COST
```

The "OBJ CODE" column represents the code for various budget categories such as office supplies. Of course, other lines could be included on the card file to list items such as vendor, purchase order number, etc.

Space does not permit a detailed consideration of the steps one must take to print out budget information sorted by budget category with subtotals for each category and a grand total at the end of the report. Suffice to say, however, that the user is led through this process by a series of clear and detailed on-screen instructions. In general, one must first sort the card file by budget category using the "SORT INDEX" option. Then the "PRINT REPORT" option will print the following report:

OBJ CODE	ITEM	QUANTITY	COST
310	3-ring binder	6	6.26
	mailing labels	1	7.80
	note books	6	1.50
	desk	1	345.87
SUBTOTAL FOR 310			345.43
952	amplifier	1	645.78
	sound level meter	1	2396.34
SUBTOTAL FOR 952			3042.12
TOTALS			3403.55

It can be seen that this capability can simplify the budget management process and save the user considerable time.

Conclusion

It is hoped that an earlier claim—that The Executive Secretary is a powerful, flexible word processing porgram—has been substantiated somewhat by these examples. It should be clear at this point that the system will indeed help the practitioner manage many administrative responsibilities. Though not covered in detail many other applications are, of course, possible with The Executive Secretary. These include mailing label production, inventory management, maintaining student practicum hours, generation of tests and test materials, and permitting the busy professional to keep in close contact with clients, to name a few. The system also permits electronic mail, incorporation of VISICALC files into documents, automatic creation of an index while writing a book, among other additonal features.

Finally, it is hoped that his presentation will aid the user in need of software to make an informed comparison between features included in The Executive Secretary and those of other word processing programs. Though one may not feel a need for all that The Executive Secretary provides, its low cost in comparison to other programs, its power and its flexibility may make it worthwhile for the practitioner to consider seriously adopting this package for use in daily practice.

A Voiced Controlled Personal Computer System with Word Processing Capabilities for the Severely Physically Handicapped

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Abstract

This paper describes the development of a low-cost voice-operated word processing aid for use by severely physically disabled individuals. The TEXTWRITER word processing aid is incorporated into the C2E2 (Communications, Environmental Control, Education, and Entertainment) system forming a complete, user-friendly voice-actuated aid. The resulting system with its easy-to-use format and extensive documention serves to bridge the gap between available high-technology and a disabled population who can benefit greatly from this technology.

The Bio-Medical Electronics Group of the Medical Rehabilitation Research and Training Center at the University of Alabama in Birmingham has developed, configured, and licensed for commercial sales a voice controlled microprocessor-based personal computer system intended for use by severely physically disabled individuals. The system, known by the acronym C2E2, was conceptualized and designed around commercially available, plug-compatible components that are very common in the marketplace and that are backed by dependable, easily accessible service networks. The early, prototype C2E2 system could be used to (1) answer and/or dial a telephone, (2) control power and volume and change channels on a television receiver, (3) operate an array of electrical devices in the household or workplace, and (4) "run" pre-written programs (software) for educational and/or entertainment purposes. A block diagram of this sytem is presented on the following page.

The objective of this project was to complete what was considered to be the system's most important function—the addition of textwriting capability enabling the physically disabled user to compose, edit, and print written material using only voice commands or instructions. The textwriting function was proposed in the original scope of work. However, lack of adequate funding did not permit us to develop an acceptable textwriting capability. However, the knowledge and experience acquired during the original work, coupled with advances in affordable speech recognition technology have resulted in a sound basis for the successful completion of this final task.

The successful development of a microcomputer system for the severely disabled enables the user to address many physical needs and perform numerous activities of daily living with only minimal assistance from family members or attendants. Such a system may be expected to foster a sense of independence, thereby increasing self-esteem. Thus, the utilization of microcomputer-based systems for environmental control, communication, education, and entertainment addresses numerous psychological as well as physical needs of the severely disabled.

Historical Perspective/Literature Review/Rationale

Despite significant advances in the prevention, treatment, and long-term management of injuries, diseases and congenital defects resulting in permanent physical disabilities, the absolute number of severely impaired individuals is increasing (Berkowitz, Johnson, & Murphy 1976). Today, over 35 million Americans are handicapped to varying extents. One factor influencing the apparent increase in the prevalence of severe physical disabilities is the near normal life span many disabled persons may now anticipate due to markedly improved acute care and rehabilitation treatment modalities. Consequently, an ever increasing number of disabled persons with functional limitations must confront numerous "environmental" obstacles when attempting to perform many activities of daily living.

The ability to perform various activities of daily living and the associated quality of life experienced by persons with little or no muscular control is often enhanced by assistive devices enabling them to interface successfully with their physical and social environment. To an extent, some of the specific needs of the physically disabled have been met by a variety of assistive devices such as electrically powered wheelchairs, page turners, "hands-free" telephones, specialized eating utensils, and custom-fitted writing equipment, some of which may be activited and/or controlled by movement of the head, teeth, eyes, or respired air. Along similar lines, a few electro-mechanical coordinated interface systems have been developed, but they have generally been single or limited purpose units (such as communication substitutes or very rudimentary environmental control systems) enabling the severely physically disabled user to operate a limited number of household appliances or, in some applications, simple business machines. However, experience has shown such equipment is expensive, limited in capability and utility, and is often unreliable and difficult to repair (Bayer, Berry, & Romich, 1976, pp. 33-37; Collins, 1974, 31-41; Fidelity Electronics; French, Siebens, & Silverstein, 1976, pp. 45-59; Maling, 1974, pp. 22-30; Parish, 1974, pp. 15-21; Raitzer, 1976, pp. 50-54; Zimmerman & Stratford, 1976, pp. 42-44).

In recent years, rapid strides achieved in the area of computer technology have resulted in significant changes in this emerging field. These technological advancements may reasonably be expected to assume an increasingly important role in the lives of many handicapped individuals (Miller, 1976, pp. 25-29). Miniaturization has led to the advent of microcomputer systems which are powerful computers designed and built around a single integrated circuit serving as the system's central processing unit (CPU). Consumer response to microcomputers has been extraordinary as evidenced by the fact that over 200 firms are currently involved in the production of microprocessor systems and components. The combination of a highly competitive market situation and a growing demand for this type of equipment has resulted in enormous improvements in the quality and capability of commercially available sytems as well as a significant reduction in price.

Increasingly efficient, commercially available microcomputers will, in all likelihood, provide the central processing units for coordinated interface systems. These will replace the "first generation" communication substitutes in environmental control units currently available. Moreover, future systems may be expected to incorporate functionally sophisticated components capable of performing or assisting in the performance of a wide variety of daily living activities, including entertainment and computer-aided instruction. Increasing the number of functions performed by the microprocessor system is a relatively simple task requiring only the addition of appropriate interfaces and software for the desired task. Finally, the eventual configuration of such units should prove far more economical than those currently existing.

The availability of low cost, highly flexible, and dependable microcomputers for use by severely physically disabled persons can be expected to "create" many new vocational opportunities for handicapped individuals. Working with one's own computer typically results in an interest in computers and in computer programming. Programming is one field that relies primarily on mental rather than physical abilities, and many disabled individuals are already successfully employed as programmers. Certainly, our application can be expected to increase the number of physically disabled persons so engaged. In

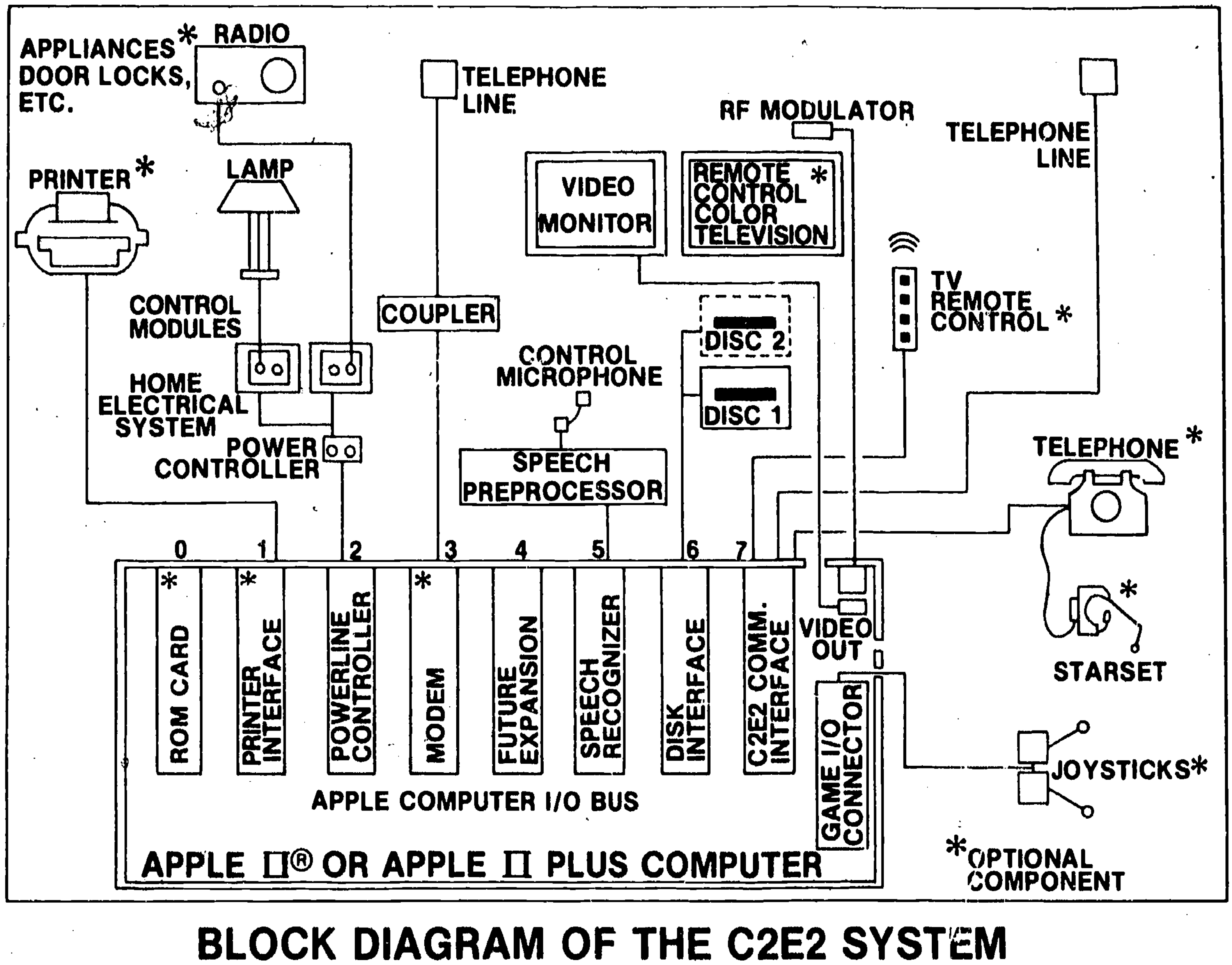

Figure 1. Block diagram of the C2E2 system.

addition, an inexpensive but functionally sophisticated and reliable control system for use by the physically disabled should prove beneficial and highly desirable for family members of the primary user by enabling them to pursue vocational and avocational activities which they may have been forced to abandon or curtail when patient care became a major responsibility.

To summarize, the primary factors making the development of microcomputer-based sytems for the severely physically disabled possible are (1) reduced cost, (2) the capacity to expand to meet future requirements (due to the fact that primary sytem characteristics may now be determined by transportable software rather than by hardware that is difficult to modify), and (3) numerous easily accessible retail outlets and service facilities.

Methodology/Results

Our approach to the development of a textwriting function for C2E2 was to adapt existing software whenever possible and to develop unique programs only when necessary or cost-effective. After exhaustive testing and study, we determined that a commercial text editor, marketed under the name of APPLEWRITER® by Apple Computer Company of Cupertino, California, would best suit the needs of the population and could be readily modified for use in the C2E2 TEXTWRITER™ environment. Additionally, we adapted voice training and utility software developed as part of previous RT-sponsored work on the early, prototype C2E2 system.

Two major tasks needed to be successfully accomplished to achieve the goal of providing severely physically disabled users with the ability to "create" written text by voice. First, our group had to identify a reasonable set of vocabulary words capable of being easily "understood" by C2E2's speech recognition unit. Second, we were faced with the challenge of establishing an environment conducive to rapid and efficient generation of text. The challenge was to bring the same tools to the disabled voice-user as are normally available to able-bodied users working with personal computer systems.

Approach

Letters of the alphabet constitute the primary set of characters entered with the TEXTWRITER®. Unfortunately, experience demonstrated that many letter sounds are quite similar phonetically thereby causing some "confusion" for the speech recognition unit. For example, B, P, T, D, E, C, G, and Z all end with a long e sound and frequently cause problems. To overcome this problem we proceeded in two phases. At the onset we defined a set of substitute sounds for the letters, numbers, and command word that were causing voice-recognition confusion. These were selected after it was shown they produced only minimal recognition problems, despite known differences in dialect. This approach facilitated rapid text entry. Subsequently, we verified that the set of selected replacement words met all operating criteria by testing the system with different users.

Table 1 reflects the final vocabulary selected for alphabet and command words. The spoken words or letters appear in the left-hand columns. Characters actually typed-in when these words are spoken appear in the right-hand columns. For example, when A is spoken, A is typed; when JUICY is spoken, J is typed. The @ symbol preceding some of the entries indicated that the subsequent letter is a control character. For example, when RETURN PLEASE is spoken, @ M is entered, which produces a carriage return on the APPLE computer.

To verify the utility and appropriateness of the "vocabulary," we conducted tests on its performance with different male and female subjects. None of the subjects had used the C2E2 system before. Prior to testing, each subject was briefed on the system's operation. Each subject went through a procedure during which the system was "trained" to recognize different voice patterns for each of the spoken words. Following this, a scoring program developed specifically for this purpose was executed in the machine. The program "asked" (i.e., prompted) the subject to repeat each word one time and automatically scored the response. The test procedure incorporated all information needed to determine if there was a problem with two different words sounding too much alike. If there was, an alternative utterance was selected to correct the problem. After several iterations with candidate vocabularies, we established that the vocabulary words listed in Table 1 constituted a reasonable set providing minimal recognition errors when used by persons with different dialects (a phenomenon frequenly encountered in different regions of the United States).

Table 1

Vocabulary Word Selected For Alphabet And Command Responses

Spoken Word	Typed Entry	Spoken Word	Typed Entry
YELLOW	Y	I	I
NOMAD	N	JUICY	J
GO LEFT NOW	@H	KHAKI	K
NOW GO RIGHT	@U	LADY	L
CAPITAL	@O	MOSES	M
RETURN PLEASE	@M	O	O
REPEAT REPEAT	@O	POPEYE	P
CONTROL KEY	@G	Q	Q
PERIOD	.	ROOSTER	R
COMMA KEY	,	S	S
NOW SHIFT KEY	@Q	T	T
SPACE BAR		U	U
A	A	VICTOR	V
BASIC	B	WALDO	W
CHARLIE	C	XRAY	X
DELTA	D	ZEBRA	Z
E-QUIP	E	TELEPHONE	@N
FAMOUS	F	THANK YOU	@Z
GANDER	G	VOCAB	@A
HALO	H		

Speed of entry was also a consideration in selecting the vocabulary words. Letters that occur most frequently such as vowels (one exception is the letter E which does not possess sufficient spectral energy to work well with our speech recognizer) and the letters T and S are assigned their corresponding single-syllable sounds. Other letters are assigned multi-syllable sounds that begin with the corresponding letter to be entered. For example, Z is entered by speaking Zebra, and B is entered by speaking BASIC.

Once a suitable vocabulary was established, our efforts were focused on selecting an environment conducive to the generation of text-by-voice. After examining several of the popular commercially available text editors (software packages) for the APPLE computer, we chose APPLEWRITER™ version 1.1. Although APPLEWRITER has been available for several years, it is not as sophisticated as other text editors investigated. However, it does have several advantages: (1) it is not a copy-protected program, which allowed us to modify it; (2) it is licensable from Apple for a small fee, which minimizes cost to the user; (3) it does not require an additional video display card (hardware), which also minimizes cost to the user.

Since the source code for APPLEWRITER™ was unavailable from the manufacturer (as was the original author of the program) we were forced to work with a disassembly listing of the program to modify it. All modifications were accomplished using assembly language, a computer language consistent with the language in which the program was originally written. Our modifications to APPLEWRITER™ included the addition of the following functions for use by voice: (1) shift key lock, (2) control key actuation, and (3) automatic repeat. These are functions that normally require the depression of two keys simultaneously, a feature that cannot be executed by voice without these modifications. In addition, the text editor was modified to allow entrance to it from the other C2E2 software and exit from it to the speech utility function.

Although not directly related to the operation of the text editor, another adaptation was made that increased the speed of voice entry. The speech recognizer used in C2E2 has a design limitation of 40 vocabulary words that can be recognized at any one time. Suffice it to say, the number of characters (letters, numbers, control keys, and commands) the sytem required exceeds forty. One method of expanding the number of words is to utilize more than one vocabulary; for example, the alphabet plus special characters could be placed in one vocabulary, while numbers and special characters could be placed in a second vocabulary. However, to move between vocabularies requires accessing the disk which can require up to ten seconds; a period of time considered unsatisfactory for our intended purpose. To overcome this problem, we developed a special program that stores all vocabularies in the computer's memory and allows them to be "swapped in and out" in approximately one second, a period of time that is acceptable for C2E2's TEXTWRITER™ function.

Summary

The completion of the TEXTWRITER™ component for C2E2 brings to the market a complete, user-friendly, voice-actuate aid to the severely physically disabled. The system is not only low cost which is important to the user population but also easy to use. Experience has shown that the latter characteristic may be the most important of the entire system; although the manufacturers of speech input devices advertise that their devices permit commercial software to be run without modification, the knowledge required to effectively do so greatly limits the successful application of these devices to the disabled. The C2E2 system with its menu-driven format and extensive documentaion overcomes this problem, bridging the gap between available high-technology and a disabled population who can benefit greatly from this technology.

Additional Information: For ordering or further information on the C2E2 system, contact Serota Engineering Consultants at the address listed below. The complete C2E2 package is available for $400.00 (US only) F.O.B. plant.

Serota Engineering Consultants
3730 Alta Crest Drive
P.O. Box 43286
Birmingham, AL 35243

Vocational Education Curriculum Adaptation to Appropriate Language Level

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Abstract

Hennepin Technical Centers has successfully utilized computer assisted instruction to adapt academic content of mainstreamed vocational education classes to individual language and reading levels. This was done through the cooperative efforts of instructors in the vocational education area, with special education teachers and support personnel. Mini-authoring systems are explained. The flexibility and ease of mini authoring is illustrated through specific examples. A step by step approach reveals the potential that such a system has for adapting to the needs of learners at various levels. Elements of preparation and of the word bank are explained.

We work for Hennepin Technical Centers or District 287, as some of you know us. We are an intermediate school district which provides special ed services and vocational training to the thirteen suburbs west of Minneapolis.

Our vocational training is provided on two AVTI campuses. Our special education services range from staff servicing students in their home schools to having students bused to a central location for services.

The students whom we have prepared materials for today receive services for the hearing impaired at a central location and attend our vocational campus, as part of their high school program for two hours a day.

We utilized the team concept quite effectively in getting our computer assisted instruction together. As we explain our team process you'll be able to relate how various members of your staff could work together to achieve the results our team has.

Special needs students such as our hearing impaired students are integrated into the regular vocational training program. I (Judy Simon) am the liaison person from the hearing impaired program to the vocational program. I met with the instructor and the vocational support service people to put together the overall approach to supporting the students in their regular vocational program class. One of the support components we decided to use was computer assisted instruction (CAI). The vocational program instructors indicated the information that was important for the students to know. Most of the information was in textbooks, workbooks, and learning packets.

Erik and I got together and reviewed the materials as to the most appropriate kind of adaptation considering the language levels of the students. I then started doing rewriting of information.

I gave the rewritten material to Erik for computer adaptation. Erik will now explain and demonstrate the actual adaptation process.

We'd first like to cover exactly what an authoring system is. Whenever you prepare a program for a computer there are two sets of instructions or pieces of information you need to include in the program. The first component is a set of instructions to the computer itself—this is usually handled by a programmer. The second component is the information that will be actually processed or dealt with or manipulated by the computer. When you use an authoring system you do not need to be a programmer. The programming has been done for you and has taken care of the first component, the instructions to the computer are already contained on the authoring system disc. You provide the information that will be used by the computer and by the student using the computer.

Authoring Systems fall into two categories usually called major authoring systems and minor authoring systems. Major authoring systems, for example, are like the EZ Pilot authoring system which usually allows for sophisticated graphics and branching so that a student can be branched to do a particular problem over again if they have trouble doing the problem the first time. We will be showing you a mini-authoring system today; it's fast, easy to use and flexible. The flexibility of the sytem depends only on your own creativity and imagination.

In any authoring system you can use a team or a solo approach. It's easy either way to do the actual authoring. If there is any expertise needed, the expertise is needed at the preparation end, preparing the materials for authoring. Perhaps it's as we have discussed earlier, preparing language and changing it from one level to another level, or perhaps supplying visual aids, whatever the student whom you work with needs. That's where the expertise comes in; preparation, not the authoring. The expertise is NOT needed at the computer end. The technical part of programming has already been done for you. You simply need to prepare the material and we'll show you how we do that in our district now.

We've prepared some forms—the forms that we use help assure a good layout. This is important. How something is presented on the computer for a student is crucial for their ease of reading and comprehending what's on the computer. We try to avoid, for example, a word appearing in isolation at the end of a sentence, placed back over at the left margin again.

The first form we use is one for instructions.

The authoring system allows you to put in specific instructions to the student. This form allows us to map that out so that it's presented to the student in a good visual way, and in the appropriate language level. The second form is a question by question form.

Whoever prepares the materials would fill in this form so that the person who does the actual clerical work of typing it into the computer will not have any problems putting it in the proper format on the screen.

Another form we have used has a numbered set of columns which automatically tell you how many spaces to push the space bar to center something on the monitor screen. The point of describing these forms is that you can either make your own forms or use the forms that come with the system. We have made our own forms because we wanted them tailor-made to our own specifications. The forms are a time saver and as I said before, the layout is essential, especially in our area where we may have students who have vision or reading problems.

Now we will show you an actual run-through of authoring. We will make a program right now. I will name the program "Safevoc-Demo." The first step in creating this program (after the preparation work has been done by perhaps a resource teacher, a couple of different aides or a student computer aide) would be to put the authoring disc into the disc drive. It now gives me instructions to remove the authoring disc and put in the student presentation disc. This particular system uses two discs. The one disc is used by the teacher or the aide who is preparing the material. Only student presentation discs will be handled by the student and contains the actual lesson. At this point the authoring system asks for the name of the lesson and I type Safevoc-Demo, and now I use the forms that have been prepared prior to the actual authoring.

You will be surprised at how fast and easy I can type a lesson into the computer without having to necessarily know any computer programming. On the left-hand margin we see the number of spaces that need to be left in order to make the statement centered on each line. The forms also save us time on correcting. It's not necessary for us to do much correcting after proofreading, compared to creating a lesson off the top of one's head. When I finish typing in the material from the forms (all the instructions and the questions and answers, I can push "Stop," I can take the disc out, and I can send it to another school. I can send it to another room, I can put it away for a couple of days and when I take it out and put it back into the disc drive, type in the proper call name Safevoc-Demo, the program reappears and you can see the program that has been authored in just the few minutes that we've been working here today.

I want to reemphasize a couple of key points. The first key point—Good preparation—we all know how to do that in our appropriate areas. Then it's just a matter of typing it in from the forms. You could type it in or perhaps a student aide could. The second key point—the use of the forms and the mini-authoring system—is fast enough to keep up with class work. We work with students in the mainstream and it is essential that we produce these programs at a good clip.

I would now like to show you a few sample programs we have made and use in our district. The first one is called Safety Color. I will emphasize a few things about the program as I show it to you. This format features the graphic type of printing. It's a larger type and is easier to read for students with reading or vision problems. It also moves at a slower speed which can help those kinds of students. It could also be a minus (-) if a student is a good reader and can read at a good pace, to have a program work this slowly. The choice is up to you. This program also features format #1 as far as the authoring. Format 1 allows you to type in one set of answers. For example, in this case we are using the international safety colors, and the same colors will be used over and over again no matter what the question is. That saves a lot of time in authoring—you need type in those answers JUST one time, and the computer will use them for each question. You can use the features of graphics lettering or text lettering—Format 1 or Format 2 in any combination. I will now answer one of the questions wrong and you see it allows you to try again.

```
1.  TRAFFIC FLOW

Possible choices:
 A green  E yellow
 B red    F orange
 C purple
 D black and white
```

```
I USED THE ....... TO LIFT
THE ENGINE OUT OF THE TRUCK.
POSSIBLE CHOICES:
A HAND TOOL
B EXTENSION CORD
C CHARGER
D CHAIN HOIST

?C
INCORRECT.
PRESS ANY KEY TO TRY AGAIN: ?B
INCORRECT. THE CORRECT ANSWER IS
D.
PRESS SPACE BAR TO GO ON:
```

Figure 1. Safety color showing opportunity to get correct choice twice.

I will answer it wrong another time—this time it gives you the correct answer. You are allowed two wrong choices and then it gives you the feedback of the correct answer.

```
TOTAL QUESTIONS ASKED: 6
CORRECT ON FIRST TRY: 4
CORRECT ON SECOND TRY: 1
NUMBER INCORRECT: 1
PRESS SPACE BAR TO GO ON:
DO YOU WANT TO RUN ANY MORE LESSONS?
```

Figure 2. Feedback of the correct answer.

You can see now at the end of the lesson that the authoring system has provided for automatic feedback of how the student did, with the number of right on the first try—the number right on the second try—and how many questions were tried altogether and percentage correct. It gives the student a chance to do the same program over again or to use a different program.

Now I would like to show you a few other variations on the authoring system. These particular examples will show you format 2 which will allow you to put in multiple-choice answers. At this point I would like to explain briefly our idea of a word bank. A student word bank allows you to build up a student's vocabulary through repetitive drill and practice. However, we are not trying to actually stump a student, question by question, by using closely related words that fit the question in the specific subject area—we will use words from throughout the student's word bank. For example, you may start a student word bank in the fall and add to it all through the year.

Some questions might at first seem strange as you may ask something about skiing and for one of the possible choices you may have an answer that has something to do with auto body shop. This allows the student to jog his or her memory and go back and remember something that he/she studied a couple of weeks or months before. We don't make all of our programs that way, but I did want to mention it too because it is an exciting use of the computer—it would be hard to manage without a computer to do that kind of word bank system for you. The examples we are showing you now were done with text type and they have an A, B, C, D word choice.

```
        THE ROOM WHERE WORK IS
        DONE IS CALLED A -?-.
 POSSIBLE CHOICES:
   A STORE
   B POWER TOOLS
   C SAFETY
   D SHOP
 ?D
GOOD!

 QUESTION NUMBER 2:
   PAINT IS VERY COMBUSTIBLE.
 POSSIBLE CHOICES:
```

Figure 3. Multiple choice: A, B, C, D word choice.

The A, B, C, D is a fast way of having the program work but you can also create the program so that the student types in the entire word. I'll talk more about that in a minute.

The next program shows the same kind of text and it has an A, B, C, D meanings choice, but we are showing you that the word is underlined within the question. We underlined the important word and the student then tries to find the meaning from the A, B, C, D choices. The next example shows a fill in the blank, where we leave a blank in the sentence and an A, B, C, D choice.

```
        PAINT IS VERY COMBUSTIBLE.

POSSIBLE CHOICES:
    A CLEANS PAINT
    B A VERY SMALL PIECE OF FIRE
    C CAN BURN EASILY
    D HOT, BOILING
?C
EXCELLENT!
```

Figure 4. Important word is underlined.

```
        I USED THE ..... TO LIFT
        THE ENGINE OUT OF THE TRUCK.
POSSIBLE CHOICES:
    A HAND TOOL
    B EXTENSION CORD
    C CHARGER
    D CHAIN HOIST
?C
INCORRECT.
PRESS ANY KEY TO TRY AGAIN: ?D
THAT WAS CORRECT!
```

Figure 5. Fill in the blank.

Again, these are all using the same authoring system but by just using our imagination we have come up with different ways of typing in information.

Here is an example I mentioned a few minutes ago, where we do not have A, B, C, D, but the words are typed out and the student types in the entire word. This gives kinesthetic feedback to hearing impaired students and also practice in spelling.

```
        A MACHINE THAT IS USED TO LIFT
        HEAVY THINGS LIKE ENGINES IS A:
POSSIBLE CHOICES:
    CREEPER
    CHAIN HOIST
    MACHINE GUARD
    RADIATOR
?CHAIN HOIST
PERFECT!
```

Figure 6. Words of answer are typed in by student.

The next program is a picture-match program.

```
            PLEASE LOOK AT NUMBER 8.****
                THIS IS THE -?-.****
POSSIBLE CHOICES:
  A FUEL FILTER D OIL FILTER
  B FLYWHEEL    E GLOW PLUG
  C OIL DRAIN   FAN BLADE
?A
INCORRECT.
PRESS ANY KEY TO TRY AGAIN: ?C
INCORRECT. THE CORRECT ANSWER IS D.
PRESS SPACE BAR TO GO ON:
```

Figures 7. Picture-Match Program

You will notice here that we have had six choices put into the authoring system A, B, C, D, E and F. You can put a dozen in if you like. You can use the screen any way you like when you are using the authoring system. Again, it's flexible and the uses are limited only by your imagination. In the picture match we use an actual photograph of a diesel engine in this case. You can find authoring programs that will allow sophisticated use of graphics on the screen and we do use those ourselves, but in some cases there is no substitute for an actual photograph. Another reason to use the photograph is that it is much easier to quickly make a xerox of a photograph and have the student match between the computer and the photograph or drawing than it would be to actually draw in and program the graphics on the screen. So, it's fast, economical and if you are on a timeline it's a good ploy to remember.

The last sample on this particular disc shows a thinking exercise.

```
        KEEP PLACES WHERE PEOPLE WALK
            CLEAN AND PICKED UP SO:
POSSIBLE CHOICES:
    A PEOPLE CAN GET OUT OF THE
        SHOP IN AN EMERGENCY.

    B PEOPLE WON'T GET MAD AT YOU.
?A
GOOD!
```

Figure 8. Example of a thinking exercise.

Here we make a silly and then a straight answer to questions from a shop class. The student will read the question and then have to use his/her common sense to decide whether possible choice A or B is correct. I included this to show you that you are not obligated to use A, B, C, D. You can just use two choices, A and B, and as you can see there are quite long sentences given in those choices.

I'd like to show you a couple of programs from other areas we work in. An area of interest in our district is working with physically handicapped. A teacher called one day and asked if I knew of a program that was a one-finger typing tutorial. I said I had never heard of one and I'm sure there must be one somewhere—but it would take some time to dig one up. So why didn't she come over that afternoon and I would help her author one? We decided to use the graphics mode because the student was not only involved with mobility but also had problems with reading and was partially blind. Then we created the one-finger typing tutorial. It was really neat—that afternoon we had enough lessons finished so that the very next morning the student was using the tutorial.

We also have the possibility in this authoring system of eliminating the words "possible choices" from the program so it makes a very neat screen when no choices are given. When a better typing tutorial comes along designed for one finger typists, we will use it, but in the meantime students all across our district are using a program that was authored in a day, almost immediately upon the need being pointed out.

We also have some more sophisticated packages or kits. One of our teachers who just a couple of years ago was wondering if computers would ever find their way into her classroom has become a fan of computers. She created a kit involving menus. The menus are local menus from restaurants around the Twin Cities area. I'm sure there is no kit available on the national market that would be designed specifically for Twin Cities restaurants. So, whatever metropolitan area you live in or small town you live in, you could use an authoring system to make a survival skills menu reading type program for your students.

There are hundreds of ways of using authoring systems: from simple true-false questions and yes and no questions to programs where the student provides the answer to questions. This particular kit includes the software, the menus, a user's guide, other backup activities—flash cards for example, and it uses vocabulary reinforcement activities and it's all contained in a kit put together with the authoring system. When you use an authoring system, no longer will the student be bending to meet the particular software you have bought, but in this case it's the software actually working for the student.

We have other reasons for using computer authorings systems which have been mentioned earlier in the conference. For example, the computer allows individual work, it's highly motivating, it allows drill and practice, and the materials can be presented in sequential or random order. I mentioned one other idea that I would like to emphasize again and that was the Word Bank idea. That's something that really only a computer can manage with any speed and reliability. Another important goal I mentioned just a minute ago was the immediacy. If you have good preparation, you can author something quickly and you can have the product now, and it can be for a very specific area (such as creating specific language level activities using restaurant menus from the local restaurants of your town).

In conclusion, I would like to say that an authorizing system, whether it's a mini-authoring system or major-authoring system, allows you to put information into computer programs without having to have any expertise in programming. You have expertise already in given educational areas. You can meet your goal. We have met our goal of making useable computer programs in adapted language to meet the students' needs that we work with. And you, using an authoring system can do the same thing. Thank you very much!

The TIES QA and V Authoring System used in the demonstration is available from:

TIES
1925 County Road B2
Roseville, MN 55113

LOGO: LD Students Explore Their Intellectual Potential With a Computer

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Abstract

Learning disabled students in a junior high school resource room learn to program computers in the LOGO language. They create graphics, program robots, and have written an interactive adventure story with this powerful, versatile language. They experience enhanced social status, working with and teaching other students to use microcomputers. LOGO may provide children with an improved opportunity to develop their intellectual potential in school: the programming activity is highly motivating and academic skill deficits don't prevent children from using the computer as a creative tool for thinking.

When you look into the junior high school classroom, you wonder what subject is taught there. At one of the built-in science tables, a seventh-grade girl cleans acquariums. The aroma of airplane glue wafts from one corner of the room, where a cluster of boys gossip as they build rockets. Two students search within the recesses of the tall cabinets that divide the room. Children work alone and in pairs at five Apple II microcomputers grouped near the wall opposite the classroom door.

"Julie, what are the five steps to follow when you read a chapter in your history book?" You enter the room to discover the source of the female voice.

Behind a clutter of microscopes and empty acquariums, a male teacher sits behind a desk heaped with brochures and magazines, eating a hamburger. He converses with a girl about tropical fish while she fills out an order form. To your right, beyond the partial barrier formed by the cabinets, Julie answers her teacher, "Survey, question, read, review, recite." Eight students are seated at tables.

"Laura, show me how you 'survey' a chapter". While the teacher quizzes the two girls, their classmates work on assignments from textbooks. The oral review finished, she moves to the computer area. A small boy edits the list of phrases that appears on the screen of this computer. The words disappear. He types "HOUSE 50" with one finger, clasps his hands, and sits back in anticipation. Immediately a tiny triangle appears in the center of the screen and swiftly draws the outline of a house, a roof, a window, and then an odd shape. (See Figure 1.) The boy studies it. The words reappear and he continues editing, oblivious to the presence of his teacher.

```
TO HOUSE :SIZE
WALL :SIZE
FD :SIZE
RT 30
ROOF :SIZE
PU
LT 30
BK :SIZE  2
RT 90
FD :SIZE  4
PD
WINDOW
DOOR
HT
END

TO WALL :SIZE
REPEAT 4 [FD :SIZE RT 90]
END

TO ROOF :SIZE
REPEAT 3 [FD :SIZE RT 120]
END

TO WINDOW
REPEAT 4 [FD 10 RT 90]
END

TO DOOR
FD 30
RT 90
FD 30
RT 90
FD 30
END
```

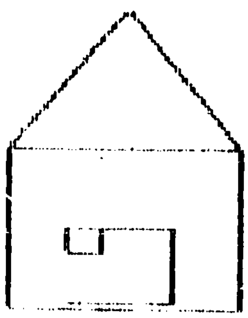


Figure 1. House 50.

After lunch, half of the students and the female teacher return to the room and gather around the computers. A small, domed, two-wheeled device traces a square on the floor, beeping at each turn. The students standing at the computer attached to the end of its cable noisily collaborate on writing another program for the little robot turtle.

Three boys watch a solid circle evolve from a triangle on another monitor. One boy explains Bill's program to a friend. Bill ignores them, studying the action on his screen. With a few keystrokes, a series of commands replaces his design. He edits. The triangle appears again and grows into a circle. (See Figure 2.) This time, the sequence of colors is different. Meanwhile, Jeff, the boy who interpreted the program for his friend, asks Bill permission to copy the program onto his and Sam's disk. Bill nods. Jeff removes Bill's disk, slips it into his own computer's disk drive, and types some commands. The disk drive runs. He changes disks and types another phrase. The disk drive runs again. When he's finished, Jeff hands the disk to Sam and teaches Sam to do what he's just done.

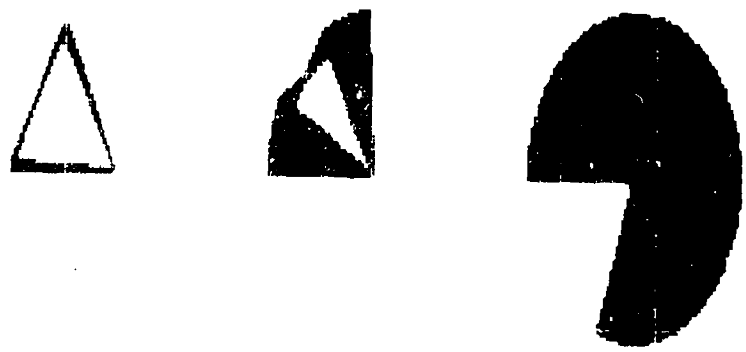


Figure 2. Bill's procedure.

Your attention is drawn to another screen, on which the cursor draws a small green tree and a long, vertical line. The boy seated at the computer traces an imaginary line across the screen with his finger. You overhear him explaining to his teacher that he meant the ground to appear beneath, not next to, the tree. He types. A list of commands replaces the picture. Tim slowly reads the words aloud while the teacher moves her hand across the screen to simulate the movements of the cursor. Tim changes a command. The cursor draws the picture again. This time, the ground is horizontal. (See Figures 3 and 4.)

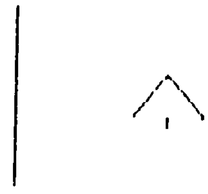


Figure 3. Tim's "park" procedure, initial attempt.

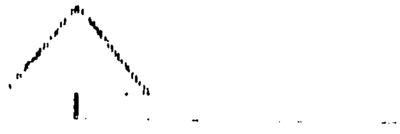


Figure 4. Tim's "park" procedure, second attempt.

The bell rings. The students continue working. "Give me your disks! No, you don't have time to finish it. Finish it tomorrow!" Four minutes later, the tardy bell ringing, the last student dashes from the classroom.

The scenes described above occurred on a typical day this Spring in room 2 at Ryan Junior High School in Fairbanks, Alaska. Two groups of exceptional children and their respective teachers share the classroom. The gifted/talented students pursue a variety of independent projects, one of which is programming the computers in BASIC. The learning disabled students are learning to program in the M.I.T. version of the LOGO computer language; the majority of their time, however, is spent away from the computer, learning and practicing reading and language arts skills.

I (the female teacher mentioned earlier) began teaching LOGO to my LD students last Fall. I continued to teach reading and language arts: LOGO was "enrichment". It soon became apparent that LOGO was much more than that. Let me tell you more about the children whose activities I described earlier.

The boy who is attempting to add a door to his house has been labeled "hyperactive" throughout his school career. Test results indicate visual perception deficits and poor sequential ability. He's learning to subtract whole numbers in his Resource Math class.

This seventh grade boy created the house design himself. I helped him only with writing the variables in his procedures. No signs of hyperactivity are apparent when he's programming. This boy is in my classroom again this year. He'll finish his house and choose another LOGO activity.

Jeff, the boy who taught his friend to transfer Bill's triangle/circle procedure to another disk, scored below the 20th percentile in oral communication on the CELF diagnostic test administered by the speech and language specialist at the beginning of the year. Jeff received individual instruction in oral communication skills throughout the year. He had ample opportunity to practice communication in our resource room: children want to learn LOGO, and gladly teach and learn from one another. At the end of the school year, one of the gifted/talented students asked Jeff to teach him LOGO. I felt very happy and fulfilled as a teacher, eavesdropping on Jeff's lessons.

Tim created the tree and park procedures. He had a hard time deciding what he wanted to do with LOGO. I suggested that he create a tree. Tim made mistakes the first time he estimated angles, distance, and direction, as all LOGO users do. The turtle (the triangular cursor that draws on the screen) provides instant feedback, carrying out instructions exactly. After two sessions, Tim finished his tree and had decided what else he wanted in the picture. His final product appears in Figure 5.

```
TO TREE
FD 10 LT 90 FD 20 RT 120 FD 40
RT 120 FD 40 RT 120 FD 10 FD 5 FD 5
HT
END

TO GROUND
PU BK 100 PENDOWN FD 200 HT
END

TO BENCH :GREEN
FD 10 RT 90 FD :GREEN FD 10
RT 90 FD 10
END

TO DOG :K9
FD 10 RT 90 FD 30 RT 90 FD 10 BK 10
LT 180 FD 5 BK 5 LT 45 BK 5 LT 90
END

TO PARK
HT
TREE
PU FD 100 RT : ) BK 10 PD
BENCH 20
LT 90 PU FD 70 PD
GROUND
BK 40 LT 90 DOG 5
END
```

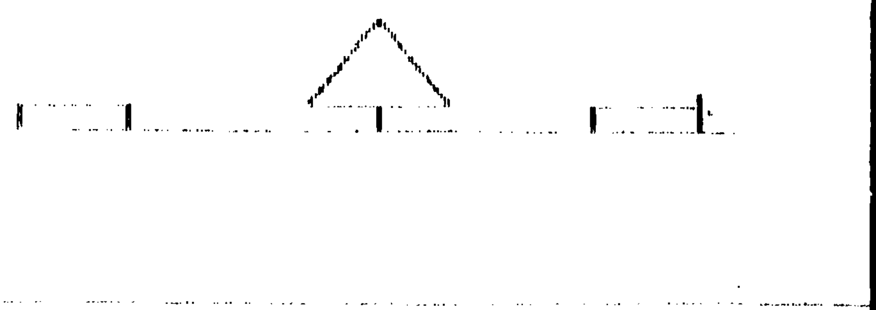


Figure 5. Final "park" procedure.

My initial response to LOGO was amazement at the unusual way my students dealt with initial failure: they persevered. The computer demands not ony perfect spelling, but also perfect spacing. If the input isn't formatted correctly, an error message appears on the screen. The computer waits silently (no "Try it again, Tim!"), ready to respond to a command it can understand. I've never seen anyone become angry or ask "why does it have to be spelled right?": they just keep at it or ask the nearest person for help.

Sometimes commands are spelled correctly, but what happens on the screen is not what the programmer had in mind. Tim, for example, never intended that the ground should have a vertical orientation in his picture. There is no arguing, no "But I meant..." with a computer. Tim asked for some help from me and fixed it -- not for a grade, but to achieve a goal he had set for himself.

Because LOGO is a tool students use to create something of their own design, there is no possibility of failure—at least, not the school kind of failure. They fail only when they set unrealistic goals, such as Geordie did when he decided to learn assembly language, and Jeff did when he wanted to write music with LOGO. Both Geordie and Jeff pursued these illusive goals for a week or two. They gave up of their own volition because they weren't accomplishing much with either music or assembly language. They chose tasks with a greater promise of reward.

I had always engineered each educational goal for every student until this past year. I contrived consequences for every possible behavior. It has been fascinating for me to watch students respond to naturally-occurring consequences. Jeff and Geordie learned from their own experiences to choose more appropriate goals. The boy writing the HOUSE procedure demonstrated far greater amounts of perseverence at solving the problems that cropped up along the way than he does at his academic tasks—perhaps because it's a task he's set for himself, and therefore much more interesting to him. I now believe that students can learn without directed instruction in an environment conducive to the exploration of math, language, and spatial concepts—one in which they are free to theorize, test, and revise.

By introducing LOGO into my special education curriculum, I provided my students with the opportunity to observe an adult learning—an opportunity that occurs infrequently in many classrooms. I knew very little about LOGO and computers. Those children have heard me say, "I don't know" in response to their questions countless times. They've seen me search through manuals for answers. They've looked up information themselves. They've heard me ask colleagues for answers. When we couldn't figure out how to program the turtle's touch sensors, one colleague called M.I.T. for the information. The children helped me adjust the robot turtle's pen and motors. There's not a chance in the world that I'll ever regain my flawless, perfect teacher image in that school: the kids have all seen me kneel on the floor before the turtle, gripping a screwdriver, reciting "Righty tight, lefty Lucy" to remember which way to turn it.

Obviously their perceptions of me changed. As the year progressed, my perceptions of my students changed. Let me use Mark as an example.

Mark looked as though he would disintegrate at any moment as he walked down the hall. Smudged glasses threatened to escape from his face. His shirttail refused to be confined beneath a belt. Books slipped from Mark's arms; when he bent to retrieve them, his pencil made a quick getaway. His shoes were usually untied. Spelling and handwriting skills proved to be as intractable as his shoelaces. I taught Mark spelling that year, probably with as little success as his previous teachers.

The following year—this past one—I eased up on the spelling instruction, focused on study skills and introduced LOGO. Mark learned LOGO commands and grasped concepts far sooner than his classmates, and wrote complex programs months before they did. LOGO provided Mark with the opportunity to express his intellectual potential without being held back by his poor spelling skills. Whereas I still provided special education services to Mark because of his disability, I no longer viewed him just in terms of his deficits: I had caught a glimpse of his strengths.

These learning disabled students have shared the evidence of their ability to learn with their classmates and the community. They served as aides in the district computer lab, housed in our school, when children from other schools came to learn about computers and to program in LOGO. Eric, now in the eighth grade, helped out in the lab last week when a high school geometry class came to learn LOGO—Eric, a boy who probably can't spell "geometry", introduced by the lab facilitator to 24 high school students as "the LOGO expert". Later Eric shared with me, "It felt kind of good, teaching kids who are older than I am!"

Last Spring the local Apple computer dealer loaned us TOPO, a three-foot tall robot. My students collaborated with their gifted/talented classmates in programming it to move down the hall and around the corner to the principal's office (with a hall pass taped to its head), turn around, and return to our classroom. They wheeled a computer and TOPO into classrooms and taught their peers to operate TOPO. A crew from the local T.V. station interviewed and filmed them for the evening news. While the cameras were being set up, Eric confided to me that he was "...bursting with happiness".

I feel that students make gains in many areas while they work with LOGO: self-esteem, number skills, logical thinking, ability to persevere, and all types of communication skills. Researchers at M.I.T. have reported numerous case studies which indicate that individual students make significant academic gains while they work with LOGO (Papert et al., 1979; Papert, 1980; Watt 1979; Weir, 1981a, 1981b). The nature of LOGO makes it an unlikely candidate for rigorous experimental designs, yet if working with LOGO really does for kids the things that I and other educators have observed, I am hopeful that empirical evidence will be forthcoming.

I will conclude with the description of a project my seventh period class undertook: the creation of a branching adventure story on the computer, which the students titled, "The Day The Teacher Dropped Dead."

I had read about the feasibility of such a project in a magazine (Riordon and Martin, 1983). The process looked fairly straightforward and the concept of writing a story as a class activity intrigued me. It turned out to involve much more programming than I had anticipated, but the rewards were commensurate with the time invested.

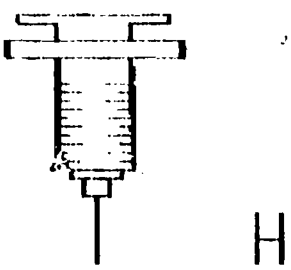
The students dictated the adventure's commencement, which I transcribed on the blackboard. They wrote about themselves, their class ("computer class"), the teacher of gifted/talented students (Mr. Kern), the principal (Mr. Norman) and even their class pets. (See Figure 6.)

THE DAY THE TEACHER DROPPED DEAD

By Mark Byrnes, David Colvin,
Tara Earl, Morgan Evans,
Jason Smith, & Linda Wade

You are a student at Ryan Jr. High.
You're in computer class, where Mr.
Kern is lecturing on dissecting guinea
pigs. Jason is trying to stop Mr.
Kern as he's about to inject the
animal with a sleep-inducing chemical.

You will see a picture in a minute.
When you're ready to go on, type the
letter you see in the corner of the
picture, then return.



Now press "L", then return.

Figure 6: "The day the teacher dropped dead."

In groups and individually, they wrote the story strands which lead to nine different endings. To facilitate editing, I typed their rough drafts with a word processing program. Peers, parents, and I helped them edit. When everyone was satisfied with the text, the children input it at the computer, using LOGO. (See Figure 7.) Oftentimes two would work together at the computer, one reading aloud and one formatting the text in LOGO.

```
TO H
NORDRAW PRINT ""
PRINT [MR. KERN IS DISTRACTED BY JASON'S]
PRINT [VERBAL AND PHYSICAL PROTESTS.]
PRINT [HE ACCIDENTALLY INJECTS THE SOLUTION]
PRINT [INTO HIS OWN ARM WHILE THE GUINEAU]
PRINT [PIG SCAMPERS AWAY.]
PRINT [""
PRINT [IF YOU WANT THE CLASS TO TRY TO HELP]
PRINT [MR. KERN, TYPE "E". THEN RETURN.]
PRINT ""
PRINT [IF YOU WANT MR. NORMAN TO ENTER THE]
PRINT [ROOM, TYPE "P", THEN RETURN.]
PRINT [<BE PATIENT: IT TAKES A MINUTE.>]
END
```

Figure 7. Part of the program behind the story.

Tara and Linda made a particularly good team: Tara's reading and spelling skills are relatively good, but she had trouble learning to format PRINT statements. Linda had learned the LOGO syntax and could move easily between the regular screen (i.e., what you see in the final product) and the editing mode, but her spelling skills were poor. Together, they created a satisfactory product.

Social relationships were an integral part of the story. Mark and Jason had exchanged many unkind words throughout the school year. In the branches Mark wrote, Jason committed suicide (two ways!). Mark had a gleeful look on his face when he showed Jason his part of the story. I prepared myself for an angry outburst. Surprisingly, Jason liked it. Both were satisfied: Mark killed off Jason and Jason received recognition.

Jason, in his strand of the story, not only killed the principal, Mr. Norman (whom he likes), but also cut him up into small pieces. I tried to help Jason view the scene from Mr. Norman's perspective and actually had them get together and discuss it. Jason insisted on going ahead with the murder, but added this note to his text: "We mourned his death to this day."

I never learned Jason's motivation for killing the principal. His motivation for WRITING, however, was clear: he was writing on a topic that had personal meaning, and the purpose of his writing was to create an interactive computer story that he and his friends could read. These students displayed an enthusiasm for writing that they never expressed for workbook activities. Tara wrote a lot of dialogue—the perfect opportunity for her to finally learn to use quotation marks. Linda learned a way to cope with her spelling disability. Jason wrote at home. Morgan spent extra time in the room, creating LOGO illustrations. Instead of a grade on a paper, crumpled in the wastebasket, these students have their story on a disk.

Programming in LOGO is a "learner-driven" activity: the student determines the course his/her learning will take; the teacher is a facilitator of the learning. Individual children's strengths and interests become apparent as they choose from among the many possible programming activities. The learning disabilities specialist can capitalize on an individual child's strengths and interests when developing an instructional plan for the child's weaker areas.

I hope that I have begun to instill in my students the qualities of a lifelong learner by letting them discover that they are good at learning and by providing them the opportunity to choose to learn for intrinsic reward. Perhaps it's time that learning disabilities specialists focused more on the "learning" and less on "disabled."

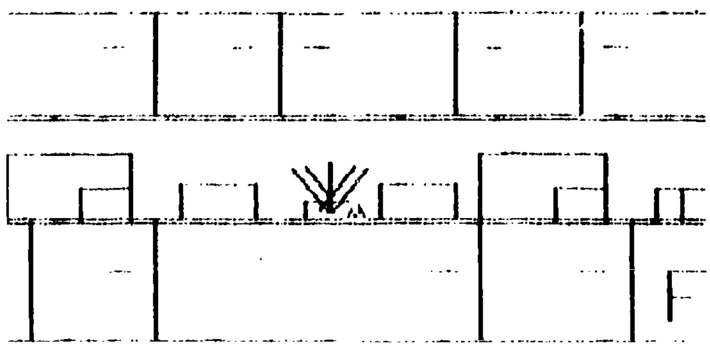


Figure 8. The lab in "The day the teacher dropped dead".

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