COMPUTERIZED CONFERENCING E- COMMUNICATIONS CENTER

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NEW JERSEY INSTITUTE OF TECHNOLOGY

COMPUTERIZED CONFERENCING AND THE HOMEBOUND HANDICAPPED

By

MURRAY TUROFF AND HOWARD GAGE

RESEARCH REPORT NUMBER 6

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ABSTRACT

Computer conferencing is a relatively new technique which can be applied to improve both the efficiency of education, and communication services available to the homebound handicapped. A system is currently being implemented at the New Jersey Institute of Technology which allows such individuals to engage in a written form of conversation with other individuals or groups. Here the computer stores the discussion and keeps track of what everyone has or has not seen, so participants can communicate at a time and pace of their choosing. There is also provision for a range of ancillary facilities such as voting, word processing, speedwriting, annonymity and personal notebooks not attainable through other communications media.

One extremely important potential use of such a system is for those who are handicapped and/or mobility limited such as the aged. In this context, a host of new educational, rehabilitation and employment opportunities now become feasible. Among these are:

- More effective tutoring for homebound youngsters by establishment of class-like environments.
- 2. More immediate and responsive training and rehabilitation programs for recently handicapped adults.
- 3. A wider range of psychological and social services available per person without augmenting professional staff.

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- 4. The availability of new job opportunities for the homebound made possible by the growth of commercial computer systems.
- 5. Utilization of the elderly as counsellors, confidants or pseudo-grandparents for homebound youngsters.
- 6. Expanded wide area peer group communication channels to help break down the psychological effects of isolation.
- An improved state of dignity and self-development for the individual.

The system is composed of a central processing unit (the computer and its memory storage banks) and a variable number of home use terminals. These stations consist of an ordinary telephone, on interface device where necessary, and a microprocessor. The first two items are standardly available, while fabrication of the third has already begun. Costs of such a system, although initially high, are expected to decline significantly in the near future. Furthermore, it is anticipated that a net cost-benefit gain can be demonstrated after all aspects of service delivery comparison have been made between the new approach and current methodology.

Introduction

Computer conferencing is a relatively new area of applications for computer and information systems involving the use

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of the computer as a direct aid to the communication process between human beings. This process replaces the verbal conference telephone call or face to face meeting with a written meeting in which people at different geographic locations converse or interact by typing their questions, answers or comments, or read the corresponding inputs of others from a typewriterlike computer terminal. The process not only allows geographic dispersion of the group, but also permits each member to engage in the discussion at times convenient to him, and at a rate of interaction of his choice. This form of communication breaks the coincident time barrier imposed by the telephone and the sequential one-at-a-time restriction of verbal communication. The computer records and stores the inputs of each individual until they are needed or requested by other members of the group. Providing humans the ability to communicate through a computer brings the machine's logical processing capabilities under their control. Therefore, one can tailor the features of such a system to be responsible to the specific problem area faced by the communicating group as, for instance, a group of handicapped children.

The inherent ability of asynchronous participation by members of a compurerized conference means that no one has to be delayed while one person is composing and editing his or her message or comment. It also means each individual may take as much time as needed to comprehend or reflect on what others

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have said. This "self-activation" form of communication would be particularly significant for a group comprised of individuals who are handicapped and who may require significant intervals of time in composing or examining comments

Although computer conferencing techniques can be modified to provide new opportunities for regular dialogue among all kinds of users, two significant problems must first be overcome before use by the homebound handicapped become feasible.

- Costs of individual terminals and interface devices must be kept within a range affordable by persons with limited resources and little or no outside support.
- 2. All interface devices must be rugged, highly versatile and contain a coding system which is relatively easy to master.

The current cost of these terminals can range from \$1,000 per unit for a deaf person to \$8,000 per unit for a quadruple amputee. Such costs are too high even for government supported activities. However, the cost of similar equipment in the computer field is declining at a rapid rate, and some sources anticipate as much as a 67% decline over the next decade (Turoff)¹³. Research efforts in the design and applicability of such interface systems are being pressed. These will spur production, and favor the introduction of high volume techniques to accelerate further the downward cost trend. Although the current costs of such installations is undoubtedly high, averaging \$6,000 per student, this figure

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is not excessive when judged against an equivalent service Neither is it unreasonable when compared to the societal scale. cost of a handicapped adult who is unable to realize his full potential because of educational limitations. Telephone communication networks are already in place; computer memory space and communication time can be made available at a nominal rate estimated at no more than two dollars per hour utilizing current technology for large scale systems (Turoff)¹³. Finally, work has already begun on fabricating a number of breadboard model devices at NJIT which would allow interfacing between typing devices already available and computer terminals. These modules provide for typing inputs by many different types of handicapped into computer terminals.

It is anticipated that within a decade, costs will be reduced to a level to make practical the installation of wide scale systems to service the educational and communication needs of hundreds of individuals. These include not only homebound handicapped children during their schooling years, but also populations of adult handicapped whose rehabilitation could strongly benefit from similar programs. Such individuals could even eventually be trained for home jobs involving the use of their personal terminals (such as remote process monitoring) which could add immeasurably to their self-esteem and value to society. Therefore, despite the apparently high initial costs, experimentation is necessary now to develop the concept so that specifications for the system's design will be ready once wide

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scale implementation becomes economically feasible. This approach will assure the system's availability as costs become more competitive.

Background

Computers have been used for over a decade in the classification and education of both mentally and physically handicapped children. The majority of such applications have centered on computer aided instruction (CAI).

In CAI, the machine's chief advantages of personal selfpacing, more direct and unambiguous S-R cueing, provisions for instantaneous feedback or knowledge of results, and allowance for infinite repetition are ideal for children with severe learning disabilities. In addition, computers have proven to be a valuable screening tool for both exceptional and "normal" children. Here they serve to identify the extent of any learning disability and where necessary, help in fashioning individualized curricula (Hall⁴, Cartwright¹). Past work has emphasized reading programs for the mentally retarded (Peterson)¹² and the development and management of special instructional materials and techniques (Eisels)³.

A large majority of the previous work in programmed instruction has concentrated on the teaching of verbal skills to the deaf, but nonverbal autistic children have also benefited (Colby)² and mathematical skills too have been sharpened after the necessary language prerequisites were mastered. The most

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successful programs for the deaf utilized various Edison Responsive Environment instruments, such as the talking typewriter, talking page and voice mirror. Many factors are responsible for the success attained. Thompson¹² maintains that computer usage helps to increase a child's span of attention and heightens the enthusiasm shown towards his teacher, whom the machine does not replace, but merely supplements. The widest application of computers to date was done by Sandals¹¹ who successfully used individual terminals to aid in several diverse phases of learning including drill and practice, tutorials and simulation.

Scope of the Problem

Any initial demonstration project must be conducted on a local level even if it has important national implications. New Jersey's problems in educating its homebound handicapped children are virtually no different from those of any other state. If anything, they are less severe. Because of the relatively high population density in this state, distances traveled by special tutors are considerably less than in the western United States, for example, significantly decreasing one important cost factor.

The scope of this problem is very extensive. Over 9,000 children received some form of special instruction in the 1973-1974 school year in New Jersey alone. Costs for these services vary widely, but average seven dollars per hour with a typical

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student receiving 105 hours of instruction annually⁷. However, these figures include both temporary and full-time homebound children. The typical permanently handicapped child receives an average of five hours of instruction per week. Although this is on an individualized basis, it represents no more than 15% of the exposure of children attending regular schools. Such limited learning experience practically insures that these children will fall behind in their educational progress, and thus restricts future career opportunities even if their disability is purely physical. The key to widening their horizons is presently strictly financial as it is thought to rely solely on the number of hours of individual instruction available.

It is difficult to compile national figures regarding current educational costs for homebound children as state by state criteria vary somewhat. However, estimates in the neighborhood of from 70 to 100 million dollars per annum can be considered reasonable. The total number of specially trained instructors qualified to tutor the 100,000 permanently homebound handicapped in the United States was estimated at 60,000 in 1965 (Weber)¹⁷. As a statistical rule, there are usually two temporarily disabled children confined at home for each one permanently incapacitated. One direct way to increase the effectiveness of tutors already practicing is by supplementing their face to face student visits with an educational program which embodies computer conferencing. The typical homebound student receives five hours of direct instruction per week which is implicitly assumed to be equivalent

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to a full week of normal exposure in group classes (30 hours). With a computer conference class, a student could be provided two hours per week of direct one-to-one contact which is the legal minimum according to New Jersey's Education Laws^{8,9}. His total instructional time, however, could be supplemented by many hours of indirect computer work. For example, as the same number of tutoring man-hours utilized to provide five hours could now provide 47 hours of instruction to a "class" of ten joined via a computerized conferencing network. This change would significantly increase the number of students each teacher could handle and thus radically improve system cost effectiveness. Figure 1 clearly shows this increase in teacher effectiveness; its derivation is explained in the Appendix. More than one teacher can now be made available for each student allowing for some degree of specialization which becomes increasingly important at the junior high and high school levels.

But both the educational and economic effectiveness of any such fundamental changes must be clearly demonstrated on a local scale before any nationwide programs can even be proposed.

Each handicapped individual who does not successfully overcome his disability to the extent of being unable to gain employment or self sufficiency, becomes a long-term cost that society eventually must bear. Lifetime residential costs are on the order of \$300,000 per patient. This dependency often

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results not from the severity of the handicap, but from a lack of proper education and opportunity, and from the psychological problems brought about by the isolation often imposed on those who are handicapped. It is believed that this isolation also directly hampers their education. The inability to interact and communicate with similarly afflicated peers is nearly absolute. Most handicaps create disturbances to all three aspects of function - cognitive, affective and conative, and programs beneficial in one area often result in theraupeutic improvements in the other two. For example, groups such as Alcoholics Anonymous suffering from mental and physiological problems have found regular peer group communication to be of tremendous psychological benefit. This technique helps participants by showing that problems, attitudes and adjustments are not unique, but have already been faced and overcome by others in similar circumstances. Yet, this avenue of assistance has rarely been applied to the homebound physically handicapped.

The traditional one-to-one relationship in special education can be considered similarly restrictive. True, each student possesses a combination of factors which makes him virtually unique, but from this set, a philosophy has evolved which provides support for research and development in education of the handicapped by focusing on narrowly oriented problem areas, rather than a broad systems approach. While such an

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orientation is often appropriate because of its personal nature the more unified systems approach advocated here would allow for education of interactive subpopulations of handicapped helping them to become more functional in society.

Large student populations must be available in order to match up relatively homogeneous student groups into classes. These usually cover broad geographic areas for the handicapped and thus have rarely ever been formed. Small group therapy sessions such as those set up at hospitals or rehabilitation centers are of necessity quite diversified because of the variety of disabilities, ages and backgrounds they include. The conference telephone call was thought to offer an approach towards solving this problem, but several obstacles have prevented this technique from gaining wide acceptance. For instance, barriers such as high costs and sequential inputs may be surmountable, but it should be remembered that many of the potential users also have significant speech disabilities which make oral communications slow and/or difficult. Also, the need for time coincidence of the conferees severely restricts interaction possibilities. Others have pointed to closed circuit or cable television networks as the best means of overcoming the extreme isolation endured by these persons. This approach however, is limited by the lack of private network facilities in many geographic areas and the significant expense involved in establishing such access. Computer conferencing on the

other hand, requires only a second commercial telephone, an electric typewriter and a semicustom interface terminal. Finally, the limited speed of input (typing) in no way hinders communication between class members because of the asynchronous nature of the inputs.

The computerized conferencing system undevelopment at NJIT provides in addition to group discussions, the facility for private messages, personal notebooks and a journal or newspaper for reports. This means that teachers and students may each keep personal files where they can compose material for later use such as reviewing for an examination. The tutor and students may use the private messaging for individualized instruction, or developing closer personal relationships. Finally, the newspaper-like facility provides a mechanism of making public essays and other accomplishments public to fellow students after review by tutors. Tutors may also have their own private conference to discuss particular problems and approaches.

An Attack on the Problem

Any initial project in this area should lend itself directly towards improving the learning skills of a completely homogeneous group of students such as the deaf. Such children would require no special hardware, only the ability to type. For them, the electric typewriter represents the standard

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interface device and it could easily be demonstrated if the use of computer conferencing accelerates learning. But a majority of such children have no other handicaps and are able to travel to centrally located facilities for group instruction. These usually consist of special classes held in one or more schools within a district. New Jersey has only one residential school for the deaf, (The Katzenbach School in Trenton) which is consistently oversubscribed with admission subject to a long waiting list. Any results obtained solely with the deaf would have neither the impact nor the cost savings of similar results obtained with physically handicapped homebound youngsters.

However, it is widely recognized that young deaf children do have difficulties in appreciating the benefits of the written word. This lack in turn leads to a diminished motivation with the result that many deaf adults have little writing ability. One wonders if computerized conferencing might not have a dramatic effect on altering how deaf youngsters view the written word and eventually improving their ability to master such communication. For the homebound, specific interface devices have yet to be developed on a commercial scale. In the interests of scientifically controlling any initial evaluation of the system, the test sample should be restricted to children with specific illnesses, or those with common, well-defined residual functions. Only by this approach can any significant improvement in learning rates, or cost savings (or both) be clearly attributable to the effects of computerized conferencing.

In addition, simply providing such children with an outlet through which they can communicate with other similarly afflicted youngsters can constitute an important secondary benefit. Among all children, learning leans heavily on motivation which in turn relies on peer competition. The homebound handicapped who receive special one-to-one tutoring are totally deprived of such competition, which may seriously restrict their rate of educational progress. Their computer terminal represents a link to the outside world whose use is not restricted exclusively to learning situations; but could also be used for more general peer group communications. As such, it can help to boost morale and break down the severe isolation suffered by these children by encouraging their interaction with others who face similar problems and restrictions. In addition to communication via their computer terminals, students will also be able to speak among themselves via conventional telephone lines. Costs here are minimal since wide area telephone service can be secured.

Furthermore, one can not detect through computerized conferencing the difference between a handicapped and nonhandicapped child. The nature of the communications format used is totally blind in this respect. Therefore, children who would

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normally feel embarassed by their disability could be freed of such inhibitions.

Emphasis in early studies should be placed on improving reading comprehension skills. This is both a general problem area and one which can be directly affected by the introduction of computer conferencing. Mathematical skills may also be noticeably improved by this approach, but programs in this area bring into play more specialized aspects of computer aided instruction requiring revised curricula and instructional materials. A great deal of development has already taken place in the field of CAI which can be directly incorporated into a computer conferencing system. There are two general philosophies in CAI -- one embodies a large system where highly trained specialists develop a series of standard lessons in great detail. An alternative approach is to prepare a local language consisting of a small number of simple, universal commands. Mastering this language will allow teachers to prepare a wide variety of instructional lessons without any special training. Several such languages already exist and have successfully been taught to children as young as age twelve who have themselves prepared lessons for their peers. additional advantage of this method is that it allows broad flexibility in tailoring lessons to meet the needs and abilities of the students. Therefore, although our initial efforts will concentrate on improving verbal skills and communications

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techniques, CAI skills such as those needed in solving mathematical problems will also be developed in subsequent studies after the conferencing technique has been successfully demonstrated. We will tend to favor the latter approach where students can be encouraged to develop lessons from one another.

The major items comprising the communications system in the home are as follows:

- 1. <u>A Cathode Ray Tube (CRT) Terminal</u> a normal keyboard with a TV-like surface exhibiting the text normally typed or sent from the computer.
- An Auxiliary Printer to produce compatible computer hard copy output for a permanent record of all transmitted material. This will be valuable for lesson review, test preparation and scoring.
- 3. <u>Alternative Devices and Keyboards</u> These include a variety of designs fabricated by Cybernetics Research Institute of Washington, D.C. which interface with a modified electric typewriter. They greatly facilitate the ability to type by persons afflicted with many different forms of physical handicap such as spasticity, muscle degeneration, partial or complete blindness, and all but total muscular paralysis.
- 4. <u>A Microprocessor</u> A very small computer used to regulate the flow of information between all the above units, and to do limited processing of the material.

We also forsee developing a speed writing capability in addition to conferencing system for a few thousand of the most frequently used words. Here, the child needs only to type an abbreviation and the computer fills in the rest. The availability of vocabulary could be regulated by the tutors and increased as the child progresses.

In addition to the features already noted, the conferencing system contains a number of unique aspects which give it exceptional flexibility and allow its use in a number of unusual communications applications. For instance, each student can maintain his own personal notebook for keeping a dated, individualized record of his progress, and for easy review for examinations. This notebook can be restricted to two or three authors as well, to allow for controlled interaction as in a joint class project. Subconferences can be arranged between coauthors and private or confidential messages can be sent between any pair of correspondents. Messages can also be screened by the instructor prior to transmission either for correction or approval before before being sent on to the rest of the class. In such a setup, student terminals are slaved to the instructor's to provide close control over student communications. Confidential voting on class projects is also possible. Finally, the system maintains time-dated footnotes, so that primacy of answers or ideas can be attributed to the proper student making impossible cribbing or pilfering of ideas.

At current commercial costs, the system represents several thousand dollars worth of off-the-shelf equipment. At first, this seems an excessive amount to be installing in one home. However, governmental studies have shown that the total cost to society of an unemployable handicapped person is in the neighborhood of \$17,000 annually. If the above equipment

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could improve the education of a handicapped child to the extent that employment becomes feasible, then the cost-benefit is obvious. In addition, if costs of such equipment are expected to continue declining significantly, making future savings highly probable.

No single communication system can accommodate the entire population of handicapped individuals. Those with severe mental retardation for example, must be excluded, at least in the early stages of system development.

One of the major problems facing designers of devices to aid the handicapped is the wide variance of residual function of each potential user. The advent of fully standardized computer conferencing terminals allows us to concentrate on customizing only the interface module. A number of such terminal devices have already been designed and built by Cybernetic Research Institute to service inputs from many diverse channels such as myographic, tongue, head nodding eye movement, fingers, toes, or other feasible sources. The complexity and cost of designing, building and servicing the remainder of the terminals the microprocessors is far less than that associated with entirely customized systems. All such terminals can be made fully compatible with the standard computer communications system. Efforts should focus on enhancing the capabilities of these devices by introducing a computer into the man-machine loop.

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In their present state, the interface devices are essentially passive since all inputs require active and sometimes complex procedures by the user. Introducing the computer into the loop will permit a fundamental reallocation of functions so that the machine can assume a greater share of communications loading. This arrangement can increase the maximum speeds attainable by handicapped typists, not only facititating communication by this mode, but also opening up many new employment opportunities.

The Population

Close coordination with both state and local education officials is essential in any such study. Handicapped children are ordinarily grouped by school district. Each school district normally has one individual who is responsible for the education of its homebound, and it is this office which represents the primary liaison. In addition, New Jersey is developing four area-wide Educational Improvement Centers, one of whose functions will be to coordinate all efforts in special or experimental educational programs. If feasible, these offices too should be consulted for aid in integrating any research efforts. Children should be selected based on the recommendations of the Child Study Team functioning in each local school district. This interdisciplinary group basically consists of a school psychologist, learning disabilities specialist and school social worker who can consult with other professionals. It is responsible for compiling development profiles for all handicapped children within their population. These profiles attempt to assess both the child's current state of educational development as well as his future potential. They are based on scores compiled from diverse standard educational measures such as: the Iowa Achievement Test, various intelligence tests (the WISC or WAIS), psychological personality indices (the MMPI for example) and tests of perceptual ability (such as the Goodenough or Frostig), and are often supplemented by personal interviews.

Selection of special tutors to work with designated children is based on a number of factors. One tutor normally services four children. In experimental studies, it is preferable to work with tutors who have had some exposure to computers in the form of computer aided instruction or otherwise, but this is not essential. In introducing computers, preference should be given to successful student-instructor relationship with interest and enthusiasm for both participants also of primary considerations.

Most importantly, both the children selected for computer communication studies and their parents or guardians must be fully instructed regarding the hardware to be placed in their homes, and the new educational techniques which compliment this system. All operating, maintenance and servicing procedures must be clearly explained and understood as early as possible. Written consent for participation should also be obtained.

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Measures to assess educational progress with computers consist of standardized reading diagnostic tests such as Metropolitan, Gates or Durrell. The specific index used should depend upon the preferences of the special education teams within the school districts affected. In addition, periodic parent conferences are vital to gather anecdotal and other background material regarding acceptance and usage of the terminals. Specifically, parental perception of how their children's education and development is altered by the introduction of the computer terminals and new communications techniques should be determined. Also, are there any changes in the child's self-image, his concept of his disability and his expectations for the future?

In short, the computer conferencing concept holds tremendous potential for bringing about a vast improvement in our ability to deal with handicapped cases which do not involve a loss of cognitive ability. The possibilities here are numerous, but several of the more important ones are noted briefly.

- 1. Obvious utility for the deaf, but special concern for its impact on young deaf children by giving them a greater incentive to master the English language in their crucial learning years.
- 2. Allowing classes or group type discussion among homebound handicapped so that tutors can supplement their face to face interaction with individuals, and deal with common problems as well.
- Utilization of volunteers for consulting and educating, especially with mobility limited elderly persons who have training in appropriate areas.

- 4. Multiplication of the therapeutic abilities of psychologists in the area of unbiased counselling. Communicating by computer masks the identities of all parties including their race, sex (if pseudonyms are used) and the presence and severity of physical handicaps.
- 5. Creation of handicapped peer groups better able to communicate from their homes, and provide mutual support to reduce feelings of isolation.
- Creation of teams of handicapped who are able to perform in a work environment on jobs restructured for a team approach.

Ultimately, the Institute's goal is to establish a system which can explore all of these related areas. However, we intend to begin with item two to prove the general effectiveness of the concept. Positive results with a limited number of handicapped children can assure support on a larger scale by the State of New Jersey and other interested parties with other groups of potential benefactors. In such follow-up studies, methods would be perfected to assure successful nationwide implementation.

Future Prospects

The typical modern organization which employs several hundred people, or does up to one million dollars worth of business per year has installed some form of computerized system, or as a minimum, uses computer services supplied by others. Today, most of the transactions in any such organization are computerized at some stage in their processing. Current developments in digital communications networks point to the liklihood that commercial computers will eventually begin to take over the entire function of transaction control. A decade from now, sales orders will be placed from a terminal and remain in electronic form at all stages as it progresses through different departments or organizations. While in principle this approach eliminates any necessity for human intervention, it will bring about the need for a new class of employee who could be designated an information monitor. He or she would play a role analogous to that of the monitor in the control room of an automated power plant. Because of the speed with which any transactional error could propagate through the organization and its effects become compounded, a large number of such monitors would be necessary to control the flow of transactions and review or verify special cases which exceeded given thresholds. This type of work requires a high school education and some basic knowledge of accounting and business procedures. More importantly, skill here is exclusively a function of one's mental abilities. Significant to our context is the fact that such jobs could be performed at computer terminals located in the home.

As more and more written material is created and stored in electronic media, a host of familiar functions and jobs become possible for the homebound handicapped through their computer terminals such as filing, record keeping, editing and the like. We are moving into an era where the average white

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collar employee will be able to accomplish fifty percent or more of his or her job at a computer terminal. This will mean that even nonhandicapped employees could spend as much as two or three days a week working at home.

Based on experience with organizations that have already utilized computerized conferencing, it is of interest to note that the annonymity through use of pen names, and the fact that sex, age and physical characteristics can not be detected has in fact produced discussions where ideas emerge independent of any bias associated with the individual who brought it up. Thus women have a fully equal opportunity in participating since their inputs are considered on precisely the same basis as their male counterparts. The same situation is expected to prevail in mixed groups of handicapped and nonhandicapped discussants.

To date, the only handicapped person who has been able to utilize computerized conferencing in his employment is a wheelchair bound scientist working in the Nonmedical Use of Drugs Directorate in Ottawa, Canada. Although quite mobile, he is prevented from commuting to work three months a year by the accumulation of snow during the winter. Not only is his wheel chair restricted by normal snowfalls, but also by the mounds created in street cleaning. The presence of a portable terminal in his home, and a working environment which encourages much regional and interoffice communication allows this individual to remain active even during the winter period.

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Those of us who have become involved with this unique method of communication believe that it is potentially the most "democratic" such medium available. It will ultimately provide a mechanism for overcoming both the psychological and sociological barriers which have curtailed meaningful communication between those segments of our society who are disabled and those who are not.

Summary

This report discusses the feasibility of applying the concept of computerized conferencing to enhance the education provided for the homebound handicapped, and their rehabilitation and potential for gainful employment. Much of the necessary hardware and software already exists in a variety of unrelated forms. Therefore, what is necessary is a concerted and integrated effort to interface these components and establish a workable system. The superiority of this system over current conventional techniques must then be proven. Although hardware costs are currently high, they have steadily been declining over the past decades and there is almost universal agreement that they will continue to decline in the future. This trend will undoubtedly make the cost of computerized conferencing competitive with the conventional approach of providing special tutors who make regular visits to the homes of a small number of children. What also remains to be proven is the educational

equivalence, or better yet, superiority of the conferencing approach and the scope of children that can be accommodated. Developing answers to these important questions must begin now with local studies. Such studies are needed to demonstrate the efficacy of the system, develop standard curricula and instructional techniques, and generally shake down and prove out the system. Only by such a step by step approach can maximal educational benefits be realized when costs become sufficiently competitive to permit broader implementation.

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APPENDIX

HOW COMPUTER CONFERENCING CAN IMPROVE SERVICE

DELIVERY AND STAFF UTILIZATION

Given: n Tutors for m pupils. Let x = number of hours of personal instruction per week, and y = number of hours of group instruction per week given to a class of size n_c. If T_p = total hours spent per week per pupil, and T_t = total hours spent per tutor - including

all nonteaching activities,

Then:
$$T_p = x + y$$
 (1)

Assuming that 50% of a tutor's time is spent in noneducationas activities, then:

$$T_t - 1.5 \times \frac{m}{n} = y'$$
 (2)

where y' is the number of hours remaining to teach a class - of size n

The number of hours available for group instruction is then ny' which is expressed as:

$$ny' = y \frac{m}{n_c}$$
(3)

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From (1),
$$y = \frac{T}{p} - x$$
 (4)

From (2) & (3),
$$y' = {}^{T}t - 1.5 \times \frac{m}{n} = \frac{y}{n} \frac{m}{n_{c}}$$
 (5)

Combining (4) & (5):

$$T_t - 1.5 \times \frac{m}{n} = \frac{\left(\frac{T_p - x}{n}\right)}{n} \frac{m}{n}c$$
(6)

Rearranging Terms:

$$\frac{T_{t}n}{m} - 1.5 x + \frac{x}{n_{c}} = \frac{T_{p}}{n_{c}}$$
(7)

Simplifying:

$$\frac{T_{t} n_{c} n}{m} - x (1.5 n_{c} - 1) = T_{p}$$
 (8)

Currently:

$$\frac{m}{n} = \frac{4}{1} \qquad T_t = 30 \quad \frac{hours}{week} \quad x = 2 \qquad \begin{array}{c} \text{minimum} \\ \text{required} \\ hours \end{array}$$

Substituting in (8):

$$\frac{4.5 n + 2 = T}{p}$$
(9)

From the curve (figure 1) it is seen that a class size of only six will have 29 hours of group instruction available, which is essentially equivalent to regular school attendance. Alternately, the situation can be viewed as follows, assuming a new situation with two hours of personal instruction and ten hours of computerized class instruction, what is the increased number of students each tutor can handle?

Recalling equation (8):
$$\frac{T_t n_c n}{m} - x (1.5 n_c - 1) = T_p$$

In the old situation,
$$\frac{m}{n} = 4 x_{old} = 5 T_p = 5$$

In the new situation,
$$x_{new} = 2 T_p new = 10 + 2 = 12$$

Substituting the new values in (8)

$$30 n_{c} \left(\frac{n}{m}\right)_{new} - 2 (1.5 n_{c} - 1) = 12 (10)$$

but, $n = \frac{m_{old}}{4}$

6

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Therefore,
$$\left(\begin{array}{ccc} 7.5 & \frac{m_{old}}{m} & -3 \\ & & new \end{array}\right)_{n_{c}} = 10$$
 (11)

And rearranging terms,

$$\frac{\frac{m}{m}new}{m} = \frac{7.5}{3 + \frac{10}{n}c}$$
(12)

Hence a class of five students means a 25% increase in tutor utilization, a class of ten a 75% increase, etc., (see Fig. 2).

ABSTRACT

The authors

This propose wants to acquire more life data on the basic of accelerated life testing of a realistic type, on polymer insulators for very high voltage applications and to determine methods about the mechanisms causing failure so that better predictions can be made about the lives of such insulators. This will also make it possible to use them more sensibly and thus minimize possibilities of failure.

As will be noticed from the proposal and the Appendic **fee** we have done some pioneering work in this field and we wish to extend it so that the Power Distribution Industry may benefit in effecting economies in this area.

The research is proposed because of the great need for such insulators to replace heavy and bulky ceramic insulators with 214MFF A constant to make it possible for the higher organic insulators in minute the particulation in a maintain of the second effect finanial investment savings in maintaince costs. Obviously this will improve the national energy posture