Selected Telecommunications Devices for Hearing-Impaired Persons

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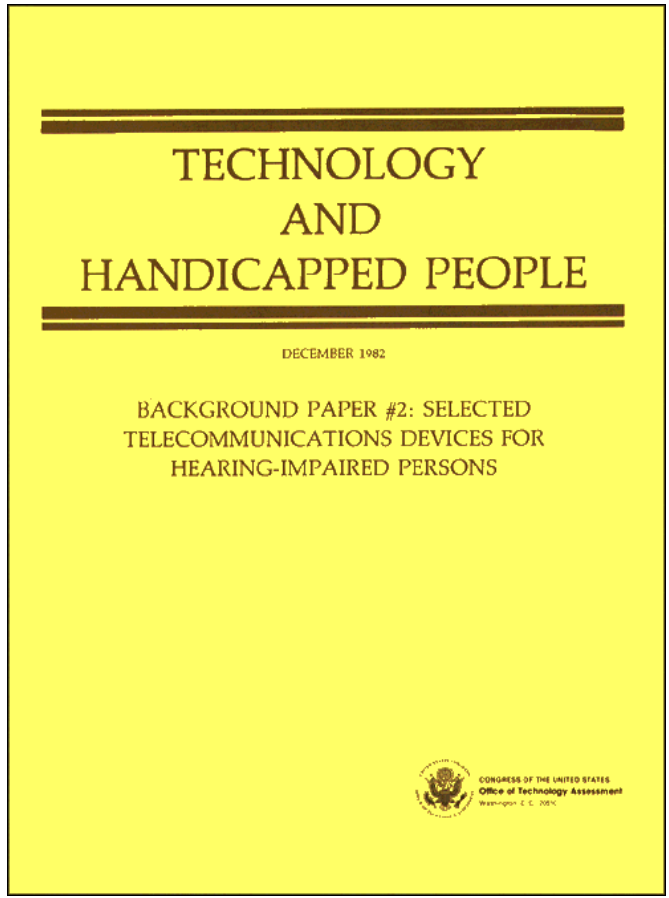

TECHNOLOGY AND HANDICAPPED PEOPLE

DECEMBER 1982

BACKGROUND PAPER #2: SELECTED TELECOMMUNICATIONS DEVICES FOR HEARING-IMPAIRED PERSONS

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OTA Background Papers are documents containing information that supplements formal OTA assessments or is an outcome of internal exploratory planning and evaluation. The material is usually not of immediate policy interest such as is contained in an OTA Report or Technical Memorandum, nor does it present options for Congress to consider.

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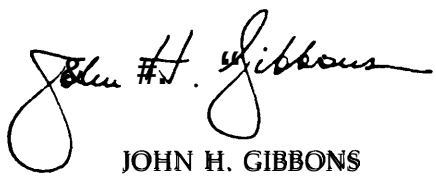
Foreword

Technology exerts a powerful influence over the lives of everyone, making life easier, more fulfilling, but sometimes more painful and frustrating. This statement is especially true for people with disabilities. The appropriate application of technologies to diminishing the limitations and extending the capabilities of disabled and handicapped persons is one of the prime social and economic goals of public policy.

The Federal Government is deeply involved in programs that affect the development and use of technologies for disabilities. Congress and other institutions have become increasingly interested in questions of how well programs that directly or indirectly develop technologies and support their use have been performing. The Senate Committee on Labor and Human Resources requested the Office of Technology Assessment (OTA) to conduct a study of technologies for handicapped individuals. That study examined the specific factors that affect the research and development, evaluation, diffusion and marketing, delivery, use, and financing of technologies directly related to disabled people. The problems and processes of the development and use of technologies were analyzed in the context of societal allocation of resources and the setting of goals for public policy. The main report of the study Technology *and Handicapped People* was released in May of 1982.

This case study is background paper #2 of the study. There will be a number of case studies published as part of the assessment, and each will be issued separately. The case studies were commissioned by OTA both to provide information on the specific technologies and to gain lessons that could be applied to the broader policy aspects of technology and disability.

Drafts of each case study were reviewed by OTA staff; by members of the advisory panel to the overall assessment, chaired by Dr. Daisy Tagliacozzo; by members of the Health Program Advisory Committee, chaired by Dr. Sidney S. Lee; and by other experts in medicine, disability policy, Government, public interest and consumer rights, and rehabilitation engineering. We are grateful for their assistance. However, responsibility for the case studies remains with the authors.



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OTA Note

These case studies are authored works commissioned by OTA. The authors are responsible for the conclusions of their specific case study. These cases are not statements of official OTA position, OTA does not make recommendations or endorse particular technologies. During the various stages of the review and revision process, therefore, OTA encouraged the authors to present balanced information and to recognize divergent points of view.

Contents

Background Information on the Hearing-Impaired Population

The hearing-impaired (i.e., hard-of-hearing and deaf) population of the United States is difficult to define. A census of the people with hearing impairments, taken in 1970-71, is the only extensive effort that has been made to date. Subject to errors resulting from nonresponse, this census still offers the best available figures: 13,362,842 hearing-impaired persons (persons with any degree of hearing impairment) in the United States, including 1,767,046 deaf persons (35).

A 1978 survey conducted by Bell Laboratories as part of its planning for products and services indicated that 16,650,000 people in the United States are hearing impaired to some degree (2). That survey found that 4,070,000 of these people have a hearing impairment that affects telephone use: 440,000 people who have a profound or total hearing loss and cannot use the telephone without a telecommunications device such as a teletypewriter (TTY); * 1,630,000 severely hearing-impaired people who use a hearing aid and who cannot use the telephone without additional amplification; ** and 2,000,000 less severely hearing-impaired people who probably do not use a personal hearing aid, but who can benefit from additional amplification in the telephone handset.

The Bell Laboratories survey also indicated that there are 8,000 people, not hearing impaired but with *severe* speech problems, who might use a telecommunications device. This figure is unquestionably low, because the nonvocal group of the disabled population, those who hear but cannot speak owing to neurological or motor impairment or surgery or an accident, are the most recently defined and possibly still the most poorly identified of all the handicapped groups.

The Office of Demographic Studies, located at Gallaudet College, Washington, D. C., was formed to organize the 1970-71 census of the deaf, and it has continued publishing statistics, notably the results of its annual survey of hearing-impaired youth receiving education in special schools and programs. The Office of Demographic Studies and the National Center for Health Statistics make prevalence estimates based on the census and on new information from the annual survey of schools. Current estimates show 14.5 million persons with any type of hearing disorder and 2 million severely hearing-impaired persons who could be termed "deaf" (24).

Approximately 300,000 deaf persons were born deaf or lost their hearing before the age of 3 and thus are considered "prelingually" deaf. Traditionally, it was said that these children could not be educated in the regular school system, because they lacked a language base from which they could be taught to speak and read. With the implementation of the Education for All Handicapped Children Act (Public Law 94-142), more deaf and hearing-impaired youngsters are being educated within the regular public school system. Whether or not such education is effective for all prelingually deaf children is an issue hotly debated in the education community. However, the result of the "mainstreaming" trend is that fewer deaf children are being educated in State schools and special classes; the fewer deaf children there are in these school systems, the less likely they are to be reached by the Annual Survey of the Office of Demographic Studies, and the less complete is the information available.

Approximately 600,000 deaf persons became deaf before entering the work force and thus are considered "prevocationally" deaf. Some of these persons had a progressive hearing loss that did not manifest itself completely until young adult-

*TTY was formerly used as the generic term for telecommunications devices for the deaf. The acronym currently used for all telecommunications devices for the deaf, including teletypewriters (TTYs), cathode ray tubes (CRTs), and light-emitting diodes (LEDs) is TDD.

•'Many telephones manufactured in the last 5 to 10 years are not compatible with the "telephone switch" on hearing aids, which has created a new barrier for hearing-impaired people.

hood, and others were deafened from disease or accident in childhood or adolescence. Although the rubella epidemic of 1964-65 as it affected pregnant women is a main cause of deafness in deaf youth who became 18 in 1982, "cause not determined" is still the most common cause of deafness in all age groups (24).

At least three-quarters of the hearing-impaired population of the country may have some hearing loss due to aging. As the population of the country over 60 increases, the incidence of hearing impairment increases dramatically. Most individuals who lose their hearing in adulthood do not consider themselves part of the deaf community and do not take advantage of its information and services. Many technological devices can be of considerable benefit both to the traditional deaf community and to gradually deafened older Americans.

2

Background Information on Technology for the Hearing-Impaired Population

It is ironic that although the telephone was invented by Alexander Graham Bell, who as a teacher of deaf students was constantly searching for ways to overcome barriers to human communication, as telephone lines were extended throughout the country, and commerce became more and more dependent on them, deaf individuals were closed out of the telephone network. Deaf people, able to communicate only during face-to-face encounters or by written correspondence, began to be unable to reach help in emergencies, were isolated from significant information about community and educational services, and were severely limited in seeking new employment. Bell's invention, opening channels of communication for the population at large to an unprecedented degree, effectively isolated a substantial portion of the population—those whom Bell most wanted to help.

Over the past 20 years, however, the range of technological aids available to deaf and hearing-impaired individuals has increased greatly. Significant advances in the microminiaturization of electronic circuits and concurrent developments in digital signal processing have improved the quality and diversity of sensory aids.

Conventional hearing aids, which are now lightweight and unobtrusive, are the most widely used sensory aids. Related to personal hearing aids are various types of *auditory trainers* for classroom use, *h&h-gain telephone handsets,* and *special extension headphones for TV and radio.* The problems with hearing aids, especially in fitting children and elderly persons, are not so much in the technology as in determining the correct prescription, assessing the aid's performance, and educating the user. Hearing aids are still very expensive when compared to the cost of advanced pocket calculators and other mass-produced electronic devices in general use.

Auditory speech-processing aids (devices that raise or lower the frequency of the speech signal) and *tactile and visual aids* are in use in schools and clinics as speech-training aids. Such aids are generally not portable devices (although miniaturized versions are being developed). They are often effective in structured training settings, although there are problems in generalizing their use to that in everyday situations.

Auditory loops had been used for a number of years in special schools for the hearing impaired and in some regular school classes where there were hearing-impaired students. Loops became more widespread and convenient when Desmond Carron, a Maryland engineer, designed and built the first portable loop for his deaf daughter in the late 1960's, The portable audio loop, a wire loop connected to an amplifier and to the speaker's microphone, is easily transported and set up in any meeting room. Persons with hearing aids set their aids on the "T" or telephone switch and receive a much clearer and more direct signal, free of background noise. With the support of William Paschell and others in the Washington, D. C., Area Group for the Hard of Hearing, loops are now used in houses of worship, classrooms, theaters, recreation centers, senior citizen centers, and some places of employment in the Washington area and elsewhere.

More recently, *infrared amplification systems* have been successful in theaters (including the Eisenhower Theater in the Kennedy Center in Washington, D. C.) and in large houses of worship. A hearing aid is not necessary to use an infrared amplification system; hearing-impaired members of the audience borrow or rent a receiver headset that brings them clear, strong sound directly from the stage. The system is particularly helpful to individuals with a mild hearing loss who often miss some words from the stage.

A variety of *warning and alert systems* that convert noises into visual or tactile signals are available to deaf individuals for use at home every day. These systems include flashing-light doorbell

signals, vibrating alarm clocks, baby cry signals, smoke detectors, and burglar alarms.

The most recent technological development for deaf individuals is *captioned television*. Although captioned films for use by schools and social groups for the deaf and open captioning on late evening TV news from WGBH in Boston had been available for some time, closed captions on television (which appear on the screen when the viewer uses a special adapter, but do not appear to other viewers) were first offered in early 1980. Research and development of the closed-captioning concept was financed by the Bureau of Education for the Handicapped, with the support of the Public Broadcasting System and two national networks. In addition to early evening news, 20 to 36 hours per week of prime-time television programs are currently captioned. Deaf viewers who can afford to can buy either a captioning adapter to attach to a television set or a set that has the adapter built into it, both sold by Sears.

Video telephones have been tried on a limited scale. They would be of value to the hearing-impaired as a communication aid for lip reading, signing, or reading the printed word, but the costs of a videotelephone network are prohibitively high. Computerization of typed information into nearly instantaneous yet remote readout is now beginning to appear and is in use by a deaf member of the British Parliament. It has also been used in the U.S. Supreme Court (April 1982).

Research continues on *cochlear prostheses*, which electrically stimulate the ear by means of an implant. A few initial efforts have been made, but practical results are not widespread.

Electric mail systems have been adopted for use by deaf users of telecommunications devices for the deaf (TDDs) through two demonstration projects funded by the U.S. Department of Health, Education, and Welfare. * These systems have been actively used by a small group of deaf people but have not reached the general deaf population.

Research on *machine recognition of speech* has gone on for many years, although still with only limited success. It may be possible to develop a system that will automatically recognize all essential features of running speech and display them in an easily understandable form.** An ideal system would generate a typewritten message directly from the acoustic wave form, Limited speech recognition devices for single-word spoken commands have been developed and may prove useful to telephone users. It is highly unlikely that an accurate system operating on running speech from any speaker will be developed in the near future, but systems with limited message sets are being developed now (27).

The development and diffusion of *TDDs that allow deaf persons to use the telephone* have been different from all the other technological advances mentioned above. The new network was developed on the basis of existing technology, including the phone system, teletypewriters, and modems. *** It has allowed deaf persons to use the telephone, which has become a necessity of American life. The imagination and persistence of a few individuals got the movement started; the "enthusiasm on the part of the deaf participants was the propelling force behind the concept of telecommunications for the deaf" (45).

● Now the Department of Health and Human Services.

● 'Real-time graphic display, a system of video captioning based on stenography, is a recent development. A real-time graphic display device, consisting of a stenotype machine and video display screen, was used Mar. 25, 1982, at the U.S. Supreme Court to allow a deaf attorney to read the questions raised by the justices. The device, developed by Translation Systems, Inc., of Rockville, Md., costs approximately $73,000. It requires the services of a skilled stenographer, who enters phonetic symbols into a computer that translates them into conventional English and displays the results in print on a television screen. A similar translating system is currently being used by the National Captioning Institute to provide live, closed captions for the ABC Evening News.

* **A modem (modulator/demodulator) converts TDD electrical impulses into telephone transmittable form.

3

The Development and Diffusion; of Teletypewriters for Hearing-Impaired People

In 1963, Robert Weitbrecht, a physicist with a profound hearing loss, hiked up Mount Lassen in California. As Weitbrecht exclaimed about the beauty of his surroundings to his hiking companion, his voice was overheard by another hiker on the trail, Ed McKeown, whose wife is deaf. The speech of deaf individuals varies, but it usually has a distinctive quality that is easily recognized by a person with a deaf family member. McKeown introduced himself and the two exchanged names. Weitbrecht mentioned that he had technical interests and education and that he was a radio ham and operated a radio teletypewriter (TTY).

Some months later, Weitbrecht received a letter from James Marsters. Marsters, a deaf orthodontist from Pasadena, had heard about Weitbrecht via the McKeowns and the social network of deaf persons in northern California. Marsters, who had developed a whole set of strategies to run his office efficiently, was deeply frustrated at being unable to use the telephone. Marsters was using his expertise in electronics to explore ways that deaf individuals might communicate with each other by radio or telephone, and his friends in the Bay Area network had suggested to him that Weitbrecht might be a good coinventor.

After more correspondence, Marsters purchased a Western Union 32ASR TTY. He continued to encourage Weitbrecht, and in November 1963, Weitbrecht invented an acoustic coupler modem* that permitted him to communicate with Marsters over the voice-grade telephone lines by typing from his TTY to a similar unit in Marsters' home. The two men used the telephone because a radio system would have required a Federal Communications Commission license, which Marsters lacked. Also, both men reasoned that if a communications system were to be useful to the entire deaf population, it would have to be based on the telephone. Although relatively few deaf people could make direct use of the telephone, many of them owned telephones so that their children, other relatives, or neighbors, could make calls for them in times of emergency. A commercial TTY network already existed, but its costs were prohibitive for private individuals.

As the TTY communications went back and forth between Weitbrecht's home in Redwood City and Marsters' in Pasadena, tests and modifications were made to overcome telephone line echo problems. Finally, an echo-suppressing tone burst was achieved. This meant that the modem reliably converted TTY signals into tones that could be carried by the voice band of the telephone line. All this time, in the tradition of home-workshop inventors, Marsters and Weitbrecht were donating their time and the money for parts. Neither private industry, the Federal Government, nor academia was interested in deaf people's need for telephone communications.

On June 23, 1964, the new equipment was demonstrated in Salt Lake City, Utah, at the biennial convention of the Alexander Graham Bell Association for the Deaf, an international organization of parents, teachers, and deaf adults who advocate use of lipreading, speech, and residual hearing. Latham Breunig, a deaf statistician present at the convention, wrote (5):

> It was . . . an exciting and thrilling experience. There, between two rooms in the Hotel Utah, these deaf people were, for the first time, able to make unassisted telephone calls over the regular voice grade telephone network by means of a teletypewriter in each room. This feat was made possible by the development of an appropriate coupler or modem, interfaced between the TTY and the telephone.

*Couplers existed before Weitbrecht invented his model. His patent hinged on eliminating echo on the line.

Marsters encouraged Weitbrecht to apply for a patent. The R. H. Weitbrecht Co. was founded in 1965. Marsters enlisted the additional capital and business expertise of a third deaf man, Andrew Saks. In 1967, Weitbrecht, Marsters, and Saks formed the Applied Communications Corp., which replaced the Weitbrecht Co.

Until 1967, the TTY communications system grew slowly. The acoustic coupler, known as the Phonetype@, had to be debugged under various conditions. The first working TTY units were installed in Los Angeles, New York City, Indianapolis, and San Francisco, followed soon after by installations in St. Louis and Washington, D.C. Used TTYs were not readily available, and newly manufactured ones were too expensive for individuals and families to buy. Surplus TTYs could not be released by the American Telephone & Telegraph Co. (AT&T) until it settled a Carterfone lawsuit, which it did not do until 1967.

To make a TTY call, a person making a call places an ordinary telephone handset on the acoustic coupler modem and dials the telephone. When the call is answered, the caller types the message, stopping to type "GA" ("go ahead") when a response is expected. The acoustic coupler modem transforms the electrical signals into two sounds of different frequencies, which are then transmitted over the telephone line. At the other end of the line, the signal is received by another modem.

In the 1960's, the surplus TTYs looked as if they belonged in a turn-of-the-century Western Union office: they were made of sheet metal and stood about 4 ft high; they were noisy and shaky in use; and they took up a lot of space. But they worked. As the surplus machines became available, scattered people created a network of deaf people who could communicate with each other, and that network grew.

In 1967, surplus TTYs were made available to deaf persons through an agreement between AT&T and the Alexander Graham Bell Association for the Deaf. By the end of 1968, there were 174 TTY stations for deaf people operating around the country; by 1970, there were 870.

Because the Alexander Graham Bell Association for the Deaf was not set up to be an equipment vendor, Marsters recommended that it set up a separate organization involving the National Association of the Deaf and any other organizations for the deaf, to pick up, distribute, and service the surplus TTY equipment. In 1968, the nonprofit corporation called Teletypewriters for the Deaf, Inc. (TDI), was created by Latham and Nancy Breunig of the Alexander Graham Bell Association, along with Jess Smith of the National Association of the Deaf. TDI appointed deaf persons all over the country to be its authorized agents, picking up surplus machines from AT&T outlets, reconditioning them, and placing them in the homes of deaf people. The system grew to approximately 12,000 TTYs by 1975. Keeping accurate records to fulfill its agreement with AT&T, TDI was able to publish a list of stations, which continues to serve as a telephone directory for the deaf community and for those businesses that make a special effort to serve deaf individuals.

In 1973, the agreement between AT&T and the Alexander Graham Bell Association for providing TTYs to deaf people was replaced by a similar agreement between AT&T and TDI. Western Union also released a substantial number of machines at that time. Maintaining itself through membership dues and contributions, TDI was also able to establish, through a grant from the Lilly Endowment, a revolving fund to make loans to local groups for equipment acquisition, enabling the surplus equipment to be distributed throughout the country as needed.

The philosophy underlying all these activities was "by and for the deaf. " Although a few nondeaf groups with an interest in service (e.g., Telephone Pioneers, an organization of retired Bell System employees) volunteered in some locations to help with reconditioning TTY units, information about availability of equipment and advantages of different models was disseminated completely within the deaf community, through booths at conventions of deaf organizations and small advertisements in journals about deafness.

New models of acoustic couplers, developed in New Jersey and Texas in 1969, were competitive in price with the original Phonetype@ that had been patented by Applied Communications Corp.[1] All these couplers interfaced a telephone

[1] Robert H. Weitbrecht. U.S. Reissue Patent Re 27,595, Mar. 6, 1973 (based on Robert H. Weitbrecht original U.S. Patent 3,507,997 filed Aug. 22, 1966, and issued Apr. 21, 1970).

and a TTY that typed out hard copy on a roll of paper. Some deaf persons and their families bought modern terminals that were quieter and less bulky than the surplus models. Still, these new terminals were not portable, and they were too expensive for most deaf people.

In 1972-73, telecommunications terminals were introduced that utilized soft copy, or transitory readout, on a television screen or on a marquee display with a light-emitting diode showing above the keyboard. New brands at that time included TVPhone@ by Phonics Corp., MCM by Micon Industries, and Magsat by Magsat Corp. * These devices offered certain advantages over the standard TTY models: they were much smaller and lighter, portable, and quiet. TDD (telecommunications device for the deaf) was the new term coined to include the old and the new models. Portable TDDs are small enough to store in a drawer or carry in a briefcase. Many deaf users still prefer a paper printout, but portable machines offer flexibility for family and business communication. Several portable devices are now available with built-in or optional miniature printers.

Even though a variety of TDDs were available on the market by the early 1970's, the devices all had to be able to interface with one another. In 1973, TDI issued recommended standards for coupler manufacturers in an attempt to ensure compatibility among the various types of equipment.

TDI agents organized to develop training programs, operating standards, service manuals, and user handbooks. The TDI biennial convention, begun in 1974, became an important technical and social exchange for the deaf individuals who served as agents. By 1975, the number of TDD stations nationwide had grown to about 12,000.

In 1977, the implementation of sections *503* and *504* of the Rehabilitation Act of 1973 began to affect the public perception of the telecommunications needs of deaf people. Paralleling the increased civil rights activity of all disabled individuals, representatives of the deaf community met with Federal and State legislators and staff from AT&T to review the needs of handicapped persons. A number of legislators installed TDDs in their offices; every time this occurred, the installation was well publicized in the newsletters of deaf organizations. TDDs were placed in police and emergency facilities, vocational rehabilitation offices, telephone companies, and in some public transportation systems. The theme "by and for the deaf" fit in well with the recognition of the need of handicapped individuals for independent living.

In 1977, surplus TTYs became scarce again, and the cost of new equipment, including the coupler, rose. The TTYs generally used the 5-level Baudot code Weitbrecht had employed in his original device. The 8-level code, called the American Standard Code for Information Interchange (ASCII), had been in existence for some years in computer systems, and Weitbrecht knew of this code when he developed the Weitbrecht device in 1964. In 1964, computers were new, and personal computers had not been envisioned as a common household item. Weitbrecht and Marsters were looking for a simple-to-operate, low-cost device for ordinary communication between two deaf people, or between a deaf and a hearing person, over a telephone line. In 1981, Weitbrecht recalled his thinking about the Baudot code in 1964 (45):

> There were thousands of Baudot TTYs available . . . a great surplus waiting to be used. There was also compatible equipment: Kleinschmidt, Creed, Olivetti, and others, all compatible with Baudot code. [It was] an opportunity to get equipment and train the deaf without great expense. TTY machines had been surplused for many years to radio amateurs, I knew there were surplus machines ready to be put to use.

Thus, Weitbrecht built the device using the Baudot code. As other couplers appeared on the market, the Weitbrecht/Baudot 5-level code device was accepted in practice as the standard to preserve compatibility among all such couplers and modems; however, users of Baudot-code TDDs could not converse with ASCII-based computers.

By 1977, the cost of computers had come down, and the development of the microcomputer began to make some technically minded members of the deaf community wonder if the push for compatibility of all equipment in the TDI system was not a mixed blessing. Approximately *27,000* stations existed at that time; the system was flourishing.

● Phonics, Micon, and Magsat were no longer in business by 1982.

But some concerned people realized that as the system expanded, it would become increasingly obsolete with the advance of technology.

Estimates varied widely, but by 1981, there were between 50,000 and 100,000 stations. At least 10 small companies had been involved in the manufacture of TDDs. Many of these small companies were started by a deaf person or included a deaf person in their management. To some extent, all these companies infringed or Weitbrecht's patent rights and paid him no royalties. Weitbrecht never contested the patent infringement. Applied Communications Corp. and Weitbrecht chose not to use their funds and energies to pursue a lawsuit.

It has been said that approximately 20 years elapse before a technological device for disabled individuals develops from an idea into a widely available aid.[2] Seventeen years after the first TTY call, from Redwood City to Pasadena, Calif., TDDs are being distributed free by the telephone company, through a surcharge on all telephone bills, to deaf residents of California. The initial distribution site, Fremont, Calif., is not far from Weitbrecht's home workshop. This history of this development in California will be discussed in the subsequent chapter.

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[2]Robert Mare, Department of Biomedical Engineering, Massachusetts Institute of Technology, in a speech at the Helen Keller Centennial, Boston, June 1980.

4. Issues and Concerns

RATE REDUCTION FOR INTRASTATE LONG= DISTANCE CALLS

Social pressure on deaf individuals to purchase a telecommunications device for the deaf (TDD) grew as the network increased. TDDs installed in government agencies, retail chains, airlines, and a stockbroker's office in the mid-1970's increased the demand for TDDs and made them much more useful. As deaf people made more long-distance calls on their TDDs, it became evident that long-distance TDD calls are very expensive. Although Baudot-code TDDs can transmit a maximum of 60 words per minute, the average user rarely types faster than *45* words per minute; thus, a TDD call can easily take four times longer, and cost considerably more, than its spoken equivalent. According to Harry Levitt, a professor of communications science at City University of New York, the average person talks 150 words per minute, although New Yorkers often talk as fast as 200 words per minute (25).

Deaf individuals and groups began to lobby at the State and Federal levels to reduce the long-distance tariffs for TDD users. The National Center for Law and the Deaf, a public law service with some Federal and some private funding, has stated that the primary argument in favor of a rate reduction for TDD users is that charges for long-distance calls should be based on the value of service rather than on the cost of service. When the value of a call made by a deaf TDD user is exactly the same as the value of a call made by a hearing person, the cost of the call is approximately four times greater for the TDD user (30).

In 1977, the Connecticut Public Utilities Control Authority issued an order (docket No. *77-0250,* Dec. 16, 1977) allowing a 75 percent reduction in the telephone bills of deaf individuals using TDDs for intrastate long-distance calls. Over the next 4 years, similar reductions were adopted in 42 other States. States varied in their certification requirements for deaf users: some required an affidavit from a physician or an audiologist; others asked the user to take an oath that he or she was deaf. A few States certified both deaf and hearing people in the same household.

The National Center for Law and the Deaf continues to advise deaf consumer groups throughout the country on strategies for obtaining reduced intrastate rates for TDD users.

TELEPHONE CUSTOMER SERVICES FOR TDD USERS

In addition to rate reduction, there were other issues that concerned TDD users. Certain telephone services, such as business office assistance and 911 emergency numbers, are included in the monthly service charge, but deaf users could not take advantage of them. In 1981, an 800 number was established that TDD users can call to get information and assistance from an operator: information on numbers not in the telephone directory; and assistance with credit card calls, collect and person-to-person calls, and calls from hotel telephones. The National Center for Law and the Deaf has also worked with consumer groups to persuade local utility companies to install TDDs in their customer information departments so consumers can ask questions about billing services and communicate during power outages.

RATE REDUCTION FOR INTERSTATE LONG-DISTANCE CALLS

The 4 years of effort to obtain reduced intrastate rates culminated on August 21, 1981, when, in recognition of the International Year of Disabled Persons, the American Telephone & Telegraph Co. (AT&T) filed a petition with the Federal Communications Commission to reduce interstate rates for hearing-impaired TDD users. The tariff, which became effective October *30, 1981,* reduced rates 35 percent for daytime long-distance interstate calls and *60* percent for evening long-distance interstate calls; late-night and weekend rates remained the same.

One hundred five years after Bell invented the telephone, the deaf population, those Bell wanted to bring into the mainstream of society through improved communication, was officially invited by the direct descendant of Bell's own company to participate fully in the Nation's telephone linkage. According to W. E. Albert, Administrator of Rates and Tariffs, AT&T filed the tariff for calls "placed by residence customers who have been certified as requiring a visual means of communication to use Long Distance Message Telecommunications Service , . . to help to promote a fuller and more active participation in our telecommunications-oriented society" (1). Barry Strassler, Executive Director of Teletypewriters for the Deaf, Inc., the association of TDD users, said, "This is the Milestone!" (38).

ELIGIBILITY FOR REDUCED RATES

The certification process for interstate rate reductions for TDD users has not yet been decided, AT&T has suggested "friendly certification" for hearing- or speech-impaired TDD users who are already certified for intrastate reductions. However, some States have extended reduced rates to hearing persons who communicate with hearing-impaired TDD users (e.g., the hearing child of a deaf parent in another city, or the hearing staff of an agency that regularly communicates with deaf clients throughout the State over a TDD). The AT&T tariff applies only to hearing- and speech-impaired TDD users, but benefits hearing people in the same household. For States that do not have intrastate reductions, the deaf community will have to work with the telephone company to advertise the interstate reductions and certification process, because the telephone companies cannot identify deaf people from their records.

PUBLIC TDDs

Deaf consumer groups advocate placing TDDs in public places—shopping centers, libraries, transportation terminals—for use like conventional pay phones. The converted teletypewriter (TTY) machines are impossible to carry about, Many of the newer TDDs are portable, but they are not light enough to be carried comfortably all the time. In case of an emergency on the road, or a change of plans, the deaf TDD user has no access to a communication device. Although a few public TDDs have been put in places where there is a large deaf population (e.g., on the campuses of schools and colleges for the deaf), the access of deaf people to public telecommunications service remains extremely limited.

COST OF TDDS

TDDs are still very expensive. The reconditioned TTYs cost about $300 installed, with additional fees for paper supplies and servicing, plus the cost of the coupler ($250). For the past several years, reconditioned TTYs have been almost impossible to obtain and can usually be purchased only from someone who is acquiring more modern equipment.

A 1981 catalog of rehabilitative devices describes 10 portable TDDs made by different companies, with prices ranging from $300 to $700, accessories not included. One ultraportable model, with somewhat limited use, sells for $200 (43). A new Baudot model, the Minicom", introduced by Ultratec in 1982, is lightweight and sells for $259. All these devices are beyond the budget of many deaf families.

Recognizing that deaf TDD users would have to purchase an expensive device before they had access to the telephone lines, some States (Michigan, Illinois, Florida, Georgia, and a few others) lease TDDs for a monthly fee ($15 to $36 per month). Some States rent with an option to buy. Hearing-impaired persons who use an amplifying handset on their telephone pay $0.75 per month for this service in some communities, and *$1.50* per month in others; there seems to be no standard charge. Some telephone companies will sell the amplifier to the customer for a $40 charge, but it is difficult for the customers to find out about this. As other adaptive devices, it is not always easy for TDD users to know what is available and what is the most economical way to obtain it.

DISTRIBUTION OF FREE TDDS IN CALIFORNIA

An important step in distributing TDD units for access to the telephone system was taken in California in the fall of 1981. In 1979, owing to the work of deaf consumer groups (particularly GLAD, the Greater Los Angeles Council on Deafness), the California legislature passed a bill requiring the telephone companies to distribute free TDD equipment to certified hearing-impaired customers who could not use a standard telephone (California SB 597). Governor Jerry Brown signed the bill into law, and the California Public Utilities Commission was charged with implementing it.

In September 1980, the Public Utilities Commission began hearings to work out the practical aspects of implementing this law that applies to California's 40,000 deaf residents. Almost all TDDs owned by deaf Californians employed the 5-level Baudot code. TDDs were manufactured by a number of small companies, many of which *were* located in California and therefore had a financial interest in specifications for the devices. The issue of the modem code for TDDs was as significant in the hearings as was that of the system by which TDDs would be distributed.

Groups participating in the California hearings had different goals. The conflict was an example of the recurrent conflict between those with investments in "old" technology and advocates of "new" technolog, whose stand would inadvertently make existing technology obsolescent and necessitate the retraining of users. The telephone companies wanted to implement the law in the most economical and expeditious fashion. The manufacturers of TDDs were competing for the potentially lucrative equipment contracts from the telephone companies. In general, the manufacturers wanted to stick with the 5-level Baudot code, because changing over to the 8-level American Standard Code for Information Interchange (ASCII) would be expensive. They also feared competition from larger manufacturers who had not served the deaf market before. The deaf consumer groups were concerned about small matters: hard or soft copy, red or green letters in the light-emitting-diode readouts.

Other interested groups were also represented, SRI International, a California-based consulting firm, had just completed a 3-year grant project,

totaling $375,000, that the National Institute of Handicapped Research, Office of Special Education and Rehabilitative Services, funded to develop an ultraportable hand-held TDD terminal. (A prototype was made and tested with representatives of the deaf community; although the prototype was smaller than any other standard typewriter-keyboard TDD, it was expensive and never came to production.) The SRI team, which included technology-minded deaf members, was very concerned that deaf people, by using the Baudot code, would become isolated from the rapidly expanding world of computer communications. One objective of the SRI project was to develop a device that could be used with both Baudot and ASCII systems and thus bridge the gap between the two. SRI believed firmly that the Baudot system was obsolete and that communication systems for deaf people should be planned with the future in mind.

After hearing all points of view, the California Public Utilities Commission staff recommended retaining the Baudot system, and the administrative law judge followed their recommendation in setting the standard. In an unusual turn of events, however, the commissioners reversed this decision and recommended that all free TDDs had to have dual capacity, that is, to be compatible with both Baudot and ASCII systems. Two California manufacturers, Krown Research, which makes the Portaprinter", and Plantronics, which makes the VU-Phone@, received the first contract to produce the devices. * They agreed on standardized modems to comply with the ruling of the California Public Utilities Commission. A trust fund was established to pay for the distribution of TDDs. In October 1980, telephone customers in California began to pay a 15¢ surcharge on their monthly telephone bills. That surcharge goes to the trust fund for TDDs.

Distribution of free TDDs by the telephone company also began in October 1980, in Fremont, Calif., where there is a substantial deaf community. The distribution of free TDDs will continue in other areas of the State and should be completed by 1984. Customers will receive a free TDD regardless of whether they already own one. Consumer organizations in different California communities are working with the telephone companies to arrange to identify eligible consumers. There is also the question of possible loss or disappearance of equipment to consider. For example, when a deaf person moves, does the person take the free TDD along?

Although the California decision may seem like the pot of gold at the end of the rainbow, there are some members of the deaf community who do not support the free distribution of equipment. They are willing to make the purchase of a TDD a medical deduction on their income tax.** They agree that low-income deaf people should be provided with TDDs at reduced cost, but they don't want gifts. They worry about other consumers' reaction to having to pay for the devices with a surcharge on every month's phone bill, or about the stereotyping of all hearing-impaired people as "poor." (The charge on the telephone bills now reads "SB 597-TDD, " which puts the responsibility on the State legislature, At one point it was suggested that the charge be titled "DEAF," an acronym for Deaf Equipment Acquisition Fund, but that idea was rejected.)

As of July 1982, 4,000 units had been placed in California—fewer than expected. Many deaf people have no telephone or perhaps do not wish to reveal their poor language or typing skills. The trust fund has accumulated enough money that the surcharge may be reduced.

*VU-Phone is not currently being manufactured.

**The Internal Revenue Service began allowing a medical deduction for TDDs in 1971.

ASCII= BAUDOT STANDARDIZATION AND THE IMPACT OF COMPUTER TECHNOLOGY

The issue of standardizing modems is important. When deaf persons have dual-capacity devices, they will have access to additional less expensive communication systems, such as the Deafnet Electronic Mail system. * Also, the cost of TDDs might come down as has the cost of many pocket computers and other small electronic devices. The Superphone", made by Ultratec in Wisconsin, offers a dual-capacity model, and one can also buy a converter to permit a TDD to accept calls from both Baudot and ASCII units. Costs will go down significantly when the TDDs are planned to coordinate with the computer market that is growing among nondeaf persons. The prize-winning entry in a 1981 national contest on the use of personal computers to aid the handicapped consisted of a Radio Shack pocket computer with a coupler and a miniprinter to make an ultraportable TDD that could also be used as a computer—all with off-the-shelf items (26).

An issue that will arise as more deaf persons use TDDs that can access the *4* million ASCII-compatible stations is the possibility of tariff fraud. The deaf caller with reduced interstate rates or the nondeaf person calling from the residence of a deaf TDD owner would be indistinguishable from a profitmaking data caller.

● Deaf net lost funding in January 1982 and is currently operating on a much smaller scale.

NEW LEGISLATION

The California TDD distribution plan may be affected by decisions based on the Federal Communications Commission Computer Inquiry II. The provisions that are expected to take effect on January *1, 1983,* would cause AT&T to separate its role as operator of the telephone network from its role as a supplier of end-use or terminal equipment. When that occurs, there could be a conflict in the California subsidiaries of AT&T that are distributing free TDD equipment. The California distribution system may be only a transitional one; distribution of TDD terminals financed by a customer-subsidized trust fund could be considered a cross-subsidy. The full impact on the deaf of Computer Inquiry II and legislation being drafted in the U.S. House and Senate cannot be determined at this time.

DEAF POLITICS

Because the TDD system was so much a grassroots movement, one "by and for the deaf, " it has not been immune to divisions within the deaf community. The original impetus for the development of the device and its diffusion was dependent on at least four deaf men—Weitbrecht, Marsters, Saks, and Breunig—who were educated orally (i. e., to lipread and speak and to function with speech in their professional and personal lives). Marsters and Breunig were among the founders of the Oral Deaf Adults Section of the Alexander Graham Bell Association for the Deaf. The Oral Deaf Adults Section was begun in 1964 when the first TTY was demonstrated, and its growth paralleled that of the TTY system. The desire of these deaf individuals to communicate with each other from different parts of the country reinforced their work on the TTY system. In order that the whole deaf population of the United States be eventually included in the system, they included from the first representatives from the National Association of the Deaf, a much larger consumer organization of deaf persons who advocate the civil rights and vocational oppor-

tunities of deaf people. The National Association of the Deaf recommends the use of sign language in education and employment.

Federal agencies did not encourage the original developers of the system. However, Telecommunications for the Deaf, Inc. (TDI), established good rapport with AT&T and was able to use the connection to support the system's growth. Much later (1977'), the National Institute of Handicapped Research gave SRI International the grant to develop an ultraportable TDD; although the deaf community was consulted by SRI International in evaluating the prototype, deaf persons were apparently not consulted by the Federal agency when the grant was awarded. Considering that a group of deaf persons had developed the whole TDD system from two devices to a nationwide network, some people might say that deaf/deaf and deaf/hearing politics played a role in the decisions about Federal support.

TDI disseminates information about TDDs and has become increasingly social and political. Some deaf persons have suggested that it is now appropriate for AT&T to assume this organization's distribution and directory services. In at least one State, AT&T distributes equipment to deaf people through its subsidiaries. TDD users are listed in some regular telephone directories with a TDD symbol by their names. This method of listing may become more inclusive than the directory published by TDI, which does not contain the names of all TDD owners but only of those who pay dues to the organization.

Despite the tensions of deaf politics, almost everyone involved in the development of TDDs agrees that the growth of the TDD system has progressed smoothly in contrast to other developments in the deaf community, particularly those regarding the education of deaf children.

Appendix A.— Personal Communications

The authors of this background paper engaged in personal conversations, either face to face, by telephone, or by a telecommunications device for the deaf (TDD), with a great many of the individuals involved in the development of the deaf telecommunications network. Research interviews conducted on a TDD including a hard-copy printout are especially successful because they include a complete record of the conversation, which is then available for reference. In the following list of persons interviewed, the names of those who are hearing impaired are marked with an asterisk (*). The date of the conversation is included in each entry.

Bliss, J., President, Telesensory Systems, Inc., Palo Alto, Calif., Oct. 21, 1981.

*Breunig, L., Founder and first President, Telecommunications for the Deaf, Inc., currently a consultant in Arlington, Va., October 1981.

Castle, D., Telephone Communications Lab, National Technical Institute for the Deaf, Rochester, N. Y., Aug. 19, 1981.

Chamberlain, W., Public Relations & Media, C&P Telephone Co., Washington, D.C, Nov. 3, 1981.

*DePietro, L., National Academy of Gallaudet College, Washington, D. C., October 1981.

DuBow, S., National Center for Law and the Deaf, Gallaudet College, Washington, D. C., Oct. 22, 1981.

Engelke, R., President, Ultratec, Inc., Madison, Wis. (manufactures Superphone? VIP, and Minicom® TDDs), October 1982.

Fylstra, D., Software Engineer, SRI International, Menlo Park, Calif., Director of project funded by the Rehabilitative Services Administration to develop an ultraportable TDD, Oct. 20, 1981.

Karchmer, M., Director, Office of Demographic Studies, Gallaudet College, Washington, D. C., October 1981.

Levitt, H., Graduate School of Communications, City University of New York, New York, N. Y., Winner of the Johns Hopkins University First National Search on Personal Computing To Aid the Handicapped, October 1981.

*Marsters, J., D. D. S., Pasadena, Calif., Cofounder of Applied Communications Corp., with Andrew Saks and Robert Weitbrecht, Nov. 12, 1981.

*Miller, W. F., Jr., President, Oral Deaf Adults Section, Alexander Graham Bell Association for the Deaf, Poughkeepsie, N. Y., Oct. 23, 1981.

Peacock, F., General Manager, Network Operations, C&P Telephone Co., Washington, D. C., Oct. 24, 1981.

Proscia, V., Innovative Rehabilitation Technology, Inc., Los Altos, Calif., Oct. 21, 1981.

*Ross, M., Department of Communication Sciences, University of Connecticut, Storrs, Corm., October 1981.

*Stone, H., Self Help for Hard of Hearing Persons, Inc., Washington, D. C., Oct. 21, 1981.

'Strassler, B., Executive Director, Telecommunications for the Deaf, Inc., Silver Spring, Md., Oct. 20, 1981.

Traub, J., Acting Director of Technology, National Institute of Handicapped Research, Washington, D. C., Oct. 21, 1982.

Vanderheiden, G., Director, Trace Research and Development Center, Madison, Wis., Oct. 20, 1981.

Warren, D. R., President, Clinical Convenience Products, Inc., Madison, Wis., Sept. 15, 1981.

*Weitbrecht, R., Inventor of echo-suppressing acoustic coupler which made the TTY system for the deaf possible, Redwood City, Calif., Oct. 28, 1981.

Withrow, F., Director of Division of EducationalTechnology, U.S. IXpartrnent of Education, Washington, D. C., formerly Director of the Division of Educational Services of the Bureau of Education of the Handicapped, Oct. 21, 1982.

Appendix B.—Sample Personal Communications by TDD and TDD-Related Services

The following are samples of telecommunications device for the deaf (TDD) conversations that actually took place during 1 week in December 1981, All of these interactions are unremarkable, except for the fact that the persons who initiated the telephone calls, and in some cases the persons who received them, were deaf.

- A recent college graduate, seeking employment advice, called the author's office to request an interview.
- A woman telephoned METRO Information to verify changes in the bus schedule after new subway stops had opened.
- A high school senior from Washington, D. C., telephoned an adult friend in California to discuss colIege choices and ask for a letter of recommendation.
- An employee of the Department of Commerce called his office early on a snowy morning to ask whether or not "liberal leave policy" was in effect.
- A young couple, expecting their first child, telephoned an interpreter, who, in turn, called the obstetrician to confirm an appointment. When the child is due, the couple plans to telephone the hospital (which also has a TDD) to announce that they are on their way.
- A guest called her hostess to discuss how much food and how many folding chairs she should bring to the potluck supper on Saturday night.
- A Pennsylvania State college student was issued a TDD by the college for use in her dormitory room and was allowed to bring the TDD home on Christmas vacation. The first thing she did when she got home was to call her boyfriend to arrange plans for New Year's Eve.

TDD communication opportunities are expanded by volunteer, private, or State-supported answering services that handle simultaneous two-way calls between TDD users and non-TDD users. Such service allows a TDD user to make any of the types of calls listed above even if the person being called does not have a TDD. There is some loss of privacy and spontaneity, and if the call is long distance, the caller loses the cost advantage of direct dialing.

- The Micro-Dan service of the Greater Los Angeles Council on Deafness (GLAD) offers 24-hr information on job opportunities, local emergency numbers, news, and other listings to deaf TDD users.
- Telecommunication Exchange for the Deaf, Inc., of Great Falls, Va., offers 24-hr service and stresses that, up to 11 p.m., social calls are as important as emergency calls. This service is completely staffed by volunteers.

Appendix Cm—Sample Printout of a TDD Communication (October 1981)

LATHAM ON.i. GA

HI, ITS JINNY STERN. Do YOU HAVE TIME NOW IF I ASK SOME QUESTIONS ABOUT TTY HISTORYXX HISTORY Q GA

YES, FIRE AWAY. BUT DO YOU HAVE OLD COPIES OF THE TDI DIRECTORY THERE USED To BE THUMBNAIL HISTORIES BUT THESE WERE DROPPED ABOUT TWO YEARS AGO. GA

YSXX YES, LUCKILY I FOUND A 1977 DIRECTORY WHICH HAS A GOOD DEATXX DETAILED HISTORY AND I HAVE JUST STUDIED IT. I REALLY WANTED TO ASK QUESTIONS ABOUT PERSONALITIES NOW THAT I HAVE THE ACCURATE DATES.

FOR INSTANCE, DID YOU MEET BOB WEITBRECHT AT THE UTAH ODS XX ODAS MEETING IN 1964 OR HAD YOU KNOWN EACH OTHER BEFORE Q HOW DID THE NETWORK GET STARTED IN TERMS OF FINDING ONE ANOTHER Q

GA

JIM MARSTERS WAS WITH HIS FAMILY AT A RESORT IN CALIFORNIA WHEN SOMEONE HEARD A CHARACTERISTIC DEAF VOICE. THIS MUST HAVE BEEN ABOUT 1962 . SO JIM INTRODUCE HIMELF TO BOB AND THEY GOT TOGETHER

BOB WAS A RADIO AMATEUR-- HE HAD HAD ENOUGH HEARING EARLIER TO PASS THE FCC LICENSE FOR TRANSMITTING. JIM WS FASCINATED. BUT DEAF PEOPLE CANNOT ORDINARILY PASS THE FCC LICENSE TO JIM CONCEIVED THE IDE XX IDEA OF USING THE REGULAR TELEPHONE. THE STANDARD TTY NETWORK AT THAT TIME WAS BUSINESS ORIENTED AND DIRECT WIRE AND PROHIBITIVELY EXPENSIVE INSOFAR AS DEAF PEOPLE WOULD BE CONCERNED

SO OUT OF THAT MEETING CAME THE CONCEPT OF COUPLERS FOR DEAF PEOPLE ALTHOUGH COUPLERS OR MODEMS WERE AT THAT TIME KNOWN.
unfortunate)' BCB CHOSE TRANSMITTING AND RECEIVING FREQEUNCIES THAT WOULD LOCK US INTO A UNIQUE NETWORK.
THE FIRST PUBLIC DEMONSTRATION WAS AT THE A G BELL CONVENTION IN UTAH IN 1964. GA

OK FINE. WASN'T THAT THE YEAR ODAS WAS FouNDED ALSO Q GA

YES IT WAS A BUSY AND MOMENTOUS CONVENTION GA

WAIT A MINUTE.. . . SORRY FOR THE INTERRUPTION. DO YOU FEEL THAT YOU ORGANIZED INTO A CONSUMER GROUP HELPED THE DEVELOPMENT AT THAT POINT IN TIME Q GA

ACTUALLY THE GROWTH OF ODAS AND OF TTYS FOR THE DEAF MORE OR LESS PARALLED EACH OTHER. FOR THE NEXT YEARS 1964-68 THE TTY SYSTEM WAS BEING DEBUGGED AND ANYWAY TTY MACHINES WERE NOT READILY AVAILABLE SINCE AT & T WAS LOCKED INTO THE CARTERPHONE CASE LAWSUIT SO COULD NOT HELP. ODAS MORE OR LESS GREW INDEPENDENTLY OF THE TTY EFFORT. IT WAS INTERESTING THAT THE FOUNDERS OF THE TTY MOVEMENT WERE ALSO ALL ODAS MEMBERS-- CHARTER MEMBERS. GA

WHAT WAS THAT SUIT' Q I MISSED THAT. GA

AT&T WAS INVOLVED IN A LAWSUIT CALLED THE CAREXX CARTERPHONE CASE RELATIVE TO INFORMATION BEING PICKED UP OFF A RADIO AND TRANSMITTED OVER THE TELEPHONE LINES AND VICE VRSA. AT&5 XX AT&T LOST THE SUIT SO IN 1967 SURPLUS TTY BECAME AVAILABLE.

References

1. Albert, W. E., Administrator of Rates and Tariffs, AT&T Long Lines, Transmittal No. 13822 to the Secretary of the Federal Communications Commission, Aug. 21, 1981.
2. Bell Laboratories, "Survey of Sensory and Mobility Impairments and Telephone-Related Impairments" (unpublished), Murray Hill, N. J., 1978.
3. Bliss, J., President Telesensory Systems, Inc., Palo Alto, Calif., personal communication, Oct. 21, 1981.
4. Boothroyd, A., 'Technology and Deafness," *Volta* Review 77:27, January 1975.
5. Breunig, L., "Evolution of the Teleprinter System for Deaf People in the United States and the Teletypewriters for the Deaf, Inc., Organization," Proceedings of the VIIth Congress of the World Federation of the Deaf, Washington, D. C., Aug. 7, 1975,
6. Breunig, L., Founder and first President, Telecommunications for the Deaf, Inc., Arlington, Va., personal communication, October 1981.
7. Brown, J. W., and Redden, M., *A Research Agenda on Science and Technology for the Handicapped* (Washington, D. C.: American Association for the Advancement of Science, 1979).
8. Caligiuri, F. A., "The Telephone and the Deaf" (leaflet), n.d.
9. Castle, D., "Signaling Devices for Hearing Impaired People" (leaflet) (Rochester, N. Y.: National Technical Institute for the Deaf, 1978).
10. Castle, D., "Telecommunications and the Hearing Impaired," *Volta Review* 83:275, September 1981.
11. Castle, D., "Telephone Communication for the Hearing Impaired: Methods and Equipment," *J. Acad. Rehab. Audiol.* 11:91, April 1978.
12. Castle, D., Telephone Communications Lab, National Technical Institute for the Deaf, Rochester, N. Y., personal communication, Aug. 19, 1981.
13. Cerf, V., "The Electronic Mailbox: A New Communication Tool for the Hearing Impaired," *Amer. Ann. Deaf* 123(6):768, October 1978.
14. Chamberlain, W., Public Relations and Media, C&P Telephone Co., Washington, D. C., personal communication, Nov. 3, 1981.
15. Davis, H., and Silverman, S. R., *Hearing and Deafness,* 4th ed. (New York: Holt, Rinehart & Winston, 1978).
16. DePietro, L., National Academy of Gallaudet College, Washington, D. C., personal communication, October 1981.
17. DuBow, S., National Center for Law and the Deaf, Gallaudet College, Washington, D. C., personal communication, Oct. 22, 1981.
18. Engelke, R., President, Ultratec, Inc., Madison, Wis., personal communication, October 1982.
19. Fellendorf, G., *Bibliography on Deafness* (a listing of articles in *Volta Review and Amer. Ann, Deaf)* (Washington, D. C,: Alexander Graham Bell Association for the Deaf, updated yearly).
20. First National Conference of Agents of Teletypewriters for the Deaf, Inc., Proceedings, Washington, D. C., November 1971.
21. Fylstra, D., Software Engineer, SRI International, Menlo Park, Calif., personal communication, Oct. 20, 1981.
22. Fylstra, D. J., and Ross, W. C., *A Communication Device for the Deaf or Mute Person,* prepared for the Office of Technology, National Institute of Handicapped Research, U.S. Department of Education, by SRI International, Menlo Park, Calif., 1980.
23. Grignetti, M., Myer, T., Nickerson, R., et al., *Computer Aided Telecommunications for the Deaf,* report No. 3738 (Cambridge, Mass.: Bolt, Beranek & Newman, December 1977).
24. Karchmer, M., Director, Office of Demographic Studies, Gallaudet College, Washington, D. C., personal communication, October 1981.
25. Levitt, H., Graduate School of Communications, City University of New York, New York, N. Y., personal communication, October 1981.
26. Levitt, H., "A Pocket Telecommunicator for the Deaf" (unpublished paper), winner of the Johns Hopkins University First National Search on Personal Computing To Aid the Handicapped, 1981.
27. Levitt, H., Pickett, J. M., and Houde, R., *Sensory Aids for the Hearing Impaired (New* York: Institute of Electrical and Electronics Engineering Press, 1980).
28. Marsters, J., Pasadena, Calif., personal communication, Nov. 12, 1981.
29. Miller, W. F., Jr., President, Oral Deaf Adults Section, Alexander Graham Bell Association for the Deaf, Poughkeepsie, N. Y., personal communication, Oct. 23, 1981.
30. National Center for Law and the Deaf, *Strategies for Obtaining Reduced Intrastate Rates for TDD Users* (Washington, D. C.: June 1981).
31. Paschell, W., "Audio Loops Are Multiplying" (leaflet) (Washington, D. C.: The Washington Area Group for the Hard of Hearing, April 1980).
32. Peacock, F., General Manager, Network Opera-

tions, C&P Telephone Co., Washington, D. C., personal communication, Oct. 24, 1981.
33. Proscia, V., Innovative Rehabilitation Technology, Inc., Los Altos, Calif., personal communication, Oct. 21, 1981.
34. Ross, M., Department of Communication Sciences, University of Connecticut, Storrs, Corm., personal communication, October 1981.
35. Schein, J. D., and Delk, M. T., Deafness Research and Training Center, New York University, *The Deaf Population of the United States* (Silver Spring, Md.: National Association of the Deaf, 1974).
36. Schein, J. D., and Hamilton, R. N., Deafness Research and Training Center, New York University, *Impact 1980: Telecommunications and Deafness* (Silver Spring, Md.: National Association of the Deaf, 1980).
37. Stone, H., Self Help for Hard of Hearing Persons, Inc., Washington, D. C., personal communication, Oct. 21, 1981.
38. Strassler, B., Executive Director, Telecomunications for the Deaf, Inc., Silver Spring, Md., personal communication, Oct. 20, 1981.
39. Telecommunications for the Deaf, Inc., *International Telephone Directory of the Deaf* (Silver Spring, Md.: 1981 and earlier editions). [Updated yearly; The 1977 *Directory* contains a history of telecommunications for the deaf; interestingly, later editions do not include these details.]
40. Traub, J., Acting Director of Technology, National Institute of Handicapped Research, Washington, D. C., personal communication, Oct. 21, 1982.
41. Unger, B., "Bringing the Disabled User Into the Design Process: Improving New Technology for the Disabled, " in *Science, Technology, and the Handicapped* (Washington, D. C,: American Association for the Advancement of Science, 1976).
42. Vanderheiden, G., Director, Trace Research and Development Center, Madison, Wis., personal communication, Oct. 20, 1981.
43. Vanderheiden, G. C., and Thompson, C. J.(eds.), *Rehabilitation Aids Resource Book, vol.* I (Madison, Wis.: Trace Research and Development Center, University of Wisconsin/Madison, 1981).
44. Warren, D. R., President, Clinical Convenience Products, Inc., Madison, Wis., personal communication, Sept. 15, 1981.
45. Weitbrecht, R., Redwood City, Calif., personal communication, Oct. 28, 1981.
46. Weitbrecht, R. H., "Teletypewriting Over Telephone Lines" (unpublished paper), November 1965.
47. Withrow, F., Director of Division of Educational Technology, U.S. Department of Education, Washington, D. C., formerly Director of the Division of Educational Services of the Bureau of Education of the Handicapped, personal communication, Oct. 21, 1982.