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ABSTRACT

Four auditory delivery systems and their implications for instructing handicapped children are discussed. Outlined are six potential benefits of applying technologies to education, such as making education more productive. Pointed out are potential uses of sub-channel radio (such as programming for the blind), of broadband communication (such as home instruction through cable television), of telephone communication (such as a link to computer assisted instruction) and of rate-altered recordings (such as in individualized aural instruction). Also noted are advantages of each system, usually related to access and cost. (LS)

EMERGING AUDITORY DELIVERY SYSTEMS: IMPLICATIONS FOR INSTRUCTING HANDICAPPED CHILDREN

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INTRODUCTION

During the last decade, a variety of new technologies to facilitate the process of audio communication have emerged and been developed to the point where they now appear to be an economic and operational reality for a wide range of audiences. These new audio communication delivery systems offer the advantages of the ability to reach mass yet specified audiences and to adapt the audio message to meet special characteristics of the receiver.

The educational community can benefit greatly from the development of these new audio technologies by applying them in instructional settings. A 1970 report by the Commission on Instructional Technology outlines some of the potential benefits of applying such technologies to education:[1]

1. *Technology Can Make Education More Productive*
   Instructional technology has shown its ability to speed-up the rate of learning. It can help the teacher make better use of time. The teacher can spend more time on teaching—inspiring students to learn and encouraging them to apply newly acquired information in useful and interesting ways.
2. *Technology Can Make Education More Individual*
   Technology properly applied opens up many different ways to learning. Individual differences can be taken seriously. The traditional rigid control and standardization of what students learn, how they learn, when and at what pace is no longer necessary. The use of technology in education can increase the alternatives and permit the student to find his own direction more easily.
3. *Technology Can Give Instruction a More Scientific Base*
   Instructional technology can provide a framework necessary for designing conditions of learning that are more closely based on what is known about how human beings learn.
4. *Technology Can Make Instruction More Powerful*
   New forms of communication give added capability. The media of technology can simulate reality, bring distant and remote events to students, compress or expand the time a visual or auditory event takes place.

5. *Technology Can Make Learning More Immediate*

   Instructional technology can help bridge the gap between the world outside and the world inside the school. Through television, radio, and other media, a curriculum can be made dynamic. If instructional technology is creatively applied, reality can be studied almost directly, and the student's route to knowledge and understanding can be more meaningful.

6. *Technology Can Make Access to Education More Equal*

   Equal access to rich learning environments is not possible without some recourse to technology. Technology can provide not only the means of access to bodies of knowledge, but also the unique ability to deliver the knowledge in varying formats to fully exploit differences in learner styles and rates.

Within the educational community, the teachers of handicapped children can perhaps benefit the most by applying new audio technologies to instruction. The special education classroom presents a wide range of different learning styles and rates and it becomes the task of the teacher to identify and implement the most appropriate instructional strategy to exploit each child's learning potential. Levine (1973) has categorized the types of instructional strategies that are typically used by teachers of the handicapped:[2]

1. *Remediation*—an assessment of the handicapped child to determine what aspects of the child are limited, and then focusing instruction on those areas to bring them up to a specified level.
2. *Maintenance*—after the level of functioning has been defined and reached, the child is provided opportunities to practice those skills mastered to maintain their existence.
3. *Advantaged*—rather than focusing instruction on those aspects of the child that are limited, the instruction focuses on those areas that are functioning at the highest level.

For each of the above strategies, different audio delivery systems can assist the teacher in providing a wide range of learning alternatives for the instruction of the handicapped child.

In the next few pages, four emerging auditory delivery systems will be examined as well as the implications of those systems for improving the instruction of handicapped children. The systems are: sub-channel radio, broadband communication services, new uses of telephone communications, and rate-altered recordings.

SUB-CHANNEL RADIO

As happens so often with new delivery systems, the technological capability has existed for some time; it is deciding the best way to utilize that capability that has slowed the development of the system. Such is the case with sub-channel radio. In brief, sub-channel radio is a "private" radio signal that cannot be heard over a home radio receiver. The sub-channel signal operates as a special service of FM broadcasting stations (most commonly non-commercial FM stations). The typical FM broadcast signal contains three different "parts": the main signal and two sub-carrier signals. When listening to a conventional FM radio receiver, the main FM signal is heard. If the FM radio receiver is stereo, the main signal and one of the sub-carriers is heard, producing the stereo effect. The second sub-carrier signal is generally not in use. If it is, the FM broadcaster will rent the sub-carrier signal to companies who broadcast background music into grocery stores, doctors' offices, etc.

The non-commercial FM radio stations (those not supported by advertising) have begun to use their audio sub-carrier signal in many interesting ways. Reading material for the blind and physically handicapped, in-service education for doctors, engineers, educators and other professional groups are but a few of the uses. The recipients of this information must have a pre-tuned, single-frequency receiver set at the sub-carrier frequency. "Signals are receivable with good quality about as far as TV signals . . . within a radius of up to 50 miles depending upon the terrain, power of the transmitter, and height of the transmitting antenna."[3] All broadcasts on the sub-carrier signal are defined by the Federal Communications Commission as private communications, and therefore not subject to copyright restrictions.

With the above technology, several different variations are possible. One sub-channel receiver may serve an individual at home or office, or that same receiver may be used in a conference or classroom setting. The flow of information may be one-way (as in a lecture) or two-way by adding either return telephone capability or remote origination equipment. Visual stimuli, such as hand-outs or films may be used in conjunction with the audio signal to increase flexibility.

No matter what variations are used, sub-channel radio offers several advantages as an audio communication delivery system. Perhaps the biggest advantage is its ability to reach a large audience for a small cost. Aside from the individual single frequency radio receivers, one estimate of initiating a one-way sub-channel service

identified hardware costs at less than $2,000. A two-way interactive system costs are approximately $3,200. Individual receiver costs are approximately $60 per receiver.[4] Another advantage is the classification of sub-channel radio as a private communications system. This allows information that may not be in the general public interest, such as in-service medical information, to be delivered efficiently and inexpensively to its designated audience.

In an attempt to examine the implications of sub-channel radio as a means of improving the instruction of handicapped children, one can review the activities of sub-channel stations that are presently programming for blind and physically handicapped audiences. The initiator of sub-channel radio services for this specialized audience was the Minnesota State Services for the Blind in collaboration with Minnesota Educational Radio, Inc. The service began in 1969 and is presently programming over 130 hours per week. Two other stations, one in Lawrence, Kansas and one in East Lansing, Michigan, are providing programming for similar audiences while several other stations are developing plans for such a service.

The programming of the three stations in operation is designed to fill a void by the absence of print or braille which meets the everyday needs of the blind and physically handicapped. Volunteer readers share morning newspapers, periodicals, best-sellers, audio tours of the community, and programs for the rehabilitation and education of the listening audience. In short, programming is designed to serve as the eyes of the visually impaired and the limbs of the physically handicapped.

Reviewing the three teaching strategies used by special education, it becomes an easy task to apply the sub-carrier technology to improve instruction. Many school systems currently operate an educational FM station. With a small investment, the special sub-carrier signal could provide remedial, maintenance and advantaged instruction to blind and physically handicapped students not only in the classroom but also at home throughout the year. In addition to necessary cognitive skill development, specialized programming can assist in rehabilitation. Information relating to attitude, occupational requirements, hobbies and personal grooming can stimulate the imagination of the listener to an exploration of unrealized potential. Those students who are unable to attend class can either receive classroom instruction at home (one-way) or actively participate in instruction (two-way) utilizing the sub-carrier signal.

In summary, sub-channel radio can serve as an efficient and effective auditory delivery system. The advantages of low cost, specialization of audience and two-way capability mark the sub-carrier signal as an important new technology for improving the instruction of handicapped children.

BROADBAND COMMUNICATION SERVICES

Broadband communications is an advance in technology which possesses the potential to make profound changes in the way people communicate with each other. At present, the most visible evidence of this new technology is the growing number of cable television systems which supply subscribers with better reception and access to more television and radio programs. "But the promise of broadband cable communications is its capacity to carry more kinds of messages faster than existing means of communication and its capacity for two-way communication. Thus, it raises the prospect of a vast array of new kinds of services."[5]

Similar to sub-channel radio, the technological capability for broadband cable communications has existed for some time. In the late 1940's in communities where radio or TV reception was poor because of terrain or distance, an antenna was placed on the top of a nearby hill and coaxial cable was strung along telephone poles through the town. "Branches off the trunk and feeder cables called "drops" carried the signal from the street into the house, where connection was made to the antenna terminals on the back of the radio or television receiver."[6] Most of the early cable systems were limited technologically to only a few stations but now new cable systems have the ability to provide an almost unlimited number of stations.

As cable communications developed it was discovered that the coaxial cable could provide many more services than the mere carrying of radio and TV signals. The bandwidth of the cable facilitates many other kinds of information as well. Local television and radio programming can be originated from within the community as well as numerous other voice and data services. In 1972, the Federal Communications Commission required cable operators in the nation's 100 largest television markets to set aside four channels specifically for community use: a city government channel, an educational channel, a public access channel and a local origination channel. Within the past two years, a great deal of experimentation has begun to determine the most effective services and programming that can be effectively used by audiences in the franchise community.

Broadband cable communications possesses several advantages as an audio delivery system. As stated earlier, the new cable systems have the electronic ability to transmit many television signals and hundreds of radio signals. With access to these media no longer a scarce resource, it becomes very inexpensive to originate programming and have it repeated several times for the listening or viewing audience. Open access to the media in the top 100 television markets is required of the franchisee at no cost for the first five minutes and at a small cost to cover production for any time after five minutes. Access and economy then, are two advantages.

But perhaps the greatest advantage of broadband communications is just becoming a reality. The two-way applications of cable, allowing subscribers to originate and respond as well as receive programming can change one-way television into a two-way community information system. By coupling time-shared, remote access computer terminals with radio or television, uncounted sibilities exist. Home retrieval of information, two-way feedback, and computer assisted and managed information all become possible. "Two-way capability might some day enable the subscriber to literally talk back to the receiver or to interact in other ways, such as using the set and attachments as a computer terminal, utilizing a light pen to respond to a light sensitive CRT, or selecting any audio, visual, or printed material stored in a local or perhaps national library."[7] Prototypes of home terminals have already been developed and pilot studies begun. As soon as technical problems can be overcome and the terminals produced at a lower cost, the two-way uses of broadband cable will begin to make their impact on the American household.

Broadband cable communications can have implications for improving the instruction of handicapped children. The addition of visual as well as audio stimuli can greatly increase the applications of this technology to instruction. Cable services can also reach the handicapped student at home, providing instruction when travel to school is impossible. At present, many schools are experimenting with cable services to provide effective instruction for the handicapped. A review of selected projects shows some of the many uses of cable technology.

In Willingboro, New Jersey, there was a shortage of qualified speech and hearing therapists to handle the students who were victims of a severe rubella epidemic in 1964. The local school system and the cable franchisee produced a series of programs telecast over the school's cable channel to prepare children with hearing impairments and their parents for learning language skills.[8]

> The cable company in Overland Park, Kansas put its two-way capacity for subscriber interaction to a practical test by installing special terminals at the bedsides of two severely handicapped children. It also installed a small TV at each bedside and a third camera and another terminal in the cable studio. Once a week a special teacher came to the studio. She could see and talk to her home-bound pupils right from the studio, and the two pupils could see and talk to her and to each other from their beds. Results of the experiment were positive. Although both children were partially paralyzed, they learned to operate the terminals easily. The most beneficial part of the program turned out to be not the teacher's contact with the students, but the children's contact with each other. In this small instance two seriously ill, isolated children were allowed to help and learn from each other. This contact awakened a new zeal in both children—and even renewed their sense of competition.[9]

The two-way and multiple channel capacity of broadband cable allows numerous applications of the teaching strategies of remediation, maintenance and advantaged instruction. Broadband cable communications can be used for private communication to specified audiences, similar to FM sub-carrier service, as well as the more typical open broadcast mode whereby all subscribers to the service can receive the transmission. The utilization of the computer and the electronic adaptation of the audio and visual receiver to meet special student needs make broadband cable an especially attractive and versatile delivery system. It may be possible in the future to devote numerous audio or video instructional channels to meet the instructional needs of the handicapped. Satellites linked to broadband cable systems may someday provide the technology for nationwide networks for the handicapped.[10] In the interim, however, experimentation continues in an attempt to discover ways to utilize this fascinating technology to make it possible for handicapped children to receive a better education.

NEW TELEPHONE COMMUNICATION USES

Of the four audio delivery systems presented in this monograph, the telephone system is the one that will be the most immediately available to assist in the instruction of handicapped children. Naturally, this is because basic telephone service has been available for

a good number of years and is readily available in almost all homes. Most of the new applications of the telephone to instruction involve small changes in the telephone receiver equipment or in the switching devices. Being an established technology has placed certain limitations on the ability of the telephone to handle future instructional communication needs. With its present telephone lines and equipment, the bandwidth of a telephone voice channel is 5,000 cycles per second, compared to the 300,000,000 cycles per second bandwidth of broadband cable.[11] Most engineers agree the 5,000 cycles per second is sufficient for present use but not adequate for the future.

The telephone industry has developed many innovative devices to expand upon and facilitate audio communication. One of the newest is the "picture-phone" which introduces visual stimuli via a small television screen as a part of the telephone receiver. A miniature camera transmits the picture as well as the voice of the caller. Picturephones have been introduced on a pilot basis in some areas and research data is presently being collected. The current prototype model is somewhat limited in versatility, but improvements are expected shortly.

Another use of the telephone involves a special receiver called a dataphone which allows the caller to dial a time-shared, remote access computer, place the receiver on the computer terminal in the caller's office, and have full access to all the services of a major computer even though the computer may be miles away. A variation of this arrangement is a slightly different kind of terminal which allows the computer to literally talk back to the caller, responding vocally to the requests of the caller as well as providing a written response. This technique, though still too expensive for most school systems, can add a more personalized dimension to the drill-and-practice sessions of computer assisted instruction.

A more common use of the telephone system is the utilization of conference calls. In general, a conference call allows a two-party conversation to be expanded to include small groups. A special receiver which picks up several voices may be used, or several different phones in different locations may be interconnected to allow several people to participate in the conversation. Using the conference call in the classroom allows students to talk and interact directly with an author, politician or other famous figure, making the learning experience more meaningful and enjoyable.

With the simplification of telephone equipment that has occurred during the past few years, many new applications are being envisioned. A case in point is the advent of the touch-tone telephone.

The touch-tone telephone affords more simplified operation than the standard dial telephone. A lesser degree of manual dexterity is demanded of the touch-tone thereby making it potentially useful to many physically handicapped children. The touch-tone telephone, in much the same manner as a computer terminal, can serve as an input device for sending coded information. The touch-tone telephone could be used as an "always available" calculator for balancing the checkbook, a device for learning definitions of words, or a means of retrieving latest price information from the local grocery. In these examples, the user would merely punch in the question on the touch-tone dial and the answer could be returned either in the form of natural language through the telephone handset or typed out on a separate unit that is connected to the phone.

There are many ways the telephone system can be used to assist in the instruction of handicapped children. The computer linked to a voice-actuated or conventional terminal by telephone can provide numerous exercises of a remedial or maintenance nature through computer assisted instruction. The computer can also assist in managing the instruction of the handicapped child by diagnosing progress in practice exercises and prescribing additional problems or moving the student on to new problems.

The Tele-Class service was developed by Bell Telephone as a teaching device for those handicapped children unable to attend school. A specially trained teacher can "meet" with a class of up to twenty students utilizing the existing telephone network. The student participates in class work by using a telephone equipped with a headset. The service is designed to allow the teacher maximum flexibility. With a simple touch of the finger the teacher can:

1. allow all students to participate in class discussion,
2. speak with each student privately for individual development,
3. isolate students from hearing each other while she teaches and listens to the entire class,
4. divide the class into smaller groups for separate discussions,
5. transfer half the class to another teacher in another location for specialized instruction,
6. correct a tape recorder to present prepared information to the class.[12]

Another less sophisticated use of the telephone system with handicapped children is a two-way intercom system which provides a direct link between the classroom and the student's home. The stu-

dent can listen to information presented by the teacher and to the responses of the student in class. By pressing a button on the telephone, the student can talk to the teacher or class. Of course, there are numerous other uses of the telephone. By dialing a certain number, the child may be able to hear his favorite story read, hear a recorded version of what he missed in class while he was sick, or receive assignments for supplementary exercises.

The Bell Telephone System has also manufactured a variety of services and equipment to assist people with hearing, sight, speech or motion impairments to use the telephone. Such equipment and services can be combined with any of the above uses of the telephone system to make the learning experience more efficient and productive.

RATE-ALTERED RECORDINGS

A fourth emerging technology is that of rate-altered recordings. The most well-known type of rate-altering is accelerated speech. Often called the "Donald Duck effect," accelerated recordings are accomplished by merely speeding up the playback of previously recorded tapes and records. This process has been used by the blind for a number of years as a viable procedure for increasing the presentation rate of a recording. Though the pitch of the speaker is distorted, this frequency shift is tolerable to a certain extent and allows the listener to hear the recorded material in a reduced amount of time.

In the mid 50's equipment was developed that allowed the rate to be altered without the resultant pitch change. As such, the recording is heard at a faster (or slower) rate without any change in the voice of the person on the tape. This is accomplished by systematically deleting small segments of the recording. These segments, however, are so small that the human ear is not aware that they have been deleted. This procedure for altering the rate of recordings is known as speech compression or speech expansion.

Rate-altered recordings unlike the mass communication forms discussed earlier, are designed for a more individualized use. Until recently, equipment for speech compression and expansion was quite expensive. This cost factor extremely limited its widespread usage. Recently, however, the cost of this equipment has drastically dropped and within the next few years speech compressor/expander cassette units will become available for less than $100. With the reduced price can come the increased use of this equipment with handicapped children. Of course, the effective use of speech compression/

expansion of recordings will be dependent upon educators' ability to understand the potentials of the equipment.

Blind children are greatly hampered in their information reception when embossed braille material is the primary format that is used. An average braille reader is able to read at upwards of 90 words per minute. Conversational speech uses rates around 175 words per minute! An immediate advantage can be seen for this child in terms of using listening to receive information rather than reading. Studies in speech compression have shown that this same child is able to receive recorded information at rates as high as 275 to 300 words per minute. For the blind child, then, speech compression can provide an efficient means for receiving information. In fact, the blind child could be listening to information presented through speech compression equipment that is as fast as the word rate that is used by many sighted readers.

Speech compression besides the obvious uses to speed up information input to blind children, also holds promise for many types of children who are poor readers. The poor reader can be involved in remedial reading instruction for part of the school day and then receive compressed recorded information about other school topics during another part of the school day. In this way, the child is continually learning new things through listening and at the same time becoming more proficient at reading. This procedure is the underlying concept behind the advantaged form of instruction.

With the advent of inexpensive speech compression equipment, it will become possible for each child to have his own individual machine for learning through listening. This individualization will allow school children to listen at their own preferred rate. During boring passages the child will be able to speed up the rate and during complex passages the child will be able to slow down the rate. Speech compression will provide an opportunity to individualize recorded materials. No longer will it be necessary to listen to a tape at the speed at which it was originally produced. Especially if the original produced rate of the recording does not match the listener's preference.

Research is continuing to explore the potential of compressed speech in the education of handicapped children. So far we know: a) inexpensive speech compression equipment will soon be available so that many school children will be able to take advantage of this technology on an individual basis, b) many school children can listen at rates faster than they can read, c) the upper rate limits of recorded material are between 275 and 300 words per minute, d) listeners do

have a rate preference for listening (in much the same way that readers have a reading rate), and e) speech compression equipment, when used on an individual basis will allow the listener to adjust the rate to match his individual preference.

CONCLUSION

In the preceding few pages, four emerging auditory delivery systems and their implications for instructing handicapped children have been introduced and discussed. In such a brief instruction it is impossible to relate all details and applications of these delivery systems to improve instruction. Rather, the goal of this monograph has been to make the special educator aware of their existence while such systems are still in their infancy. Becoming aware of these emerging auditory delivery systems (and others) allows educators the opportunity to act and shape these systems to most efficiently meet the instructional needs of the handicapped child.

FOOTNOTES

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11. Shafer, *op. cit.*, p. 6.
12. Michigan Bell Telephone Company, "Services for Special Needs," (Detroit, Michigan: Bell System, 1974), p. 26.