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ABSTRACT

The report examines a variety of computerized aids and devices fcr individuals with visual, communication, or cther disabilities, as well as ways computers may be used in the education and employment of handicapped individuals. Considered in the section on visual and hearing aids are talking meters, braille terminals, devices for reading standard print, auditory adjuncts, and diagnosis and therapy aids. Aids for the physically handicapped described include wheelchairs, environmental control devices, a wcrktable, and self feeding devices. Systems, computerized and manual, tc improve communicaticn for the speech impaired are briefly described, and include both scanner and direct selection types. Amcng uses of the computer in the education and emplcyment of the handicapped discussed are simulation of laboratory experiments, remedial instructicn, the use of the computer in the worker's home, and computer programing as a career for the handicapped. Identified are such recent imprcvements in computer applications as simplification of hardware, increased flexibility, and decreased costs. Identified weaknesses of current computer technology include portability, problems of maintenance, and the tendency to reduce microcomputer applications tc cne task problems. Appended is a list cf resources including publications, organizations, and manufacturers. (DB)

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COMPUTERIZED AIDS FOR THE HANDICAPPED

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INTRODUCTION

More than 50 million Americans are classified as handicapped because of varying degrees of paralysis, deafness, impaired vision, educational disabilities, or a combination of these problems. Annually, another 1.2 million Americans suffer temporary disabling injuries ("New Products—A Boon to the Disabled," 1978; Wolman, 1980).

Using computers in rehabilitation engineering and education of the handicapped is a fairly new concept. Computer technology can be combined with rehabilitation techniques in many areas to augment the skills of handicapped individuals and help them adapt to their surroundings. Special education services, provided in public schools as mandated by Public Law 94-142, the 1975 Education for All Handicapped Children Act, may use computerized adjuncts.

In many cases, microcomputers can replace complicated electronic and mechanical parts providing increased portability and adaptability. When these popular, readily available microcomputers are used, usually both initial costs and maintenance expenses are minimized. In addition, computers make sophisticated control, such as use of voice rather than manual activation, feasible.

This report deals with a variety of aids and devices that enable individuals with visual or vocal impairments as well as those with visual handicaps to communicate more easily. Also described are ways computers may be used in the education of individuals with mental and emotional handicaps.

VISUAL AND HEARING AIDS

As a group, the blind have more types of devices available to them than any other classification of handicapped persons. The traditional white cane is giving way to laser canes that beep. Different tones correspond to different heights of obstacles the user is approaching. For those who are also deaf, work is progressing on a cane which responds with tactile stimulators instead of beeps.

Talking Meters

Visually impaired technicians may use meters which give an auditory response. One audible voltmeter generates a set of short and long tones corresponding to the voltage measured. Another device, a speech-synthesis module, uses a microprocessor to convert direct current input signals of 0 to 5 volts into simulated English output (Wagner, 1979).

Braille Terminals

Education for the blind is difficult because teaching materials are devised principally for the sighted and few textbooks are available in Braille. However, computerized Braille printers are making it possible for those with visual handicaps to be mainstreamed, not only into colleges but also into secondary and elementary schools ("Computerized Braille Helps Mainstream the Blind," 1978; "Braille Terminal Eases Information Dispersion," 1979). Using this system, students can tape-record lectures and later transcribe notes into the computer using a standard terminal keyboard. Thus, the computer becomes the student's notebook. Braille copies may be printed in a matter of seconds. The terminals may also be used to prepare term papers and other homework. Students' output can be printed simultaneously both in Braille and, at a different printer, in standard type. Some printers can print both standard type and Braille, though not simultaneously.

Computer systems using Braille printers allow blind individuals to function with the utmost of independence. Audible warnings and tactile indicators signal operational problems such as the need to put in more paper.

Many existing computer programs could be used by blind individuals if they were available in an accessible format. Having someone read programs to them (blind computer users) is a possibility but not really a very desirable solution. Speech synthesizers that vocalize characters for a microcomputer are available, but the cost of $400 to $10,500 limits widespread use. One computer club located in Virginia has devised an auditory system which equates a different sound frequency to each dot in the Braille cell (Smanick & Delmarva Computer Club, 1981). One drawback to this system, however, is that it requires the blind programmer to learn an additional skill. While the Braille code remains the same, the method of perceiving it is auditory rather than tactile. Most microcomputers can be readily wired for sound with a small, inexpensive amplifier and speaker. (For example, the Commodore PET uses a styro-foam cup as a speaker.)

Reading Standard Print

Even if blind persons had unlimited access to books, magazines, and newspapers in Braille, there would still be other printed material they need to read such as information on food packages, instructions on medicine bottles and personal letters. Both the Optacon (Clayton, 1979; Brody, 1980) and the Kurzweil reading machine (Michalopoulos, 1979) have the capability of translating standard print into a usable format.

The Optacon is a device that converts printed words into tactile signals. A miniature camera, about the size of a pack of gum, held in the user's right hand, is moved over the printed words. Images are recognized and appropriate Braille symbols are formed by tiny vibrating pins located on the receiver, which looks like a cassette tape recorder. The message is relayed to the user through the left index finger which rests on the vibrating pins. Although the Optacon is somewhat slow, it does provide an adequate and independent means for the blind person to obtain information.

The Kurzweil reading machine is a device that converts print into speech. It recognizes a variety of print styles and type sizes. The printed material is placed face down on a scanner which looks much like a small Xerox copier. An electronic camera scans and sends an electronic signal of the image to a minicomputer. The computer forms the image into discrete character strings (words) and produces simulated speech. There is some contouring of the output in an attempt to reproduce a "natural" sound; for example, if the string ends with an exclamation point, the word is emphasized.

Auditory Adjuncts

To make telephone communication possible for individuals who are deaf and blind, a Braille printer can be attached to a standard telephone through an acoustic coupler, enabling deaf-blind persons to "see and hear" phone messages with their fingers. If an individual is mute, a computer with a typewriter keyboard may be connected to the system. The outgoing, typed message is converted by this device into speech for the listener at the other end (Brody, 1980).

One difficulty with telephones for hearing impaired individuals is signaling an incoming call. Deaf individuals may be signaled by flashing lights but calls may be missed if the user is not looking at the light. One way of overcoming this problem is to connect an electric fan to the signaling unit. The use of air currents is a simple and surprisingly effective way to alert deaf and deaf-blind persons to incoming messages.

Another aid for the blind and/or deaf is a wristwatch-like wireless signaling system that transmits tactile sensations. It responds to auditory inputs such as doorbells, telephones and fire alarms.

Diagnosis and Therapy Aids

The National Center for Infant Hearing Assessment is using a computer to analyze the brain-wave responses of infants to various sound levels (Wolman, 1980). This technique provides a means for testing the hearing of a newborn baby, thus allowing defects to be treated early in the infant's life.

Experimentation involving implanting electrodes into sensory systems is providing promising results. For some deaf individuals, hearing can be restored by connecting an electrode to the auditory nerve. The electrode converts sound into electrical impulses which can be processed by the intact portion of the auditory system. Experimentation is also underway to restore sight to blind persons. This process involves a camera-like implant placed near the optic nerve (Brody, 1980).

AIDS FOR THE PHYSICALLY HANDICAPPED

Wheelchairs

Lack of mobility is one of the most acute problems for many physically handicapped persons. Specially adapted wheelchairs are providing more independence to those who have heretofore been totally dependent on others to help them move around. Persons with limited limb movement may be able to use a joystick (control lever, like those used in airplanes) to control their wheelchairs. But for many quadriplegics, those with no upper limb response and only minimal head and neck movement, use of a joystick is impossible. A microprocessor-based wheelchair control activated by sip and puff switches, hum control, voice control, or movement of head or chin is now available.

The University of Virginia Rehabilitation Engineering Center has developed a wheelchair that is able to move in any direction, has automatic speed control, avoids obstacles, and monitors its own resources (Aylor, Johnson, and Ramey, 1981). The prototype of this wheelchair did not discriminate between the voice of its user and that of another person. This was realized when a nurse's voice sent the chair, with its helpless patient, down the hall, out of the hospital and into heavy traffic. Subsequently the chair has been tamed by "tuning" it to respond only to the user's voice or breath flow pattern.

Computers are now being used to help train paralytics in how to move their wheelchairs. The motions used by individuals to drive the chair are analyzed and evaluated. Recommendations are then made concerning more efficient concentrations of effort.

Environment Control

The types of signals that operate a wheelchair can also be used to establish control over other aspects of the environment. Handicapped individuals should be able to control lights, change television channels, or play a phonograph without having to call an attendant. Those who want to live alone need to be able to open, close, and lock doors and windows, to monitor appliances, and to summon help should it be necessary. The Sears, Roebuck Company markets a home security system which is adaptable for use by handicapped persons (Rye, 1980). In normal use, a button is pressed to perform one of the above functions. Light-emitting diodes (LED's) give visual feedback about the controller's state. The device is easily adapted for the physically handicapped with an interface that uses tongue-depress, head-activated, or sight switches.

William J. Warner has developed a whistle-activated environmental controller for turning on various appliances (Hamilton, 1979). Warner's system is about the size of a stereo amplifier with rear jacks into which appliances plug. Each controlled device is assigned a number. The numbers are lit sequentially on the front panel. When the desired number comes up, the user whistles, thus turning it on. A second whistle turns it off. Most noises will not trigger this system; however, as a defense against accidental triggering, the system can be programmed to require a sequence of whistles to activate it. Adding a microprocessor created a more flexible design with more logic, more options and more refinements. The device can be used to store phone numbers and can dial the phone automatically. This item, a boon to many quadriplegics, was invented by a young man who is himself a paraplegic.

Worktable

Traditionally, high-level quadriplegics have had to depend on friends and/or attendants to provide help with most tasks. Modern technology has opened the door to greater independence by developing robotic arms to assist the disabled individual. The Jet Propulsion Laboratory and the Applied Physics Laboratory (APL), in conjunction with Johns Hopkins University (JHU), have developed worktables with robotic arms (Ramey, Aylor, & Williams, 1979; Schneider, Schmeisser, & Seamone, 1981).

The APL/JHU scheme consists of a series of interlocked tables. A robotic arm, mounted on the table, is operated by the same controller which runs the electric wheelchair. Signals are transferred from chair to table via an infrared link; consequently, the user needs no assistance to make or break connections to the worktable. The robotic arm has several joints. A trajectory is not computed for the manipulator. Instead, during a "learning phase", an attendant guides the arm through desired sequences of motions. This establishes point-to-point coordination of the motion with commands. In this manner, the microcomputer can automatically reproduce complex routine movements with few instructions.

In a manual mode, the user can control the arm with a chin-motion transducer which generates voltage proportional to the vertical position of the user's chin. Therefore, the operator controls the arm, one joint at a time. Although manual control is tedious, the user can accomplish varied tasks such as getting a writing utensil or mouthstick.

Table modules hold vocational, recreational, or personal objects. For instance, a portion of the complex might be designated for reading materials. It would include a reading stand that would allow pages to be turned with a mouthstick. A storage unit or bookshelf, holding a small collection of books and magazines, would be located behind the stand. The arm would be capable of reaching the storage unit, selecting an item, and placing it on the reading stand.

A portion of the standard table might be set aside for a telephone. Some telephones are activated by voice so they need not be lifted by hand. With a normal phone, the robotic arm could bring the receiver to the individual's ear. The arm could also hold the phone for push-button dialing. Some specially designed phones have large keys (1" X 1") with actuating force adjustable to the users capabilities ("Special Telephones Aid Handicapped," 1979). These special telephones may interface with

with other network-compatible accessories such as a telefacsimile service. Many of these experimental phones are already used in rehabilitation training centers. A table may be designed to hold an environmental controller and/or a personal calculator, which would be useful beyond basic mathematics. Calculators can tell time, play music, talk, signal like an alarm clock, and perform many other functions. Calculators can also be operated with mouthsticks.

Microcomputers can be even more helpful to the physically handicapped than calculators. The modem of a personal computer may be connected directly to the phone jack, thus permitting the computer to be interfaced to the phoneline without an acoustic coupler. The robotic arm could load disks or cassettes, remove listings from a printer, and display printouts on the reading stand. The computer center could be used professionally or for recreation.

Still another module might contain a typewriter. Paper could be inserted and removed by the robotic arm. Notes or other reference materials needed during typing would be placed on the reading stand.

In each of the above applications, the individual would probably operate the equipment with a mouthstick rather than with the robot. Because of a control problem, the robotic arm would not be used to actually depress the keys or buttons of the typewriter, computer, or telephone. The arms are appropriate for preprogrammed standardized tasks such as positioning reading material, but keypunching sequences require more flexible control.

The whole worktable environment would not necessarily include all of the possible modules, as the work area would need to be limited to a size accessible to the robotic arm. Since space is limited and it seemed unlikely that the typewriter and computer center would be used together, the designers have made these modules interchangable. An attendant must perform the task of changing the units.

Self-Feeding

Self-feeding can be accomplished at one end of the worktable described above, where a second infrared link is located. Food must be sliced or broken into bite-sized portions and placed into bowls. An attendant puts the bowls on rotators built into the table and places a special spoon into the robot's "hand". In the programmed phase, the arm moves the spoon in a series of motions to scoop up a bite by moving the spoon against the vertical lip of a bowl. The bowl may be rotated as the food is consumed. If some food still evades the spoon, the programmed mode can be overridden and the spoon controlled manually. Bread, meat, and fish must be precut to bite-sized pieces. Salads can be eaten as served. All vegetables are manageable, although it is difficult to get acceptable portions of mashed potatoes which stick on the spoon. Drinks in a cup-holder with a straw, can be accommodated. Most desserts, including gelatin and ice cream, also work well. A complete meal can be eaten in 15-20 minutes (Ramey et al., 1979).

A major objection to the table-mounted arm is that it is not portable. Although very bulky, a robotic arm can be mounted on a wheelchair, thereby enabling a quadriplegic to dine independently in a restaurant. A publicly used arm should be unobtrusive, move in smooth arcs with no jerking, and be readily reprogrammable for novel paths. There presently exists an arm that fulfills these specifications. The arm is manipulated by an assistant through the desired Cartesian coordinates. The positions of each joint are storedin the computer's memory. The processor uses a software program to reproduce these stored motions (Kamey et al., 1979; Aylor et al., 1981; Schneider et al., 1981). Away from the worktable, a wheelchair-mounted manipulator could be used to perform other tasks such as turning a doorknob and retrieving items from shelves.

COMMUNICATION FOR THE SPEECH IMPAIRED

Computers can be used to give speech to nonvocal individuals. Basically, there are two types of communication systems. One is a scanner type, in which a switch controls an indicator light that moves across a display of letters, words, or symbols. This type of system requires voluntary motor control of at least one muscle. The other type of system is a direct-selection technique where symbols are indicated directly by touch or pointing.

The symbol display on lapboards may be marked with pictures, letters and numbers, Braille characters, or other communication symbols (Thomas, 1981). A talking Blissymbol board is a graphic communication system. The user selects simple line drawings representing semantic concepts and proper names of persons in their environment. The success of this system depends on the recipient's ability to interpret the message. Unfortunately, few people have the patience and attention span to communicate by this means. With the advent of computers, an intelligent Blissymbol board has been developed which translates symbol sequences into phonetic strings which in turn are sent to a small printer or are articulated by a speech synethsizer.

Still other lapboards have been designed to use several sets of communication symbols. The symbols can be mounted on plastic overlays and changed as needed. Minor modifications in the microprocessor program would accommodate changeovers to different sets of symbols. Such versatility would allow very large symbols to be used by those with only gross motor control (Thomas, 1981).

In other systems, a joystick may be used to select symbols from a display screen. The operator would push the stick to select a message. The message would then be sent to a printer or voice synthesizer. As with voice control of wheelchairs, a joystick may have to be specially tuned to an individual user. For example, a digital filtering mechanism could be used to extract an average of spastic hand movements which would be generated as the user moves the joystick.

With single-switch operation, an indicator light moves at a set rate across symbols displayed on a T.V. screen. Closure of the switch when the indicator light is on the desired symbol signals the microprocessor of the selection. Using this technique, the user can gradually construct a message. When complete, the message may be printed out or spoken by the computer. For maximum versatility, the display of symbols usually comprises alphanumeric characters arranged according to frequency of use.

A unique single-switch communications system has been developed that uses the operator's line of sight. A sensor and an infrared light are mounted on a pair of eyeglass frames which are firmly attached to the user's head. Corneal reflection is used to discern the direction of gaze. Different directions are assigned different interpretations.

In another system, neck movements can be substituted for specific words or phrases. However, if the device cannot form an entire phrase or thought from a single movement, composing simple messages will quickly fatigue the user.

Developments such as those described represent immense improvements over noncommunication; however, each is still a greatly limited version of normal communication. They are effective in the limited environment, classroom or home, but very cumbersome in a more public setting. To increase communication speed, information amplification is the next logical step. A software package available for a TRS-80 augments communications for those who are able to type only two to six words per minute. This program permits single words to be retrieved with one or two keystrokes, using an abbreviation expansion approach. This approach works well for commonly used words and mnemonics. The system also uses anticipatory spelling, thus truncating the typing process. A phrase/sentence recall system is still in the formulation stage (Giannini, 1981; Vanderheiden, 1981).

SPEEC is a spoken communication system for non-vocal individuals. It uses English phonemes and their most frequently repeated sequences. For 400 of the SPEEC items, only 1.6 selections per word need to be made, compared to 5 choices when spelled out. Printed output is spelled phonetically; spoken communications can be produced using prerecorded speech as input.

A major barrier to using microcomputers as communication aids is the custom interfaces needed to achieve optimum speed. Even with all the interfaces available, it is impossible to duplicate normal human communication with existing prosthetic devices; however, advances in new memory chips and microprocessors are leading to more intelligent devices that know syntactic rules, anticipate user's needs, and remember the context of communication.

Some investigators have hypothesized that in producing speech, certain electrical signals occur in our bodies, signals which could be translated into artificial speech. Using this theory, they have successfully devised a system which correctly interprets speech for one individual. Unfortunately, because the signals vary so tremendously from one person to another, the system is not transferable.

This procedure uses the body's covert electrical signals to trigger myoelectrically activated switches that operate the communication device. Electrodes on the skin surface were found to be less than ideal because they had to be removed for functions like bathing. Exact positioning is critical and a period of adjustment was needed after repositioning. In the next few years researchers will explore implanting of electrodes and will undoubtedly be able to modify the programming so it will be capable of adjusting to individual differences (Rahimi, 1981).

EDUCATION AND EMPLOYMENT OF THE HANDICAPPED

Many individuals have invisible handicaps. Fifteen percent of the children in elementary schools may have learning difficulties (Thompson, Ross, & Horwitz, 1980). Impaired cognitive processes may be generalized or specific dysfunctions of short-term memory or word-finding abilities may exist.

With microcomputers, handicapped persons who have a slow response rate can work on their lessons independently. The computer is infinitely patient with remedial drill and practice needed by the learning disabled. Emotionally impaired students may find that frustration is alleviated by working an uncritical machine (Blaszczyk, 1981).

Computers can be extremely useful in teaching chemistry, physics, and other science laboratory classes to handicapped students. Simulation of laboratory experiments can eliminate the necessity of manipulating chemicals and other equipment. Computers can replace notebooks, calendars, dictionaries, phone lists, and filing systems.

Obviously computers can be used in remediating problems only if equipment and software are available and if therapists are aware of their existence and are familiar with their use. It would be helpful if schools were more involved in developing assistive devices and had more access to information about computerized aids.

Computer programming is an attractive occupation for many handicapped individuals (Giannini, 1981; Leneway & Montgomery, 1981). Handicapped people who initially learned about computers so they could improve their own environment and increase their independence later began to sense the career possibilities available.

Braille printers and devices that substitute verbal responses for printouts make the study of computer science accessible for blind students ("Braille Terminal Eases Information Dispersion," 1979). The University of Manitoba in Winnipeg, Canada, has an extensive training program for blind programmers. The success of this project is measured by their 75-80% job placement rate ("Computerized Braille Helps Mainstream the Blind," 1978).

Many firms are now considering moving computer job sites to workers' homes, a beneficial innovation for those with limited mobility. In a sophisticated office-like environment, which can be provided using the worktable, a quadriplegic can function effectively.

Rehabilitation agencies and businesses are now cooperating in projects in 16 states to train the handicapped in computer programming. However, the job market is opening only slightly for these individuals. Too few opportunities exist for qualified handicapped programmers.

Computers are used for recreation and game-playing by the handicapped, just as they are by the nonhandicapped. Children with severe physical or sensory handicaps can use computers with special adaptations to control, explore, and manipulate objects. The computer which thus gives the child a new perspective on the environment, is more than just a recreational aid, it can also be a paramount developmental aid.

STRENGTHS AND WEAKNESSES

The most important improvements in computer applications for handicapped individuals have been the simplification of hardware, increased flexibility, decreased costs, and more sophisticated control concepts such as voice synthesis. Major weaknesses include too many stationary designs, limited durability, slow storage access speed in low-cost systems, limited operating systems, and the need for battery backup.

Portability also continues to be a major problem. Worktables are useful, but stationary. Robotic arms mounted on wheelchairs are less versatile and more bulky than stationary designs. Lapboards are helpful for communication, but are very slow and so large they barely fit through doors. Electric wheelchairs provide mobility, but don't fold up and therefore are not readily portable except under their own power. Really good speech synthesizers aren't portable, either. Handicapped persons are eager to do away with what they perceive as additional restraints imposed upon them by their assisting devices.

The incorporation of computer elements into adaptive equipment has added somewhat to problems of maintenance. Repairs tend to be costly, parts are hard to get, and the units usually must e sent to specialists for repair. Downtime may be a prolonged period. More emphasis needs to be placed on user maintenance.

To make computers useful to the handicapped, special custom hardware is frequently needed; the extra cost may negate the advantages of microcomputers.

Computer systems should be flexible enough to accommodate a variety of handicaps and be adaptable for use by nontechnical persons. On the other hand, development of the most flexible and useful device for a specific person with any physical disorder may prove to be prohibitively expensive.

Although funding an appropriate device may be a problem, several resources do exist that link consumers with manufacturers and distributors of specialized equipment. ABLEDATA is a computerized listing of approximately 5,000 adaptive products and devices for handicapped individuals. Accent on Information (AOI) is another computerized retrieval system containing information to help persons with disabilities live more efficiently. (See Resources, Organizations and Manufacturers.)

Another factor frequently overlooked by designers is practicality. Sometimes operating commands are not simple and short. Occasionally, developers concentrate too hard on the problems and not enough on the user. For instance, considerable effort has been put into devising a wheelchair to climb stairs, but no thought was given to the psychological terror that might be experienced in going down the same stairs in a chair on wheels!

The microcomputer's potential as a rehabilitation tool is presently limited by several systemic and configural constraints that tend to reduce applications to one-task problems. Future development of multilevel and multitasking capabilities is necessary. A comprehensive network for dissemination of information about new developments of assistive and corrective devices to reduce duplication of inventive efforts is needed.

Use of microcomputers in rehabilitation engineering is in its infancy. Many improvements in self-help devices are on the horizon. As developments occur in microelectronics, software design, artificial intelligence, pattern recognition, signal processing, and language theory, improvements in self-help devices will accelerate.

REFERENCES

Aylor, J.H., Johnson, B.W., & Ramey, R.L. Impact of microcomputers on devices to aid the handicapped. Computer, 1981, 14, 35-40.

Blaszczyk, H.J. Computing and the handicapped: The challenge in education. Computer, 1981, 14, 15-17.

Braille terminal eases information dispersion. American School and University, 1979, 51, 116.

Brody, R. Breakthroughs help deaf-blind persons to see and to hear. Science Digest, 1980, 88, 49-51.

Clayton, W.E. Machine to help blind "read" print. Moneysworth, 1979, 9, 5.

Computerized Braille helps mainstream the blind. American School and University, 1978, 50, 26.

Giannini, M.J. Computing and the handicapped: A promising alliance. Computer, 1981, 14, 12-13.

Hamilton, P. Whistle system lends quadriplegics a hand. Electronics, 1979, 52, 46-47.

Leneway, R.J., & Montgomery, B.R. Rehabilitation & the handicapped programmer. Computer, 1981, 14, 49-52.

Michalopoulos, D.A. Blind readers can use machine to recognize all fonts. Computer, 1979, 12, 97-98.

New products - A boon to the disabled. U.S. News and World Report, 1978, 85, 65-66.

Rahimi, M.A. Intelligent prosthetic devices. Computer, 1981, 14, 19-23.

Ramey, R.L., Aylor, J.H., & Williams, R.D. Microcomputer-aided eating for the severely handicapped. Computer, 1979, 12, 54-61.

Rye, D. Appliance-controller interface aids the paralyzed. Electronics, 1980, 53, 177-178.

Sand, J. Tero's Apple. Creative Computing, 1981, 7, 62-63.

Schneider, W., Schmeisser, G., & Seamone, W. A computer-aided robotic arm/worktable system for the high-level quadriplegic. Computer, 1981, 14, 41-47.

Smanick, S., & Delmarva Computer Club. Micros with the handicapped. Compute!, 1981, 3, 52-55.

Special telephones aid handicapped. Design News, 1979, 35, 32.

Thomas, A. Communication devices for the nonvocal disabled. Computer, 1981, 14, 25-30.

Thompson, J.S., Ross, R.J., & Horwitz, S.J. Computed axial tomography and minimal brain dysfunction. Journal of Learning Disabilities, 1980, 13, 334-337.

Vanderheiden, G.C. Practical applications of microcomputers to aid the handicapped. Computer, 1981, 14, 54-61.

Wagner, W.S. Talking meter voices DC voltage readings. Electronics, 1979, 52, 123-124.

Wolman, P. New devices, breaking barriers, turn disabled into the able. Science Digest, 1980, 87, 44-48.

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RESOURCES

Publications

Baltimore brings "Plato" to the classroom. Education Daily, April 23, 1981, pp. 5-7.

Bulletins on science and technology for the handicapped. American Association for the Advancement of Science, Office of Opportunities in Science, 1515 Mass. Ave. NW, Washington, DC 20005.

Careers in science for the handicapped project: Training manual. 1978 Career Planning and Placement Center, University of California, Irvine, CA 92717.

Computers aid handicapped. Singularities, 1979, 3 (3), 1.

Computers effective way to handle special education, NASDSE told. Education Daily, October 30, 1980, pp. 5-6.

Computers revolutionize aids. Asha, 1981, 23 (8), 555-558.

Electronic devices at N.Y. hospital help patients to expand social horizons. UC People, etc. November/December 1980, P.S. United Cerebral Palsy Associations, Inc., 66 East 34th St., New York, NY 10016.

Fullwood, N. Technology and the handicapped: Telecommunication systems in the rehabilitation of the blind. Washington, DC: Rehabilitation Services Administration, 1977.

Fox, R.G. Micro-processor based visual image controlled (Vis-I-Con) instruction delivery system for deaf and hearing impaired persons. Journal of Special Educational Technology, 1979, 3 (1), 15-21.

Goldenberg, E.P. Special technology for special children. Cambridge MA: Bolt Beranek and Newman, 1979.

Hallenbeck, C.E. Curriculum standards in the United States for training blind persons in computer occupations. New Outlook for the Blind, 1973, 67 (6), 266-271.

Jung, P. Help for the handicapped. Personal Computing, 1980, 4 (8).

Kleiman, G., Humphrey, M., & Lindsay, P.H. Microcomputers and hyperactive children. Creative Computing, 1981, 7 (3), 93-94.

Media applications for special education. Resources, 1980, 12 (1). Newsletter available from Regional Resources Center of Eastern Pennsylvania for Special Education, 1013 West 9th Ave., King of Prussia, Pennsylvania.

Monroe, C.H. Adjustment services for the blind. Journal of Rehabilitation, 1978, 44 (1), 30-34.

Personal computers for the physically handicapped. Avaialable from Apple Computer, Inc., 10260 Bandley Dr., Cupertino CA 95014

Sauka, C. AV for special children - Part I. Audio Visual Directions, March/April 1981, pp. 64-71.

Shworles, T.R. Development of modern vocational objectives for severely disabled homebound persons: Remote computer programming, microfilm equipment operations, and data entry processes: A final report. Washington DC: Social and Rehabilitation Services, Division of Research and Demonstration Grants (BBB02829), 1973.

Simmons, F.B., McFarland, W.H., & Jones, F.R. An automated hearing screening technique for newborns. Acta Otolaryngol, 1979, 87, 1-8.

Smith, E.I. The employment and functioning of the homebound disabled in information technology. American Journal of Occupational Therapy, 1973, 27 (5), 232-238.

Thorkildsen R., et al. A microcomputer/videodisc CAI system for the moderately mentally retarded. Journal of Special Education Technology, 1979, 2 (3), 45-51.

Ward, B. Very special computers. SKY, June 1981, pp. 46-55.

Williams, L. High tech: Media support for teaching. NTID Focus, Spring, 1981, pp 16-19.

Willoughby, D.M. A resource guide for parents and education of blind children. Available from National Federation of the Blind, 1800 Johnson St., Baltimore MD 21230.

Wilson, K. Computers for special education management: Progress, potential, and pitfalls. CEC Hot Topics paper: Reston VA: Council for Exceptional Children, ERIC Clearinghouse, 1981.

Organizations and Manufacturers

ABLEDATA
National Rehabilitation Information Center
4407 8th Street, N.E.
Washington, DC 20017
(202) 635-5826

Accent on Information
P.O. Box 700
Bloomington, IL 61701

Alexander Graham Bell Association for the Deaf
3417 Volta Place, N.W.
Washington, DC 20007
(202) 337-5220 (Voice or TTY)

American Foundation for the Blind
15 West 16th Street
New York, NY 10011
(212) 620-2000

Amyotrophic Lateral Sclerosis Society of America
15300 Ventura Boulevard, Suite 315
Sherman Oaks, CA 91403
(213) 990-2151

Arthritis Foundation
3400 Peachtree Road, N.E.
Suite 1101
Atlanta, GA 30326
(404) 266-0795

Carroll Center for the Blind
770 Centre Street
Newton, MA 02158
(617) 969-6200

Disability Rights Center
1346 Connecticut Avenue, N.W.
Suite 1124
Washington, DC 20036

GREEN PAGES Rehab Source Book
P.O. Box 1586
Winter Park, FL 32790
(305) 628-0545

Grosset and Dunlap (Source Book for the Disabled)
51 Madison Avenue
New York, NY 10010
(212) 689-9200

International Association of Laryngectomees
American Cancer Society
777 Third Avenue
New York, NY 10017
(212) 371-2900

Job Development Laboratory
Department of Rehabilitation Medicine
The George Washington University
2300 I Street, N.W., Room 240
Washington, DC 20037
(202) 676-3847

Michigan Center for a Barrier Free Environment
6879 Heather Health
West Bloomfield, MI 48033
(313) 626-4907

National Association of the Deaf
814 Thayer Avenue
Silver Spring, MD 20910
(301) 587-1788 (Voice or TTY)

National Clearinghouse of Rehabilitation Materials
Oklahoma State University
Old USDA Building, Room 115
Stillwater, OK 74074

Organization for Use of the Telephone, Inc.
Post Office Box 175
Owings Mills, MD 21117
(301) 655-1827

Possum, Inc.
Controls for the Severely Disabled
105 Madison Ave, 12th floor
New York, NY 10016

Prentke Romich Company
(Electronic Aids for the severely handicapped)
Contact. Carol Fusco
Marketing & Educations
R.D. 2, Box 191
Shreve OH 44676

Regency Electronics, Inc.
7707 Records St.
Indianapolis, IN 46226

Sensory Aids Foundation
399 Sherman Avenue, Suite 12
Palo Alto, CA 94306
(415) 329-0430

Sister Kenny Institute
Division of Abbott-Northwestern Hospital
Chicago Avenue at 27th Street
Minneapolis, MN 55407
(612) 874-4149

Telesensory Systems, Inc.
3408 Hillview Ave.
P.O. Box 10099
Palo Alto, CA 94304