Feature Article

The Liberation of Disabled Persons in a Technological Society: Access to Computer Technology

E. JANE BURKHEAD, Ph.D., JAMES P. SAMPSON, Jr., Ph.D., and BRIAN T. McMAHON, Ph.D.

ABSTRACT: Traditionally, problems of access for disabled persons have centered around architectural, transportation, recreational, legislative, and attitudinal issues. Given the increasing importance of computers in today's society, it is likely the matter of computer access will become as viable a concern as the issues above. This article describes the specific obstacles to complete accessibility regarding computer technology; the role of adaptive devices in the use of computer technology; the development of these devices; types, descriptions, and classifications of adaptive devices; as well as recommendations for practice and future research.

BARRIER-FREE ENVIRONMENTS have long been a major goal in the rehabilitation movement. Although gradual progress is being made in these traditional areas of rehabilitation awareness—the removal of barriers in architecture, transportation, parks and recreation, legislation, and attitudes[1]—the time has come to look ahead and anticipate which new obstacles must be confronted before they become deeply "entrenched" as major impediments to the opportunity structure for disabled persons. Perhaps the next frontier toward which accessibility efforts must be directed is that of computer technology.

Over the past 15 years computer applications have become an increasingly common resource used by rehabilitation professionals and disabled persons to enhance various aspects of the rehabilitation process: physical restoration, cognitive retraining, education, vocational exploration and decision-making, independent living, environmental control, job placement planning, and employment to name a few. Rapid growth in the use of computer technology has been a function of the development of software relevant to the rehabilitation process[13] and improvements in computer hardware—e.g., size and cost reductions, increased speed, and ease of use.[4] Microcomputers have offered independence from the telecommunications and access problems associated with large mainframe computers.[21] It is conceivable, then, that providing disabled persons with direct access to computer technology may be every bit as important to the ultimate assimilation of disabled persons in the future as architectural accessibility is presently.

The specific obstacles to complete accessibility to computer technology take many forms. First, there is the nagging problem of human resistance to change—the entire range of myths and fears associated with the operation of a computer is well delineated by Hallet.[16] Second, there is the difficulty of selecting the appropriate computer software for the myriad of available applications.[23] Third, there exist ethical dilemmas such as wrongful access to confidential

E. Jane Burkhead and James P. Sampson, Jr., are associate professors in the Department of Human Services and Studies at The Florida State University in Tallahassee. Brian T. McMahon is executive director of the Waterford Center for Rehabilitation (a new MediCo-managed facility) in Waterford, WI. *This article is a revised portion of a larger monograph entitled* Computer Access and Applications to Career Counseling with Vocational Rehabilitation Clients, *which is part of the Rehabilitation Research Review Series of the National Rehabilitation Information Center in Washington, DC. The authors extend their appreciation to NARIC director Susan Flowers, Freddi Karp, and other NARIC staff for their assistance in this project.*

Address: E.J.B., Dept. of Human Services and Studies, The Florida State University, 215 Stone Bldg., Tallahassee, FL 32306; (904) 644-3854.

client records and inappropriate client use of a particular system.[30] As a group, these problems are best resolved by the careful deployment of a well planned implementation process.[29]

Still, there remain additional human factors that represent significant barriers to computer access. For example, the preponderance of computer usage in the rehabilitation setting today is by the rehabilitation practitioner or administrator, not the rehabilitation client. As McMahon, Burkhead, and Sampson have stated:

> . . . (The belief) held by some rehabilitation professionals is that client use of computer technology must be guided by a qualified professional who "understands" both the client and the computer. One erroneous inference here is that each counselor must become expert in the technical operation of the system. But a more dangerous inference is that the disabled client is not capable of independent computer use, a modern example of negative professional attitudes toward disabled persons as described by others (McDaniel,[20] DeLoach & Greer[6]).[22, p. 36]

These authors suggest that independent client use of computer technology will enhance the quality of the specific application and provide clients with an enhanced sense of control over their futures.

Equally problematic are the negative reactions that some disabled persons have to the utilization of any assistive or adaptive device.[33] In addition to devices that provide access to computer technology, more traditionally rejected objects include wheelchairs, prosthetic devices, walking dogs, sign language usage, or other things or behaviors which identify one as disabled. Whereas individual counseling is often used to alter these unhealthy attitudes, those who encourage the use of any adaptive device should bear in mind the following principles:

> 1) Every effort should be made to improve functioning without the use of an artificial device or to minimize the need for such devices. . . . Modification of standard equipment should be avoided unless the disabled person is unable to learn how to manipulate the standard version;
> 2) Evaluation of a device prescribed for a person is based upon at least three criteria:
> *a)* the person's physical performance in the target behavior;
> *b)* the person's psychological reaction to the use of the device; and
> *c)* the effectiveness of the device itself.
>
> Individualization is a principle because what works well with one person may not serve another, even though the two have the same type and severity of disability.[40, p. 744]

The final problem, and an important focus of this article, involves the assumed lack of adaptive and assistive devices that would allow disabled persons independent access to computer technology. It is likely that the real barrier in this area has nothing to do with the availability of adaptive devices. If each such device that provides access to computers for disabled persons can be regarded as a distinct research finding, then the practitioner's naivete about such devices is only a modern variation of the longstanding issue of inadequate research utilization by rehabilitation professionals. This problem was succinctly expressed by Bolton:

> In fact, there is scant evidence that the tremendous amount of money and energy expended on research projects has had any significant impact of the efficacy of rehabilitation practice.[3, p. 229]

It appears to be the practitioner's lack of knowledge and resistance to change, in the midst of exciting and abundant technological choices, which raises the research utilization problem. Certainly there is no lack of adaptive or assistive devices. The remainder of this article is devoted to the role of adaptive devices in the use of computer technology; the development of these devices; types, descriptions, and classifications of adaptive devices; as well as recommendations for practice and future research.

The Role of Adaptive Devices in the Use of Computer Technology

The development of adaptive devices to provide unrestricted access to computers for disabled persons is viewed as a priority by researchers, practitioners, and consumers.[7,8,10,27,38] Considering the pervasiveness of computer technology in all aspects of daily life, the sense of urgency about devising ways for persons with disabilities to use this technology is not surprising. Computers have been integrated into education, employment, and everyday functions such as banking. Without devices to access this technology, disabled persons will be further excluded from the mainstream of society.[10,38] Vanderheiden recognizes the almost unlimited possibilities of computer technology to facilitate the functioning of disabled persons, but at the same time he stresses that ". . . 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 to overcome these gaps."[38] Access to standard hardware and software is needed to enable disabled persons to be fully participating members of our technologically oriented society and to prevent computers from becoming obstacles to this participation.[8,10,27,38] The issues described above are also potentially relevant for women and individuals who are economically disadvantaged.

In addition to the broader societal implications, access to computers is important on a more personal, affective level. As pointed out by Papert,[26] severely physically disabled individuals are often placed in a passive, dependent role by their limitations, their actions seldom impacting upon the environment. Being able to independently use the same equipment for the same functions as their able-bodied peers in educa-

tional and employment settings has a positive impact on self-image. Papert noted that severely disabled adolescents using the LOGO system to perform spatial manipulation tasks not possible in "real life" and to perform other intellectual activities experienced a marked improvement in their sense of personal worth.[26] The ability to function without the aid of others reinforces the disabled person's view of self as a competent individual.[39]

Providing access to computers used in service delivery, such as career exploration and decision making, is particularly vital to the rehabilitation process of disabled individuals. Client/counselor co-management of rehabilitation plans has long been a guiding principle in rehabilitation.[39] The client is encouraged to set goals and assume as much responsibility as possible in achieving the goals. The ability to independently participate in career exploration activities contributes to this assumption of responsibility and to feeling capable of independent functioning in other areas of life.

Development of Adaptive Devices

The need to include disabled consumers in the process of developing adaptive devices and other technology has been stressed by several consumers and researchers. Shworles[34] insists that consumers be treated as problem-solvers, not problems-to-be-solved—that their perspectives, values, and feelings be considered in judging the usefulness of any particular technology and in determining the need for additional research and development. An Australian professional who visited Rehabilitation Engineering and Rehabilitation Research and Training Centers in the United States stated that the research and development he observed were often not based on the life experience of disabled persons but rather on the interests of researchers. This professional reported that his plan of action, upon returning to Australia, would involve the following components:

1) assessment of the needs of disabled persons;
2) use of adaptations of existing technology if possible; and
3) new product development based on the needs of disabled persons.[10]

A similar process is illustrated in Desch's description[7] of the development of devices to provide access to computers for disabled children in a school setting. Existing equipment was chosen and modified or new equipment developed on the basis of the abilities and needs of the students.

Behrmann and Lahm[2] present a formal systematic approach to comparing a user's abilities and goals with available technology in order to develop a computer system. Applying systems theory and human factors engineering research, they have developed a model called Handicapped User's Method for Analyzing Needs-System Development (HUMAN-SD), to be applied in situations where the use of technology is being considered. The model provides the structure for matching the potential disabled user's capabilities and limitations with existing hardware and software. The HUMAN-SD comprises five stages or phases: requirements analysis, functions analysis, task analysis, interface analysis, and field evaluation. At the end of each phase, the potential user is provided with a planning document which details the proposed system. Ensuring maximum participation by the consumer, this document allows the user to make an informed decision about continuation or termination of the planning, production, and testing of the system. A systematic approach such as this appears to have utility in the development of adaptive devices that provide access to computers.

Types and Descriptions of Adaptive Devices

In developing adaptive devices to facilitate disabled persons' access to computers, researchers and product developers have used two approaches—the *special or modified software approach* and the *transparent access approach*.[7,27,37,38] The *special or modified software approach* requires modification of software for a particular computer so that simple devices, such as joysticks or light pens, can be used to control the computer. The control device is usually the only additional hardware required. However, device "handler" programs typically have to be written to allow the computer to receive input from the control device and to provide special screen displays, and standard software packages have to be modified to interact with the "handler" programs. An example of this approach is the NRC Screen Writer package.[27]

According to Vanderheiden, the *special/modified software approach* presents three significant problems:

1) For commercial reasons, the source code necessary for making modifications is generally not made available by the companies.
2) The cost of writing or modifying programs can be exhorbitant.
3) Software is continually revised or made obsolete by new programs, making it almost impossible to keep up with the standard software through a custom patching of each version as it comes out.[38]

The software approach may be useful for limited applications, but it is not acceptable as a means of access to the majority of computer software used by most disabled persons.[27,38]

The *transparent access approach* involves the use of de-

vices that allow special input to the computer in a way that the computer cannot detect any departure from the usual and customary manner of inputting data. Additional hardware and modifications in hardware are usually necessary to achieve complete transparency. Although these hardware interventions may be quite costly, this approach is generally accepted as the preferred method because it allows the disabled person to use standard software.[7,37,38]

Vanderheiden[37] describes four types of transparent access:

*1) **Direct Keyboard Modifications.*** This type of access entails mechanical or electro-mechanical modifications. Examples are keyguards, a hinged weight to operate the shift key, and substitute keys.

*2) **Electronic Keyboard Emulation.*** A module, which is installed in the computer between the keyboard and the remaining part of the computer, accepts input from a special device and feeds it directly to the computer so the computer accepts it as coming from the regular keyboard. Alternate keyboards and special communication aids that use brow switches, scanning displays, lightbeam headpointers, Morse code, eye gaze detectors, and other special indicators are examples of input devices that can be used with keyboard emulators. Vanderheiden[38] and Desch[7] note the possibility of disabled persons having their own specialized input devices which they could "plug into" standard classroom computers made accessible by emulators.

*3) **Dual Computer Approach.*** The dual computer approach is an extension of the electronic keyboard emulation technique discussed above. Instead of using a special communication aid to drive the keyboard emulator, this approach uses a standard computer in both the "special computer" role and the "standard computer" role. The first computer runs special interface software and provides special features to meet the user's unique needs. The output from the first computer is then fed, through a keyboard emulator, to the second computer, which runs the standard software. Vanderheiden concludes that this is often the "most flexible, straightforward, and least expensive" approach at this time.[37] (Newer operating systems due out in the next three to five years may make it possible to implement both computers within the same physical computer as a result of the ability of these operating systems to run concurrent and nested software.) The MOD Keyboard is a dual computer system, with the first computer having a dynamic screen display. This feature allows the user to change the keyboard displayed on the video screen, providing additional characters or words, phrases, or computer commands from which to select.[27] The user thus is able to perform more functions with the computer. The Long Range Optical Pointer system,[14,15] a second example, utilizes a headpointing technique and has the dynamic display feature.

*4) **Pseudo Dual CPU Approach.*** According to Vanderheiden:

> Some of these techniques take the form of special software routines which are hidden in infrequently used portions of memory. Special pointers within the operating system are reset to cause the computer to access the special routines instead of the normal keyboard servicing routines.[37, p. 67]

Vanderheiden cited as examples a program providing voice output of the display, a voice entry terminal, and the Adaptive Firmware Card,[31] which allows control of the Apple computer by devices such as single and dual switch Morse code, timed scanning, stepped scanning, expanded keyboard, and game paddle.

Other adaptive devices discussed in the literature are described in Figure 1. For clarity of presentation, the devices have been classified based on the type of physical impairment (motor, visual, or hearing) for which the device would be most useful. The lack of technical data presented in most documents represented in the literature does not allow for classification according to Vanderheiden's schema. It should be noted that this review focuses on selected references that pertain only to adaptive devices to provide access to computers, not on all adaptive devices.

Classification of Adaptive Devices

Two major classification systems for adaptive devices have appeared in the literature. Crimando and Godley[5] categorized devices on the basis of type of impairment, while Vanderheiden[37] presented a schema based on type of system, as discussed previously. Although these classifications are useful in understanding types of devices available, a schema based on functional limitations would be more useful to the practitioner assisting a disabled person in obtaining the most appropriate device(s). For example, in working with a person who has limited finger/hand strength and mobility, the practitioner needs information on devices to remediate these deficits, not on all devices related to motor impairments. The Job Related Physical Capacities (JRPC) project in Florida is attempting to classify adaptive devices in this manner. Szeto, Tingle, and Cronk[35] describe another project, Automated Retrieval of Information on Assistive Devices (ARIAD), which has used a simple functional classification to match adaptive devices with the disabled person's needs.

Conclusions and Recommendations

As demonstrated in this article, an abundance of adaptive devices to provide disabled persons access to computers currently exists. Individuals with the most

FIGURE 1. Adaptive Devices

Description of Device	Name of Device (if available)	Reference
Motor Impairment		
1. Remote keyboards with special features: latching switches for SHIFT, CONTROL, and REPEAT; keyguard; control by joystick or two push buttons		Graystone (1982)
2. Expanded keyboard		Graystone (1982)
3. Magnetic sensitive keyboard with magnetic pointer		Desch (1984)
4. Keyboards with 14 buttons and with 4 buttons		LeCavalier, Vaughan, and Wimp (1982)
5. System for variation in speed or direction (proportional control) of marker for scanning computer screen; input by lighted pointers, joysticks, or pneumatic controls operated by bending finger, pressing wrist on a surface, or sip and puff	PACE	Gaddis (1982)
6. Voice entry system for educational settings	VBLS	Horn and Scott (1979)
7. Voice entry to compose, edit, and print written material	TEXTWRITER	Serota (1984)
8. System to provide control of computer by optical head pointer, manual pointer, or rocking lever	EXPRESS Series	Taber (1981)
9. Other input devices: a. head-operated joysticks b. flat pressure plates, game paddles, leafswitches c. voice activation, Morse Code, chin and foot controls		Desch (1984) LeCavalier et al (1982) Rizer (1984)
Visual Impairment		
1. Word processing program allowing voice output of a character, a word, or whole file	BRAILLE-EDIT	Holladay (1984)
2. Voice output of screen display	Text Talker	Moyles and Newell (1982)
3. Portable machine types, displays, and stores Braille on cassette tapes; runs a printer, acts as microcomputer terminal, or accesses a mainframe computer	Versa Braille	Moore (1984)
Hearing Impairment		
1. Audio device connected to Phonic Ear microphone		Dugdale and Vogel (1978)
2. Flashing light to signal computer detection of touch on screen		Dugdale and Vogel (1978)

severe motor and sensory disabilities are able to operate computers using available technology. However, access to computer technology is still limited for many persons with disabilities; a number of obstacles to complete access (e.g., consumer and professional attitudes and difficulties in obtaining information on available devices) remain. Rehabilitation professionals have a responsibility to join with disabled consumers to focus advocacy efforts on the provision of access to the world of technology. Without this access, integration into society as fully functioning members will be difficult or perhaps impossible for many persons with disabilities.

With the goal of enhancing access to technology, the following recommendations for practice and research are offered:

1. Developers of adaptive devices should expand their use of a central clearinghouse, such as ABLEDATA,[22] to collect and disseminate information about adaptive devices.
2. Consumers as well as professionals should have direct access to information clearinghouses such as ABLEDATA.
3. Clearinghouses should categorize information about adaptive devices on the basis of the func-

tional limitations for which the devices would be appropriate. This would enable consumers and professionals to obtain information on the adaptive devices most pertinent to their situations.

4. Research should be conducted to identify adaptive devices that provide access to computers for 75 percent of the disabled population.
5. The adaptive devices which provide access to computers for 75 percent of the disabled population should be available for use in educational and agency settings that provide services to disabled persons.[22]
6. To increase acceptance of adaptive devices by disabled persons, multimedia training materials should be developed to educate disabled persons about the use of adaptive devices. Suggested topics to be included are expectations about the capabilities of technology, issues related to the use of technology, misconceptions regarding the use of technology, and role modeling of the use of adaptive devices.
7. Training (preservice and inservice) for rehabilitation professionals should be developed to inform them of the types, availability, and potential use of adaptive devices.
8. Research and development of adaptive devices should continue so that as technology improves, the improvements will be incorporated into the utilization of adaptive devices.
9. Development of adaptive devices should be based on the needs of disabled consumers. A potential model that ensures consideration of consumer needs is provided by Behrmann and Lahm.[2]
10. Rehabilitation professionals should enhance employers' awareness of adaptive devices and their role in the work setting.

List of References

1. Architectural and Transportation Barriers Compliance Board. *Resource Guide to Literature on Barrier-Free Environments with Selected Annotations.* Washington, D.C.: ATBCB, 1977.

2. Behrmann, M. M., and Lahm, E. A. But It Will Be Obsolete Tomorrow: Evaluating Ultimate Needs of Users vs. The Capabilities of Devices. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

3. Bolton, B. *Rehabilitation Counseling Research.* Baltimore, Md.: University Park Press, 1979.

4. Botterbusch, K. F. Computers and Vocational Evaluation. *Voc. Eval. & Work Adjustment Bul.* 1983. 16:79-81.

5. Crimando, W., and Godley, S. H. Use of Computers in Expanding the Employment Opportunities of Persons with Disabilities. *Rehab. Research Review.* Washington, D.C.: The National Rehab. Information Center, 1984.

6. DeLoach, C., and Greer, B. G. *Adjustment to Severe Physical Disability.* New York: McGraw-Hill, 1981.

7. Desch, L. W. Adapting Computer Equipment for Handicapped Children: A Review of Current Strategies and a Report of a Project. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

8. De Witt, J. C. Computers for the Disabled: A Contradiction in Terms? In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

9. Dugdale, S., and Vogel, P. Computer-Based Instruction for Hearing-Impaired Children in the Classroom. *Am. Annals of the Deaf.* Oct., 1978. 730-743.

10. Fenderson, D. A. High Tech/High Touch: Making Good on the Promise. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

11. Gaddis, E. Proportional Computer Interface Increases Speed of Nonvocal Communication. In: *The IEEE Computer Society Workshop on Computing to Aid the Handicapped. Proceedings.* Silver Springs, Md.: IEEE Computer Society Press, 1982.

12. Graystone, P. Special Computer Interfaces for the Vocational Rehabilitation of the Severely Disabled. In: *The IEEE Computer Society Workshop on Computing to Aid the Handicapped. Proceedings.* Silver Springs, Md.: IEEE Computer Society Press, 1982.

13. Growick, B. Computers in Vocational Rehabilitation: Current Trends and Future Applications. *Rehab. Research Review.* Washington, D.C.: The National Rehab. Information Center, 1983.

14. Gunderson, J.; Kelso, D.; and Vanderheiden, G. A Multifunction Alternative Computer "Keyboard" for the Physically Handicapped Using Headpointing Techniques. In: *The IEEE Computer Society Workshop on Computing to Aid the Handicapped. Proceedings.* Silver Springs, Md.: IEEE Computer Society Press, 1982.

15. Gunderson, J., and Vanderheiden, G. Direct Optical Headpointing Input to Standard Computers Using a TV Screen Based Keyboard. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

16. Hallet, P. A Coordinated System Approach. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

17. Holladay, D. An Electronic Blackboard for a Blind Teacher. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie,

Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

18. Horn, C. E., and Scott, B. L. *Micro-Based Speech Recognition: Instructional Innovation for Handicapped Learners.* Columbus, Ohio: The Ohio State University, ERIC Clearinghouse on Adult, Career, and Vocational Education *(ERIC Document Reproduction Service No. ED 231146),* 1979.

19. LeCavalier, D.; Vaughan, S.; and Wimp, M. Putting Microcomputer Technology to Work for Our Hearing Impaired Students. *Am. Annals of the Deaf.* Sept., 1982. 512-521.

20. McDaniel, J. W. *Physical Disability and Human Behavior* (2nd ed.). New York: Pergamon Press, 1976.

21. McKinlay, B. Standards of Quality in Systems of Career Information. *J. Counseling & Development.* 1984. 63:149-152.

22. McMahon, B. T.; Burkhead, E. J.; and Sampson, J. P., Jr. Computer Access and Applications to Career Counseling with Vocational Rehabilitation Clients. *Rehab. Research Review.* Washington, D.C.: D:ATA Institute, 1985.

23. Miller, D. H. Uncomplicating Software Acquisition. In: W. Herrick et al, (eds.), *Computer Assisted Rehabilitation Service Delivery.* Dunbar, W.V.: West Virginia Research and Training Center, 1981.

24. Moore, M. W. Versabraille Applications in Education. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

25. Moyles, L. C., and Newell, J. Microcomputers in a Postsecondary Curriculum. *Academic Therapy.* 1982. 18:149-155.

26. Papert, S. A. *Information Prosthetics for the Handicapped.* Cambridge, Mass.: Massachusetts Inst. of Technology, 1981.

27. Park, G.; Nelson, J.; Korba, L.; and Crabtree, E. National Research Council of Canada's "MOD" Interface System. In: *The IEEE Computer Society Workshop on Computing to Aid the Handicapped. Proceedings.* Silver Springs, Md.: IEEE Computer Society Press, 1982.

28. Rizer, B. Applications of Microcomputer Technology in a Comprehensive Rehabilitation Center. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

29. Sampson, J. P., Jr. Maximizing the Effectiveness of Computer Applications in Counseling and Human Development. The Role of Research and Implementation Strategies. *J. Counseling & Development.* 1984. 63:189-191.

30. Sampson, J. P., Jr., and Pyle, K. R. Ethical Issues Involved with the Use of Computer-Assisted Counseling, Testing, and Guidance Systems. *Personnel & Guidance J.* 1983. 61:283-287.

31. Schwedjda, P., and Vanderheiden, G. C. Adaptive Firmware Card for the Apple II. *Byte.* Sept., 1982.

32. Serota, T. S. A Voice Controlled Personal Computer System with Word Processing Capabilities for the Severely Physically Handicapped. In: J. E. Roehl (ed.), *Proceedings of Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

33. Shontz, F. C. *The Psychological Aspects of Physical Illness and Disability.* New York: Macmillan, 1975.

34. Shworles, T. The Person with Disability and the Benefits of the Microcomputers Revolution. In: J. E. Roehl (ed.), *Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

35. Szeto, A. Y.; Tingle, L. A.; and Cronk, S. R. Automated Retrieval of Information on Assisted Devices. *Bul. Prosthetics Research.* 1981. 10:27-34.

36. Taber, F. M. The Microcomputer—Its Applicability to Special Education. *Focus On Exceptional Children.* 1981. 14:2:1-14.

37. Vanderheiden, G. C. Immediately Implementable Strategies for Providing Full Access to Microcomputers for Severely Physically Handicapped Users. In: *The IEEE Computer Society Workshop on Computing to Aid the Handicapped. Proceedings.* Silver Springs, Md.: IEEE Computer Society Press, 1982.

38. Vanderheiden, G. C. Curbcuts and Computers: Providing Access to Computers and Information Systems for Disabled Individuals. In: J. E. Roehl (ed.), *Discovery '83: Computers for the Disabled.* Menomonie, Wis.: Materials Development Center, Stout Vocational Rehab. Inst., Univ. of Wisconsin, 1984.

39. Wright, B. A. *Physical Disability—A Psychosocial Approach.* 2nd ed. New York: Harper & Row, 1983.

40. Wright, G. N. *Total Rehabilitation.* Boston, Mass.: Little, Brown & Co., 1980.