

An Editorial

The Practical Use of Microcomputers in Rehabilitation^a

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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.

There are at present some well-thought-out and well executed programs and adaptations available, and a much larger number of new ideas and approaches which have been demonstrated and are under development. A recent contest implemented by Johns Hopkins University (under the sponsorship of NSF and Radio Shack) brought together a very interesting and impressive collection of such programs and adaptations. This work has only begun to scratch the surface of what is possible with this new and very powerful tool which is being made available to the rehabilitation process.

Like many new tools, however, the microcomputer's potential is in many ways over-estimated and its application over-simplified. The over-estimating 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, etc.) 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.

Potentials of Microcomputers in Rehabilitation

Microcomputers and electronics in general have enabled the creation of a whole new category of assistive devices for handicapped individuals. These include special sensory aids as well as communication and control aids. In addition, they have extended or enhanced other areas of rehabilitation, such as mobility and prosthetics/orthotics. The major contribution of microcomputers

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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 new tools.

Another way that microcomputers are facilitating the rehabilitation of handicapped individuals comes from the role that they are playing in the life of the nonhandicapped individual. As microcomputers are pervading the normal educational and work situations, they are causing more and more information and work stations to be electronically oriented. For motion or sensory impaired individuals, this change can be a tremendous benefit. For motion impaired individuals, it is good because it can reduce the amount of paperwork or physical manipulations which they would ordinarily have to do. Having their own specially designed or modified or interfaced terminal (which requires only eye motion, for example), they could access all of the information that their nonhandicapped colleagues access. Visually impaired individuals could also access the same information, but instead of using a terminal with a visible TV screen, they would use a terminal with a "talking screen" or electronic Braille display. Greater reliance by society on electronic media and information systems will further assist these populations, as well as home-bound and other mobility-impaired individuals who may no longer need travel every day in order to function productively.

Another place where microcomputers might provide a totally new capability not previously possible is in the area of intelligent prostheses which actually seek to offset the information processing difficulties of handicapped individuals. This could include aids which serve as artificial intelligence for mentally retarded individuals, as well as aids which serve as artificial language processors for language-impaired

individuals (such as individuals with aphasia). At the present time, research in these areas is somewhere between very preliminary and non-existent. The problems which must be overcome in order to produce a useful prosthesis in this area are enormous, and it is likely to be some time before significant practical aids are available. The solutions will probably have to wait for the development of more powerful computers and computing techniques. The principal barriers, however, are probably going to lie in the development of a better understanding of exactly how our brain processes information, and exactly where these processes have broken down for individuals with various types of disabilities.

Barriers Needing Research

Some of the barriers to better realization of the potentials of microcomputers in rehabilitation can be addressed at the present time. Others appear to be beyond our current reach. Some of the areas that are in need of research are:

1. Access to Standard Software—Most of the software which is usable by handicapped individuals has been either specially written or modified for them. This software, however, amounts to a very small percentage of the total volume of software available for non-handicapped individuals. While some special-function programs will still be needed for handicapped individuals, some attention needs to be turned to providing access by handicapped individuals to the vast stores of software which already exist and are constantly being created. Special techniques and strategies are going to be required if severely physically or sensorily handicapped individuals are to be able to access this pool of standard software without requiring that it be modified for them. Modification is both extremely expensive and time-consuming; if handicapped individuals must rely on modified software, they will never have more than five percent of all software available to them, and they will always be at least several years behind their nonhandicapped colleagues in education or employment.

2. Portability—This is an area which seems to be rapidly solving itself. Up to the present time, most of the microcomputers with any degree of function have been heavy stationary or workstation equipment. For individuals needing portable personal aids, these microcomputers were of limited value. Newer aids that are more portable are beginning to become available, with enough power to address some of the needs of handicapped individuals.

3. Obsolescence—In addition to providing ever-increasing potentials, the rapid developments in microcomputers have also created a very severe problem—obsolescence. It is barely possible to develop an aid before it becomes obsolete due to advancing technologies. For the regular microcomputer market, this is a problem; they must get their product up and out very quickly, and depend upon a quick mass sale and application to cover their costs and provide them with profit. In the area of handicapped individuals, the problem is more severe. Due to the much poorer information "grapevine" and the much smaller market, it is very difficult to sell enough copies of any particular software or hardware modification to a microcomputer to cover the development costs. The rather short lifetime of developments, due to advancing technologies, makes this problem very acute.

One approach to the problem is to try to develop a more modular approach in order to allow the overall solution to be somewhat independent of the actual microprocessor used. An analogy would be a hobbyist who buys a separate computer, printer, TV display, etc. With advancing technologies, he can then replace his CPU but continue to use his old printer, TV display, etc. as long as they are compatible. Within the field of aids for handicapped individuals, it may be possible to develop a standard Braille display or "talking video screen" in such a way that it could be moved from computer to computer without requiring re-design. In this fashion, the rehabilitation community would only need to design that portion of the system which did not already exist on the standard market, thus minimizing the cost of the original system. Furthermore, by carefully modularizing the system, the standard components themselves could be updated regularly to match advancing technologies without requiring that the individual continually buy new "special handicapped interfaces" to match each new system.

4. High Application vs. Low Parts Cost—With the decreasing cost of the hardware, a new problem may surface. In the application of rehabilitation aids, the cost of the hardware is often small compared to the cost to apply. With more expensive rehabilitation aids, the cost for applying, fitting, etc., could be included in the price of the aid. But as the aids come to be constructed around standard microcomputers (which the individual may want to buy on the bargain market), the rehabilitation aid suppliers may be left supplying only modifications and software, which do not amount to much in total dollars. As a result, they may have no cost base on which to

cover their application costs. The result could be either very poor service on the part of rehabilitation aid suppliers, or the lack of development and dissemination of many aids which are possible, due to the difficulties which the suppliers will have in covering their application costs and customer questions.

5. Research on the Problem Rather Than Solutions—At the present time, much of the research seems to be directed toward finding solutions to problems rather than trying to define the problems better. In many cases, it may be more appropriate to spend the effort on defining the real needs, determining what is required to solve these needs, and then determining when these necessary components will probably be available. Often, extensive amounts of money are being spent to develop a custom solution to a problem which will almost certainly be solved in the near future by the general trend of technical development. For example, a large amount of money could be spent at the present time on a special voice recognition aid for deaf individuals, which would allow them to carry a device which would correctly translate speech into visible text. Such a device sounds like a worthy endeavor, and, if it looks possible, might constitute an eminently fundable research effort. On the other hand, a device which could translate speech into text would have a natural market totally independent of the handicapped market. As such, it is likely to be developed in the near future anyway — without wasting precious rehabilitation research dollars on the effort. Moreover, it is likely to be available more cheaply when it is developed and made available for mass marketing by office products firms.

With the extremely rapid development of new technologies, it is becoming more and more important to direct greater efforts toward defining the problems of handicapped individuals and laying long-term plans for their amelioration, rather than continuing to jump at short-range possibilities which keep appearing before us on the horizon.

Other Barriers Needing Action

In addition to the research efforts discussed above, there are a number of other areas which need attention.

1. Duplicated Effort—At the present time, the field of microcomputers for rehabilitation is a very diverse and uncoordinated field. There is almost no continuing exchange of information or truly central information source. Almost all good ideas have

been implemented in two or three different places in almost exactly the same form. Rather than having work build upon the work of others, much of the work which has been done simply parallels other work and perhaps repeats the same mistakes. Much better information exchange systems need to be provided in order to help eliminate duplicated effort and allow researchers to build upon the work of others.

2. Poor Work Mixed with Good—From the handicapped individual's point of view, one very difficult problem is trying to sort out the good developments, software, and hardware modifications, from the poor. Reading a description of the software usually provides very little information as to the quality or effectiveness of the software. There is a great need for some type of evaluation and classification of the available software and hardware modifications to provide guidance to parents, handicapped individuals, and professional rehabilitation personnel involved in the selection and delivery of specialized systems for handicapped individuals.

Continuing Problem Areas

In addition to the above areas which can be and in some cases are being addressed, there are a number of problem areas which this field shares in common with many of the technological fields. These areas need attention, but will probably continue to be problem areas for some time to come.

1. View of Technology as a Cure—People often have totally unrealistic expectations for technology. Microcomputers are hailed for their tremendous capabilities, often obscuring the complexities of the problems that are faced by handicapped individuals. The problem therefore isn't that the microcomputers are not powerful and flexible tools, but rather that the problems faced by handicapped individuals are much more complex than readily meets the eye. As a result, the individuals securing microcomputers often have totally unrealistic expectations as to what the aids will be able to do. They often assume that the microcomputers will cause the handicapped individual's problems to disappear. This can lead to inappropriate application of microcomputers, inadequate application of microcomputers, and eventually to backlash by misinformed rehabilitation personnel and funding agencies when the aids do not perform the desired cures.

2. View of the Microcomputer as a Toy—Because of the heavy use of microcomputers by hobbyists, and

their obvious capabilities of functioning as very sophisticated toys, there is often a tendency by funding agencies to refuse to consider them as valid rehabilitation tools. In many cases, it is possible to secure a \$4,000 custom-designed aid for a handicapped individual, while it is not possible to secure a \$1,500 microcomputer system which would provide much more function for the individual — simply because the agency "isn't in the business of buying toys for handicapped individuals."

3. Lack of a Good Application/Delivery System for Technical Aids in General, and Microcomputers in Particular—The problem cited immediately above (microcomputers as toys) is aggravated by the fact that there is essentially no good service delivery mechanism in this area. Funding agencies would be more inclined to provide funding for microcomputers if they had a higher confidence that the aids were, in fact, both necessary and sufficient. With the current recommendations coming from almost every source, and without there being any system for verifying the expertise of the prescribers in dealing with (i) technology, (ii) handicapped individuals, and (iii) the application of technology to the problems of handicapped individuals, it is unlikely that the funding agencies will be easily convinced to spend large amounts of money on the purchase of microcomputers for these individuals. More importantly, without the development of a good service delivery mechanism with individuals trained in this specific area, it is unlikely that appropriate aids would be selected, and that they would be supported with the necessary other components of the rehabilitation process.

Summary

The entire area of microcomputers and their application for handicapped individuals is a relatively new one, and one with a tremendous potential. Because the nature of the tools which are becoming available to us is changing so rapidly, it is very difficult for us to comprehend clearly the entire impact that the microcomputers will have. In addition to allowing us to develop much less expensive and much more powerful personal aids for handicapped individuals, we are also seeing the advent of microcomputers changing the general society in a way which is tending to make it more accessible to handicapped individuals. Office systems which used to be very paper-oriented are becoming more and more electronics-oriented. For physically handicapped individuals who are unable to work with paper this can be a tremendous advantage. Also, as more and

more information becomes available in electronic form, it is easier to transfer it into tactile form, for those who are visually impaired. Similarly, advances in technology are making it easier for deaf individuals by making more and more information available in text form. With the advent of the typewriter which can print out what a person is saying (an advent which appears to be just over the horizon), deaf individuals may be able to get direct and immediate translation of speech into a form which they can readily handle. As banking and shopping systems also go electronic, additional barriers to self-support and independent living by physically handicapped individuals will be further reduced.

Although technical barriers to the incorporation of microcomputers into personal aids will always exist, they are continually being broken down by the rapid advances in technology. The more important barriers in this area are not technical barriers, but barriers to the successful utilization and application of these technologies. The primary problems are centered around the problem of identifying good applications of technology from mediocre or poor applications. There is also a tremendous weakness in terms of the actual application of these technologies within overall rehabilitation programs. Much more effort needs to be directed toward understanding the appropriate and inappropriate application of these technologies, and toward identifying the other components of the rehabilitation program which must be in place, along with the technology, if it is to be truly effective. ■