COMMUNICATION & SENSORY AIDS for the DEAF-BLIND

Report of a Workshop

National Center for Deaf-Blind Youths and Adults

New Hyde Park, New York
November 29-30, 1973

NATIONAL ACADEMY OF SCIENCES

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COMMUNICATION AND SENSORY AIDS FOR THE DEAF-BLIND

REPORT OF A WORKSHOP

National Center for Deaf-Blind Youths and Adults
New Hyde Park, New York
November 29-30, 1973

COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
ASSEMBLY OF LIFE SCIENCES--NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES
Washington, D.C.
1975

SUMMARY

A workshop was held November 29-30, 1973, at the National Center for Deaf-Blind Youths and Adults to stimulate technological innovation in communication and sensory aids for the deaf-blind. After exposure of the guest participants to the deaf-blind clients and their teachers and staff, the main needs cited were a telephone communication device (a prototype of which was developed at the Center) and body-worn telephone-bell, doorbell, and emergency alerting equipment. Contributions toward the development and fabrication of these and other devices were pledged by the participants. The establishment of a clearinghouse of information on past, present and future aids for the deaf-blind at the National Center was recommended.

ABBREVIATIONS

AT&T	American Telephone and Telegraph Company
CPRD	Committee on Prosthetics Research and Development, NAS
IBM	International Business Machines Corporation
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NCDBYA	National Center for Deaf-Blind Youths and Adults
NRL	Naval Research Laboratory
OCR	Optical Character Recognition
SRS	Social and Rehabilitation Service, Department of Health, Education, and Welfare
TTY	Teletypewriter
VA	Veterans Administration

INTRODUCTION

At the request of the Rehabilitation Services Administration of the Department of Health, Education, and Welfare, the National Academy of Sciences in conjunction with the National Center for Deaf-Blind Youths and Adults held a Workshop on Communication and Sensory Aids for the Deaf-Blind on November 29-30, 1973. Representatives of "high-technology" organizations were brought together for a first-hand look at deaf-blind clients and staff, an exchange of technical information, and contributions of expertise to help the Center's research department develop new aids for its clients. A typical letter announcing the workshop to invited participants is shown in Appendix A. Two sets of orientation materials, Appendixes B and C, were sent in advance of the meeting to those who planned to come.

Actions pledged by participants are listed on the next two pages. Follow-up on these items will be reported in a newsletter to be published from time to time by the National Center's Research Department.

Opinions expressed in this report are those of the participants and do not necessarily reflect the views of the National Academy of Sciences.

G. F. Haas
F. M. Kruger

Editors

April 1974

ACTION ITEMS

Edward Abbott - Provide personal help with Marks Script Guide improvement, wiring of circuits, and work involving computer skills.

Louis Bettica - Poll deaf-blind clients to determine the preferred standard operating procedure in deaf-blind communication (simple codes such as yes, no-no).

Jeofry Courtney-Pratt - Obtain Bell System reports on development of applicable communication devices; look into availability of letter templates for use as writing aids.

Emily Cromar and Anthony DeSimone - Secure sufficient funding for NCDBYA research department to permit implementation of KRUGER action item (below) in addition to present research department commitments.

Howard Freiberger - Act as information resource on VA and other sensory aids.

Grace Howard - Advertise in Telephone Pioneers newsletter for volunteer help; coordinate such help with Dr. Kruger's office.

Steven Jamison - Determine if any division of IBM can provide help.

Frederick Kruger - Establish clearinghouse of information on aids for the deaf-blind; prepare and keep up-to-date a list of abandoned devices together with the reasons for rejection; produce a newsletter periodically, to follow up on this meeting and to inform workers and deaf-blind subjects of developments in the field.

Gale Smith - Determine existence of AT&T devices for the deaf-blind and advise Dr. Kruger.

Phillip Stein - Provide personal help with NCDBYA computer programs and circuit designs. See if NBS can contribute to fire-prevention measures including the design of fireproof potholders.

Floyd Thomas - Solicit help of Grumman Corporation in the manufacture of eight Telebraille prototypes.

William Vaughan - Determine possible NRL contributions to embosser design and onset of boiling indicators.

Robert Zimmerman - Determine what contribution NASA can make in prototype construction.

November 29, 1973
National Center for Deaf-Blind Youths and Adults

The meeting followed the agenda (Appendix D).

Participants are listed in Appendix E.

Opening Remarks:

Mr. DeSimone, serving as Chairman for the morning, opened the meeting at 9:20 a.m. He outlined the purpose and planning behind the meeting, explaining that it was to be a program of "total immersion" in the activities of the National Center.

He referred to the permanent buildings of the National Center which will be constructed very soon at Sands Point, Long Island. He explained that the present, temporary facility was the first of its kind set up to serve this severely multihandicapped segment of the population. Although communication is the basis for all service to the deaf-blind, it has become apparent that not enough basic information exists on what communication aids are available. It might even be the case that solutions to some problems are being sought or already exist in other disciplines and could be made available to the deaf-blind with very little or no modification. In any event, the collective thinking of experts from both government and private industry might very well act either to coordinate existing information or to generate scientific solutions to hitherto unsolved problems. Mr. DeSimone hoped that the exchange of information at the meeting would be immediately useful and would form the basis for a continuing dialogue.

Dr. Salmon welcomed the group and spoke briefly of the Center's aims and needs. He made mention of the Center's mandate to establish and maintain a register of the deaf-blind, with the objectives that the deaf-blind population of the United States be identified accurately and the extent and nature of their needs be determined. He pointed out that communication is the key to service to the deaf-blind and talked of some of the methods currently in use and noted how this had become the highest priority of the Research Department. Cooperation between

the Regional Centers for Services to Deaf-Blind Children is also a vital part of the program, and it is recognized that many of the children will eventually become candidates for services from the National Center.

Dr. Haas, speaking for the National Academy of Sciences as host, explained that the Committee on Prosthetics Research and Development (CPRD) has advised the Veterans Administration and the Social and Rehabilitation Service on prosthetic devices since 1945 and has more recently taken up sensory aids through its Subcommittee on Sensory Aids. He noted that one of the participants, Dr. Carl Sherrick, was a member of this subcommittee. CPRD has traditionally started with the client's needs, promoted research and development to fill these needs, and then has tried to speed adoption of resulting new methods and devices to bring them into general clinical use. It was in this spirit that the day's schedule had been planned. While the most important factors in rehabilitation are the skill, patience, and understanding of the teaching staff in a one-to-one relationship and simple devices can be of crucial importance, nevertheless there exists a great need for sophisticated devices. There is a gap between what technology can provide and what is available at this time, and it is to fill this gap that this meeting was organized.

Dr. Smithdas was then introduced and spoke as a "consumer" of electronics aids for deaf-blind people: "I think that right here in the beginning we have a communication problem, because you will not be able to interrupt me while I speak! It is my hope that in the near future the following things will come to pass. What we need now is essentially the freedom to be able to communicate with other people--to make it possible to communicate even with a stranger. We need to give the deaf-blind person this freedom if he is to find a measure of self-reliance. Undoubtedly this freedom will always have limitations, but it is absolutely necessary for adjustment and social acceptance. It has been my experience that many people would like to help the deaf-blind, yet have

no clear understanding of how to communicate with them or what the basic problems are that need to be solved immediately. I hope that the program planned for today will help to bridge this gap and provide an understanding of our most urgent needs."

Mr. Bettica welcomed the participants and then spoke of the day's activity: "Working with the deaf-blind has been a very lonely occupation for many years. We have had past experience with companies interested in helping us but somehow or other results never materialized. Perhaps in the past, profit considerations or the lack of a large number of potential users were deterrents to groups following through. I hope that your interests and abilities are such that you will follow through on ideas developed at this meeting. Just a brief description of our position is in order. We have this temporary facility, and we have the use of the Industrial Home for the Blind's Rehabilitation Center. We are in both facilities at the present time. We have tried not to change our usual program for your visit because we have found that this might be troublesome and difficult to handle. Also, we didn't want to present a phony picture to you. With respect to today's activities, 17 clients will be involved at work in one location or the other. There is a wide range of capabilities between clients. Intellect varies widely, and visual or hearing abilities vary from none to a somewhat useable minimum. Today you will be separated into groups to observe clients in their daily activity. To indicate the start and end of training periods we use bright lights, loud bells, and wireless pagers (which many of the clients wear)."

Rotation Through Staff/Client Stations

The guests were separated into assigned groups which then rotated among the teaching stations: Communications, Skills of Daily Living, Domestic Science, Industrial Arts, Physical Orientation and Mobility, Corrective Physical Therapy, and Speech and Hearing therapies. Since these activities are divided between the National Center and the

Rehabilitation Center of The Industrial Home for the Blind, the guests were bussed between both facilities. Questions to the staff and examination of teaching aids were encouraged. Some guests communicated with clients by means of finger-spelling taught the previous evening by Mr. Bettica. From 12:00 to 1:00 p.m. an informal discussion continued during a working buffet lunch served at the National Center. Rotation of groups then continued until 4:00 p.m.

Question and Discussion Period

The participants reassembled as a single group at 4:00 p.m. and Dr. Kruger opened the session with a few comments about the workshop. He reminded the group that the entire workshop grew out of the need for communication devices which hadn't been and couldn't be manufactured commercially because of the resultant cost. Unlike the long cane, which only the handicapped person must buy, some communication devices require both the "sender" and "receiver" to have units, thereby doubling the costs. The Telebraille is in this category and would probably cost five to ten thousand dollars each if manufactured commercially, but the hope is for the National Center and possible cooperating groups to produce them for under $1000.

He solicited questions from the participants, noting that the primary emphasis for the discussion should be communications since time was limited and communication devices were urgently needed. Dr. Kruger concluded with the request that the discussion be kept on a practical rather than a theoretical level.

A question-and-answer period ensued, during which various subjects were clarified, as summarized below:

If a design were submitted, who would build it?

Any designs or ideas are acceptable without responsibility for implementing them. Others at the meeting might have the capability--or be able to share the capability of prototype construction. The Center will attempt to coordinate different skills and knowledge.

Do you have any plans to investigate new braille schemes?

It was agreed that no further modifications be made due to the widespread use and range of brailled matter available. There are many communication problems that have much higher priority.

Do the deaf-blind have a problem in obtaining paper tape for use in various aids?

There was agreement that for some the procurement of paper tape for a braille t pe embosser might be a problem, but, when the actual amount used is considered, the likelihood is that arrangements could be made to assure an uninterrupted supply.

There is a variety of different communication systems required due to emotional problems and variations in mental ability and age of clients. Will this prevent use of your devices outside the Center and thus destroy the opportunity for mass production?

Not necessarily. We are obviously confronted with this problem when we attempt to have devices commercially produced in quantity. Since the consumer cannot be made to fit the device, the device must be made to fit the consumer. Possibly basic models could be mass-produced and then custom-fitted for each client--perhaps by volunteer technicians.

Is work being done in the development of teaching aids for deaf-blind persons?

There are many aids which have been adopted from related fields, but we still need some which will assist us in teaching abstract as well as concrete concepts to deaf-blind people. For example, we have clients who come here with no language and no concept of time. We must teach them both. Over the next few years, we will have to develop the very specialized aids needed to teach the deaf-blind. Hopefully, we won't be alone in this endeavor.

What is the state of the art of optical character recognition (OCR) machines that can produce braille?

The problem consists of three parts: recognizing the characters, translating them to braille, and embossing an output medium. The first two operations have not yet been engineered to a workable system. The Visograph was mentioned as an experimental device in the 1940s that has been abandoned. (Mr. Freiberger still has a model in his office.) But there is nothing sacrosanct about braille. We find that many people who suffer from retinitus pigmentosa have usable vision for 30 to 40 years and, unfortunately, don't have the same motivation to learn braille as do the hearing blind. Devices that permit direct reading of inkprint would be far more useful, since the entire library of published literature is then opened to a deaf-blind person, while only a relatively small selection can ever be put into braille. The Optacon is available as a direct optical-to-tactual translation device but still requires skill and training. To hearing users of direct-translation devices, the fact of being able to read inkprint independently at all is frequently far more important than considerations of what reatind speeds are achievable.

Is it possible for someone to be too handicapped to be helped by the National Center program?

With regard to our selection process, yes--they have to be toilet trained and ambulatory. We don't take people under 18 generally because our residences are 15-20 miles away. In our permanent facility we will be able to take younger people. We have had people come here who literally didn't know their own names. They had no concept of language or their own identity. Yet they have been brought to the point where they can go to sheltered workshops or competitive employment. Whatever can be benefited by the children will be shared. We are anxious that the schools do not feel that the National Center is the solution to their problems. The schools have an advantage we don't have. They can work with a child for 12 years under controlled conditions and when you come to teaching language and Tadoma* it is not to be expected that we can do it in the year or two or three we might be able to devote to rehabilitation. Many things a child doesn't learn by 12 or 13 probably won't be learned by 20 or 30, such as concepts of social ethics, love, and relationship to people. It is not our desire to serve in place of the school, but rather to plan together so that education in the school will relate to the reality of a handicapped person functioning in a sighted, hearing society. Ideally, National Center clients will have had this training when they come here for services. But we have seen many cases where people, who would have been considered entirely unable to profit from rehabilitation ten years ago, are presently able to achieve a very functional level as a result of our services.

When a need is defined and a device is designed, what procedure will be followed for its development?

Development will follow the same sequence as in the electronics industry--"breadboards" will lead to prototypes and prototypes will lead to field-test models. In the field we will attempt to finalize designs such that the device has maximum utility, is resistant to breakdown or damage, and actually does the job for which it was designed.

Mr. DeSimone closed the discussion by expressing his confidence that this combined pioneering effort by government and private organizations and the National Center will soon yield concrete benefits in deaf-blind rehabilitation.

Telebraille Demonstration

At the close of the discussion, Dr. Kruger demonstrated the Telebraille--a device for sending braille over the telephone, which

*A method of speech reading in which the "listener's" fingers are placed on the lips, nose, cheek and throat of the speaker. See, for example: Vivian, Rose M.: "The Tadoma method - a tactual approach to speech and speech reading," Volta Review 68:733-737, December 1966.

is described in detail in Appendix C. Being portable, it can be used at home or carried outside and used on any telephone. However, it does not tell a person when the phone rings. (Such an indicator will be a function of the Wrist-Com, another device which was recently designed at the National Center.) When connection is established, braille can be sent back and forth. Dr. Kruger explained that it was the hope of the Center that models could be tested in the field to determine any necessary modifications to the design. He noted that the present models are basic and options such as a full alpha-numeric keyboard, voice talk-back and compatibility with the deaf phone-teleprinter network will be available in future versions.

Dinner Meeting

Following adjournment of the meeting at 5:00 p.m., guests and staff members of the National Center met and exchanged ideas during an informal dinner meeting that began at 6:00 p.m.

November 30, 1973
Holiday Inn, Westbury, L.I., N.Y.

The meeting opened at 8:45 a.m. Dr. Haas explained that, after a definition of the problems and three formal presentations, the day was purposely scheduled flexibly for the best exchange of information, allowing participants to break up into small groups if this was found desirable.

Because of lack of time, Dr. Kruger discussed only some of the devices in the previously distributed catalog of "Current Communication and Sensory Aids for the Deaf-Blind" (Appendix C):

1. The Perkins Brailler and Tellatouch are serviceable and meet with wide approval.

2. The Tactile Speech Indicator has received some criticism in that it is not sufficiently sensitive for all users, and some people forget to turn the battery switch off. Also, it works with induction-coil pickup, and many new telephones are not going to have earpieces which will radiate any significant magnetic field unless they are

modified. (Mention was made that the California State University, Northridge had funded the development of a device called the Speech Indicator, which is almost identical except that its output can also be visual.) It was also pointed out that communication by Morse Code was not as simple as one would wish because of the effects of extraneous noise, etc. In an ensuing discussion on coding schemes, an Action Item for Mr. Bettica (Page iv) was agreed on.

3. The Triformation BD-3 Braille Embossing Device is a unit which the Center is attempting to obtain for evaluation purposes. It could be installed with the Model 14 teletype unit and used for communication with the deaf TTY network, and also for communication between the Center and the apartment of the Director of Community Relations who is deaf-blind. Problems exist in that the unit is too large and too expensive.
4. Mention was made of the Bell and Howell and TAC-COM paging systems. While both are useful, there are limitations--fragility, susceptibility to water damage, and limited range. TAC-COM is capable of responding to coded signals, while the Bell and Howell is not, but it requires induction loops, which Bell and Howell does not.
5. Help is needed in further developing the WRIST-COM. There is an immediate need for a paging device which can handle individual calls, group calls, and precanned messages--plus the ability perhaps to handle Morse or other coded signals.

For further information on other devices listed, participants were urged to contact Dr. Kruger later.

He concluded by emphasizing the three immediate needs of the Center, unfulfilled by existing devices, as:

1. Eight or ten field-test models of the Telebraille.
2. A paging receiver to be worn on the body that will handle a number of types of intelligence transmission.
3. Doorbell and telephone ring indicators.

In the future, development of additional devices for use in the household, kitchen, etc. will be desirable.

At this point Dr. Smithdas reiterated that from the "consumer's" point of view the three most essential devices are:

1. A fool-proof doorbell signaling device.
2. A fool-proof telephone bell signaling device.
3. A means of communicating over the telephone, such as the Telebraille.

Participants noted the following additional miscellaneous needs of the Center that came to light during the first day's contacts with clients and staff:

1. Letter templates, a script guide and a portable brailler all need engineering or human-factors modifications.
2. Hearing-aid adapter for new telephones without magnetic fields.
3. An intervalometer that produces a worktable vibration at regular intervals of preset duration.
4. A vibratory margin indicator for use with the standard Perkins brailler.

Recommendation was made that, in addition to its other responsibilities, the Research Department of the National Center function as a clearinghouse for information on aids for the deaf-blind. Mr. Freiberger drew attention to the fact that, in the effort to establish clearinghouses of information to avoid duplication, it is possible to duplicate clearinghouses. The American Foundation for the Blind and the VA, for example, both already compile information. Dr. Haas noted that a survey of sensory aids research appears in Appendix B of the CPRD Annual Summary Report. After some discussion it was recommended unanimously that the Center serve as a clearinghouse of information on devices that are specifically designed for the dual handicap of deaf-blindness, and that a record also be kept of devices tried and rejected, with the reason for rejection. It was also felt that the issuance of a periodic newsletter on activities would

be helpful. These recommendations were made with the understanding that additional expenditures required by this expanded activity would be submitted to SRS for approval as part of the budget at the appropriate time.

Dr. Haas, speaking to the 9:00 a.m. item on the agenda, noted that the objectives had already been listed in correspondence to the participants (a typical letter is reproduced as Appendix F). The objectives for the rest of the day were:

1. exchange of technical information, suggestions of how technology, or perhaps already existing devices, can be applied to problems of the deaf-blind;

2. discussion of the possible contributions participants may be able to make in the design or fabrication of equipment through

   a. the organization's contribution of surplus production capacity (equipment and manpower) or

   b. volunteers, perhaps using shop facilities after hours, or

   c. loan or donation of organizations' surplus test or other equipment.

Dr. Haas also hoped that, even if this meeting only brought modest results, the publicity resulting from a few concrete aids would stimulate further work and thus have a snowballing effect. If future meetings of this sort are desired, the National Academy of Sciences will probably be able to arrange them.

Formal presentations were now made by Mr. Khogendra Das of the Regional Deaf-Blind Center, Bronx, N.Y., Mr. George F. Dalrymple of Massachusetts Institute of Technology, and Dr. Carl E. Sherrick of Princeton University. Summaries of these papers are given in Appendixes F, G., and H, respectively.

At 1:00 p.m., following a break for lunch at 12:00, the meeting reconvened. Dr. Haas asked the participants where they felt their particular areas of interest lay and what they might possibly contribute.

Mr. Gale Smith of Services for the Handicapped, American Telephone and Telegraph Company, will determine what devices exist for the deaf-blind and report back details, prices, etc.

Ms. Grace Howard, speaking for the Telephone Pioneers, described it as a voluntary association of the longer service employees of the telephone industry and those who are retired. Of the 380,000 members, well over 100,000 perform community services of various kinds each year. She felt that through the Pioneers' Newsletter volunteer help of several kinds might be obtained. Many members of the Pioneers' organization have expertise in electronics which they could contribute. Also, former assembly line workers might very well be able to assist in kit assembly if there were a need. In addition, she offered her office as a contact point enabling Dr. Kruger to contact groups of volunteers. She is working on a catalog of devices built by Pioneers for handicapped people, which will be made available to Dr. Kruger upon its completion.

Dr. Courtney-Pratt of Bell Laboratories mentioned that research had been done on several wireless telephone devices which operate within a building or room (e.g., infra-red, ultrasonic, and radio). He offered to obtain for Dr. Kruger's consideration any reports written on these instruments. He felt that he might also be able to arrange for small, recessed letter templates for use as teaching aids in writing. An important point he emphasized was that it might be very worthwhile to look into already existing devices which have acoustic outputs. He will also send reports of various devices developed for the handicapped by Bell Laboratories.

Mr. Thomas of the Grumman Corporation spoke of his efforts to arrange for the building of eight prototypes of the Telebraille for the Center. He had been designated by Grumman to represent the Center in its dealings with the corporation, and, while he was making every effort, he explained that it was not possible for him to give a definite answer at this time. A concurrence of management was necessary, but he, himself, was very hopeful that this could be obtained.

Dr. Jamison of IBM explained that his company was comprised of several different divisions. While his division concentrated more on marketing than on development, he felt he could be of assistance in identifying competencies within the various divisions that might be relevant to particular problems facing the Center. His personal feeling was that IBM would probably have more capabilities in the terminal area--the Telebraille or extensions to it -- than in other areas discussed.

Mr. Zimmerman of NASA stated that they would take on some prototype work as it came along--perhaps some small circuit prototypes. Investigation would be made into the area of vibro-tactile devices for the Wrist-Com.

Mr. Stein of the National Bureau of Standards explained that he was making personal contributions along the lines of assisting with computer programs and circuit design. He mentioned that truly fireproof potholders and potholder gloves and the whole question of fire-prevention items might be referred to the research and safety group within NBS, as it is quite publicly oriented. Ideas for devices to solve various problems were submitted, which Mr. Stein suggested should be built and given to the Center for use and evaluation. He pointed out that contributions could be made by him personally, but for organizational help he would have to obtain management approval.

Dr. Vaughan of the Naval Research Laboratory felt that contributions could be made in the area of embossers. It occurred to him that an embosser using plastic or some such material which could be erased at leisure would be a useful device. In the area of ultrasonics, his department might be interested in the onset of boiling and also might have helpful research reports on the difficulty of walking a straight line. The nature of the commitment of NRL will be to evaluate proposals and respond to each request as it occurs. Mr. Abbott of Naval Research Labs mentioned that although he was not a designer he was skilled in computers and could wire circuitry. He could volunteer his own time and work on the Marks Script Guide.

Mr. Freiberger of the Veterans Administration offered himself and his office as a research and consulting source. He mentioned that the Veterans Administration has an excellent collection of books, papers, patents, photographs, films, tape recordings, and a historical collection of equipment which would be open for inspection. The VA has experience with orientation and mobility devices and closed-circuit television readers. He would be most pleased to provide any information the VA has available.

In a general discussion, Mr. Stein commented that, rather than worry too much about possible shortcomings of a proposed device, one should go ahead and build it, and then let the staff and clients of the Center evaluate it--they are in the best position to do so. Drs. Sherrick and Haas elaborated on this, noting the importance of behavioral training and testing with a new device; the need for warning staff and users of frequent expected breakdowns of prototypes, so that the device's function can be evaluated independently of the prototype's ruggedness or reliability; the need for constant total communication, from the design stage through field tests and beyond, between device developer, trainer, user, and evaluator; and, above all, the necessity for persistence in the face of setbacks and real or imagined occasional lack of appreciation by the intended beneficiaries.

Although many of the participants are not mentioned individually in this writing due to space limitations, all contributed their interest, opinions, and expertise.

At the close of the general discussion, the group split into three sections in order to work on the three immediate needs of the Center: 1) eight or ten field-test models of the Telebraille, 2) a paging receiver to be worn on the body that would handle a number of types of intelligence transmission, and 3) doorbell and telephone ring indicators.

The group reconvened as a whole to hear the following concluding remarks:

Smithdas: "I am very appreciative of what Dr. Haas and the National Academy and all the participants have done in considering the problems of the deaf-blind. But I would like to remind you all once again that our present needs are the basic survival devices which I mentioned earlier. It would be easy for us to anticipate what the deaf-blind will need in the future, but right now we need these three basic devices. Perhaps some of us will come up with ideas, and we might feel that because those ideas are rejected we are being personally criticized. The question now is whether you can help this group that has hitherto never been given the opportunity to realize a certain measure of independence. Can you give them the assurance that somebody DOES CARE about their problems?"

Haas: "That's quite well taken. I think since there are three of us listed in concluding remarks that I would like to thank the people from the various organizations who came. It is inadequate to say 'thank you' because I really think that these two days have been a big contribution and I have a strong feeling that we will get additional contributions. I would like to thank them on behalf of the National Academy of Sciences. We hope that this entire meeting is the beginning of a continuing dialogue at the minimum and at the maximum much more than that in the sense of actual contributions by people, which hopefully will be as rewarding to the contributors as to the beneficiaries."

Kruger: "I would like to thank you all very much for attending and for being active participants. I realize the last two days have been hectic, but you were forewarned. Your willingness to come here to learn about some of the

day-to-day problems deaf-blind people have is appreciated. Now, it is your opportunity to turn verbal commitments into hard realities.

You will be hearing from me--maybe not immediately, but soon. If any questions come up, or problems develop, please feel free to call me.

On behalf of the entire staff of the National Center, I want to again thank you for attending this Workshop and for committing yourselves to assist in the development of aids for deaf-blind people. I am confident that you and your respective organizations will show that you do care."

DeSimone: "Well, Gentlemen, I can only add this thought. What we began seems like an awfully long time ago--only yesterday morning. But we have covered a tremendous amount of ground. And both as the chairman of the advisory committee of research here at the National Center and also representing the Rehabilitation Services Administration, I think we have achieved the objectives the planning committee has set. Secondly, I would say that this is not a concluding remark. As Gus said, this is only the beginning of what I hope will be a long productive dialogue on behalf of those objectives which Bob Smithdas has set so well. Thirdly, I think that we have all found out that when the National Academy of Sciences buys us lunch, dinner and lunch again, there's no such thing as a free lunch--they sure made us work for it. And so we're looking forward to those commitments which you've all made. Thank you very much."

April 17, 1974

NATIONAL RESEARCH COUNCIL
ASSEMBLY OF LIFE SCIENCES

2101 Constitution Avenue Washington, D. C. 20418

DIVISION OF MEDICAL SCIENCES (202) 389-6345

Committee on Prosthetics Research and Development

Dear_____:

The Social and Rehabilitation Service of the Department of Health, Education and Welfare has asked us to organize a conference with the National Center for Deaf-Blind Youths and Adults to develop technical aids for the Center's clients.

Because of the relatively small population and resultant scarcity of public funds, the Center needs:

1. Help in fabricating alerting and communication devices which have already been designed.

2. Design and fabrication of new devices as needs become identified. One such need is for an environmental monitoring device that can distinguish e.g. doorbells from telephones from fire alarms, and encode and transmit these signals for reception by a wrist vibrator.

3. Help with reconciling communication requirements with FCC regulations or with obtaining waivers to regulations.

4. Suggestions from representatives of "high technology" organizations concerning possible applications of existing equipment or designs to problems of the deaf-blind.

In addition to serving the needs of its resident clients, the Center develops aids for deaf-blind individuals in other environments and for its "alumni." Together with its four regional offices across the country, it acts as a clearinghouse of information on available devices as well as requirements for new ones.

Appendix A-2

I am wondering if personnel at your Laboratory (and other organizations being contacted) are in a position to volunteer their expertise, and possibly services and shop facilities on a "space available" basis, to contribute to the development of aids for this much-neglected population. The first step would be attendance at the conference, to be held at the Center in New Hyde Park, NY, November 29-30, 1973. One day would be devoted to exposure of the participants to the deaf-blind clients and their teachers and staff. The second day would be a discussion of technical solutions to problems and possible contributions of each participant's organization.

More detailed orientation materials will be sent to participants by November 1. Travel expenses are paid by the Academy.

We are making every effort to restrict attendance to those who are in a position to make continued contributions after the conference, and prefer negative replies to *pro forma* attendances. If your organization can participate on this basis, we would be most appreciative of its contribution, and would request attendance at the conference of one or two coordinators for your organization that you may suggest.

Yours sincerely

Gustav F. Haas, Ph.D.
Staff Engineer

GFH:ph

Copy to: Dr. Frederick M. Kruger
Director of Research
National Center for Deaf-Blind
Youths and Adults

APPENDIX B

HISTORICAL BACKGROUND
of the
NATIONAL CENTER FOR DEAF-BLIND YOUTHS AND ADULTS

Most people have never seen a deaf-blind person. Those who have, look at them as creatures worthy of pity and detach themselves from any contact with such a doubly handicapped individual. Until the past decade or so, this attitude tended to push the deaf-blind, one of the smallest of the minority groups, further into isolation and concomitant loneliness. Rehabilitation agencies for the deaf, as well as most of such agencies for the blind, felt they could not cope with the double problem that loss of sight and hearing presents.

One agency that felt it could deal with the problem was The Industrial Home for the Blind (IHB). The IHB began working with the deaf-blind in 1917 and so had the necessary experience for handling the rehabilitation of this group. With support from the Social and Rehabilitation Service of the United States Department of Health, Education, and Welfare, the IHB ran a research and demonstration program to determine the value and viability of a regional rehabilitation service for the deaf-blind. This program became known as the Anne Sullivan Macy Service (ASMS) after Helen Keller's beloved teacher. Begun in 1962 and continued for seven years, ASMS provided evidence that: 1) the deaf-blind can be rehabilitated; 2) with the help of state and local agencies, the improved functioning of the deaf-blind could be maintained in the person's home community; and 3) public attitudes could be made more positive.

In the 1967 amendments to the Vocational Rehabilitation Act, Congress provided for the creation of a National Center for Deaf-Blind Youths and Adults. In January of the following year, provision was made for the establishment of ten Regional Centers for Deaf-Blind Children to be operated under the auspices of the Bureau of Education of the Handicapped of the United States Office of Education. The Social and Rehabilitation Service of the United States Department of Health, Education, and Welfare selected the IHB in mid-1969 to open and operate the National Center. The National Center was born on June 24, 1969, one day after the official termination of ASMS. Thus, no hiatus occurred in the transferring of ongoing services.

Temporary facilities were leased in Garden City Park, New York, in December, 1969. Deaf-blind people from all fifty states, the District of Columbia, and the United States' possessions and territories are eligible for rehabilitation services from the National Center. These services include homemaking, communications, prevocational

training, speech therapy, mobility training, vocational counseling, social casework, low-vision aids, audiological evaluations, employment placement, home follow-up services, as well as a variety of services provided by regional representatives.

The Deaf-Blind Population

One of the foremost problems in planning for the needs of the deaf-blind is that there is no accurate count of the exact number composing this population. Our best current estimate of the adult deaf-blind population is 5,300. This figure, combined with the approximately 4,600 deaf-blind children who have thus far been identified, brings the total number of persons with this dual handicap to almost 10,000. The National Register of Deaf-Blind is an attempt to answer this question; it includes statistical data on all persons presumed to be deaf-blind who are known to the National Center and the Regional Centers for Deaf-Blind Children. However, there are still deaf-blind people whose names are not on register since their families--all too often unaware of available services--do not bring the deaf-blind person to the attention of the National Center. Also, many deaf-blind individuals are in the back wards of mental hospitals. Only in recent years have they been identified by hospital staffs and referred to the National Center for services. The same is true for the deaf-blind who are lumped in with other handicapped persons in institutions for the retarded and facilities for the chronically ill or aging.

In the agreement with the Department of Health, Education, and Welfare, under which the National Center operates, deaf-blindness is defined as "substantial visual and hearing losses such that the combination of the two causes extreme difficulty in learning." This definition includes many people who have useful hearing and/or sight who can be served in their home communities by local agencies in cooperation with the National Center. Because of this, and in view of the limited number of trainees who can be served at any one time at the temporary facilities of the National Center, a more restrictive definition has been employed in order to give priority to the most severely handicapped. This is the commonly accepted "legal" definition of blindness: "central visual acuity of 20/200 or less in the better eye, with correcting glasses, or central visual acuity of more than 20/200 if there is a field defect such that the peripheral field has been contracted to an extent that the widest diameter of visual field subtends an angular distance no greater than 20 degrees." Deafness is "a chronic impairment of hearing so severe that most speech cannot be understood, even with optimum amplification."

The handicapping effects of deafness lie primarily in the area of communication; blindness affects primarily physical orientation and independent mobility. However, the handicapping properties of each disability are not mutually exclusive, since blindness presents some problems in communicating and deafness affects mobility and orientation to some extent. Needless to say, learning relies heavily on the intactness of both senses; so if both are lost in childhood, educational growth is severely impeded.

The Role of the Research Department

A very important part of National Center is research. Sensory and communication aids and devices are being developed and evaluated which will assist the deaf-blind person to lead a more fruitful and independent life. (These aids and devices are discussed in detail in the remainder of this brochure.) Research into better educational and teaching techniques, personality characteristics of the deaf-blind, tools for use in assessing the deaf-blind individual's abilities, and demographic studies are other improtant projects which fall into the realm of the National Center's Research Department.

At present, the research Department of the National Center is embarking on a multifaceted program. The Telebraille and Wrist-Com (described fully in this brochure) are two devices recently designed by the Research Department which will bring the deaf-blind person into closer contact with his environment. It is hoped that a prototype of the Telebraille will be field-tested within the next several months. The Wrist-Com is still in an early developmental stage because of manpower and budgetary shortages.

Paging devices have been evaluated at the National Center. These include the Bell and Howell Vibration Paging System and the MIT Tactile Communication System (described later). These devices are being used by deaf-blind clients who, in turn, give us feedback as to the merits and problems encountered with these pagers.

The National Center's Research Department also acts as a clearing house of information on available devices and current needs for new aids.

Many problems have been encountered when private corporations have embarked on the development and manufacture of aids for the deaf-blind. Because the deaf-blind population is so small, and individual needs may vary greatly, high-volume production could not be planned. As a result, prices were frequently made so high that

the device was out of reach of most handicapped people, and few purchases were made. To improve this situation, a precise study is required to categorize the needs of groups within the client population with consideration of tradeoffs between simple, special-purpose devices with a small market and more complex, general-purpose ones that apply to larger populations.

More generally, help is needed by the National Center in the development, manufacture, and adaptation of devices for the deaf-blind. The Research Department is too small, and its budget too low, to undertake these tasks on its own. It is for these reasons that we are seeking the assistance of organizations like yours.

As noted earlier, the Research Department is responsible for the National Register of Deaf-Blind Youths and Adults. Statistics derived from this register will help the National Center in planning future services. The National Center has also undertaken the responsibility of maintaining the files of the Regional Centers for Deaf-Blind Children. The data compiled from these sources will make possible longitudinal studies from birth to death and, thus, comprehensive information on the deaf-blind will be gained.

The Future

A permanent facility to house the National Center is close to a reality. On February 22, 1971, a formal deed-signing ceremony was held transferring twenty-five acres of surplus property at the former Sands Point Naval Devices Center from the United States Office of Surplus Property Utilization to The Industrial Home for the Blind for use by the National Center. Also presented at that time was $2,500,000 for the construction of buildings. Blueprints have been completed. However, with skyrocketing building costs, $5,000,000 more was needed to effect the construction and equipping of the buildings. This money was committed on September 20, 1973. When the new buildings are completed, the number of people served at the National Center will triple. Also, the National Center will have its own residence building and will be better able to provide social outlets for the deaf-blind trainees.

With the multiple goals and programs of the National Center, the era of isolation and loneliness so characteristic of the deaf-blind is coming to an end. The future holds the promise of a rewarding and fulfilling life for these doubly handicapped people.

October 19, 1973

CURRENT COMMUNICATION AND SENSORY AIDS FOR THE DEAF-BLIND

(PROTOTYPE AND PRODUCTION)

In recent years, electronics has come to play an increasingly important role in the development of sensory and communication aids for deaf-blind people. Quite a few electronic devices of varying complexity have been produced for this population. The pages which follow contain descriptions of a number of these.

As you read the various descriptions, you will probably find several devices which you would like to modify or redesign to "make them work better." In many cases modern technological advances have not been exploited and an open exchange of ideas at the workshop will be welcome. We hope that the descriptions presented here will give you some idea of the current state-of-the-art, and that your contacts with the Center's clients and staff will indicate the functional requirements that have yet to be fulfilled.

We want to express thanks to the American Foundation for the Blind for their assistance in providing some of the descriptions and illustrations used in this publication as well as for their setting a precedent with their concise reporting of devices in the Foundation's catalog of "Aids and Appliances" for the blind.

Because this is a first attempt at cataloging aids for deaf-blind people, we welcome critical evaluation of our work and hope you will let us know of any errors found in the text.

National Center for Deaf-Blind Youths
and Adults

April 1974

Appendix C-2

Device: The Perkins Brailler

Source: The Howe Press, Perkins School for the Blind, 175 North Beacon St., Watertown, Massachusetts 02172

Purpose or Application: Enables blind and deaf-blind persons to write braille quickly and without the need to reverse the braille cell configuration when writing, as is necessary with a braille slate.

Approximate Price (10/73): $115.00

Description: The brailler is made of an aluminum frame and is 13¼ inches long by 8 3/4 inches wide by 5 3/4 inches high. There are 6 keys which correspond to each dot of the braille cell, a space bar, a back spacer, right and left margin stops, and a key to move the paper upward one or more lines. The brailling unit can emboss a maximum of 42 cells across the page. The dots are embossed uniformly regardless of unequal pressure on different keys.

Device: Tellatouch

Source: American Foundation for the Blind, 15 West 16th St., New York, N.Y. 10011

Purpose or Application: To allow deaf-blind persons who know braille to communicate with people who know neither signs nor the manual alphabet

Approximate Price (10/73): $125.00

Description: The device is 9 inches square and weighs about 3½ pounds. The sender communicates via a standard typewriter keyboard. Beneath the keyboard is a space bar on both sides of which are 3 blank keys. Each of these keys corresponds to a dot in the braille cell. At the back of this device is a metal plate with 6 holes in the shape of a braille cell. The deaf-blind person places his finger on this braille cell. The sender presses a key, causing the corresponding braille letter to be raised in the cell. When the typewriter keyboard is used, only Grade I braille is transmitted. In order to send contracted braille, the sender must be familiar with the contractions and use of the 6 keys below the alphabetical keys. The deaf-blind Tellatouch user can only send messages to persons who know braille.

Appendix C-4

Device: Tactile Speech Indicator

Source: National Center for Deaf-Blind Youths and Adults, 105 Fifth Avenue, New Hyde Park, New York 11040

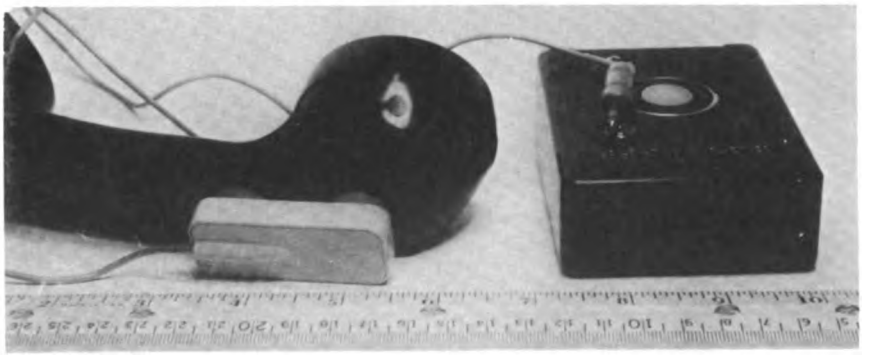
Purpose or Application: To enable a deaf-blind person to conduct rudimentary communication over the telephone

Approximate Price (10/73): Produced for the National Center by The American Foundation for the Blind on an "as needed" basis at a cost of $50.00

Description: The Tactile Speech Indicator consists of an induction coil and an amplifier box with a vibratory output transducer. When the user couples the induction coil to the telephone handset, the signals are amplified and converted into vibrations. Thus, the party who is called can activate the vibrator button by speaking into the telephone, or by signaling with prearranged dial clicks.

The technique used with this device is for the deaf-blind person to ask questions which can be answered "yes" or "no". He explains this to the person he has called and further instructs the other individual to say "yes-yes" for affirmative answers and "no" for negative ones. The former answer results in two vibrations and the latter one, so that the user can distinguish the answer. Alternatively, the hearing person might respond by dialing "1" for no and "2" for yes, the clicks being clearly distinguishable.

This device is approximately 4 inches wide by 3 inches high by 1½ inches deep and weighs several ounces.



Device: Hadley Tactaphone

Source: No longer available

Purpose or Application: Enabled a deaf-blind person to use the telephone either by Morse code or prearranged signals

Approximate Price (10/73): N/A

Description: A light vibrating disc was installed on the back of the handset to receive Morse code. The handset was held in the usual manner, with the index finger on the disc. If a "1" on the telephone dial were sent, a Morse code dot was sent; if a "4" were dialed, this indicated a dash. If a "0" were dialed once, this would signify an affirmative answer to a question; a negative answer would be signaled by a "0" dialed twice.

(See also: New York Telephone Sensicall)

Appendix C-6

Device: Telebraille

Source: National Center for Deaf-Blind Youths and Adults, 105 Fifth Avenue, New Hyde Park, New York 11040

Purpose or Application: Permits two deaf-blind people to communicate over the telephone without third party intervention

Approximate Price (10/73): N/A

Description: The Telebraille is still in the prototype stage. The Telebraille allows the deaf-blind person to communicate over the telephone by braille; however, the design does not employ punched or embossed tape (which can make telephone communication awkward and/or expensive because of the need for maintenance and replenishment of materials). Instead, the design provides for the "listener" to read the message from a single braille cell like that on the Tellatouch, while the "speaker" sends braille.

The designer explains the process as follows: In order to send a message, the user presses keys on a keyboard similar to that on a Perkins Brailler. The braille character is then converted into corresponding audio frequency-shifted binary strings which are acoustically coupled to a telephone handset. On the receiving end, the handset is acoustically coupled to an identical unit which converts the binary strings to signals that drive pins in the braille cell. Thus, the Tellatouch is essentially split in half and modern electronic digital transmission techniques are substituted for the mechanical linkages of the Tellatouch. Moreover, both Grade I and contracted braille can be transmitted via the Telebraille.

Plans provide for the future availability of a standard typewriter-type keyboard so that persons not familiar with braille would be able to communicate with deaf-blind individuals. As in the Tellatouch, a letter would be pressed on the keyboard, and the appropriate braille character would be transmitted. Only Grade I or modified contracted braille could be sent by this adaptation. Future plans also call for: 1) an "add on" to provide for Teletypewriter input or output so that deaf-blind persons could converse with seeing deaf persons or anyone who can read braille, speak, or read print, and 2) a "talk-back" provision so that a speaking deaf-blind person can verbally respond to a hearing person.

(See also: Siemen's Telephone for the Deaf-Blind)

Device: Telephone for the Deaf-Blind

Source: Siemen's Electronics, 8520 Erlangen 2, Post Fach 325, West Germany

Purpose or Application: To enable deaf-blind residents of the Hanover Center for the Deaf-Blind to communicate with each other by telephone within the building

Approximate Price (10/73): $3,000

Description: "Braillophones" are substituted for conventional telephones and are directly connected to the PABX. The deaf-blind person is alerted to a call by the vibration of a selective call pocket radio receiver. Messages are transmitted over the telephone by one individual typing the message on his braillophone keyboard and the other person receiving the brailled message on punched tape from his braillophone. The Hanover Center reports that future plans call for using this system on public telephones and for long distance calls.

(See also: Telebraille)

Device: Braille Control Electronics and Embossing Device (BD-3)

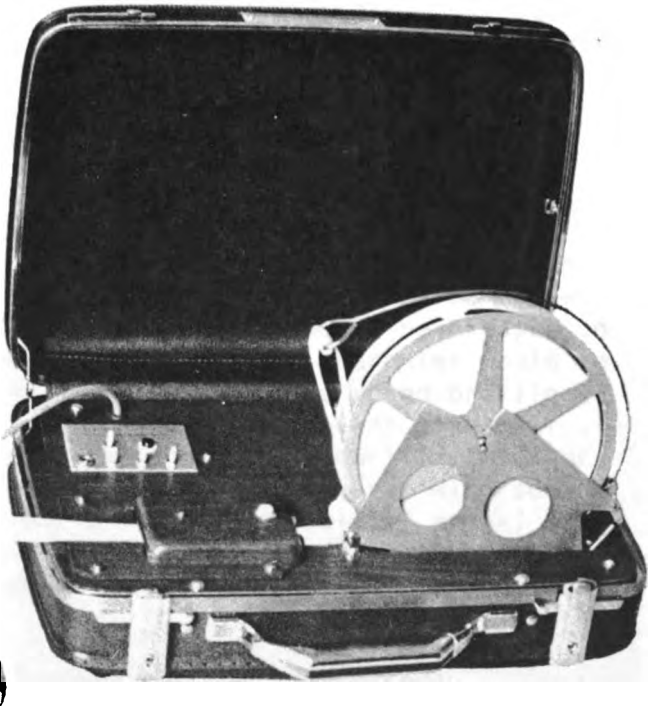
Source: Association for the Blind of Rochester and Monroe County, Inc., 422 Clinton Ave., So., Rochester, New York 14620; Triformation, Inc., 139 Yosemite Circle, West Henrietta, New York 14586

Purpose or Application: Translates standard ASCII code into embossed braille characters on a one for one basis

Approximate Price (10/73): $1,850

Description: This is a portable tape strip device (15 pounds) which can be connected in place of a teleprinter to enable a blind or deaf-blind individual to read character-by-character what is being sent or received.

According to the designer, the device permits a blind individual to operate, program, and machine debug computer programs with complete independence. It also extends the braille cell to 7 or 8 positions to permit technical computer teleprocessing characters or other special codes. Extensive preprocessing of textual material would be required if contracted braille output were desired. (A computer with M.I.T.'s DOTSYS software could do this.)



Device: M.I.T. High Speed Braille Embosser (BRAILLEMBOSS)

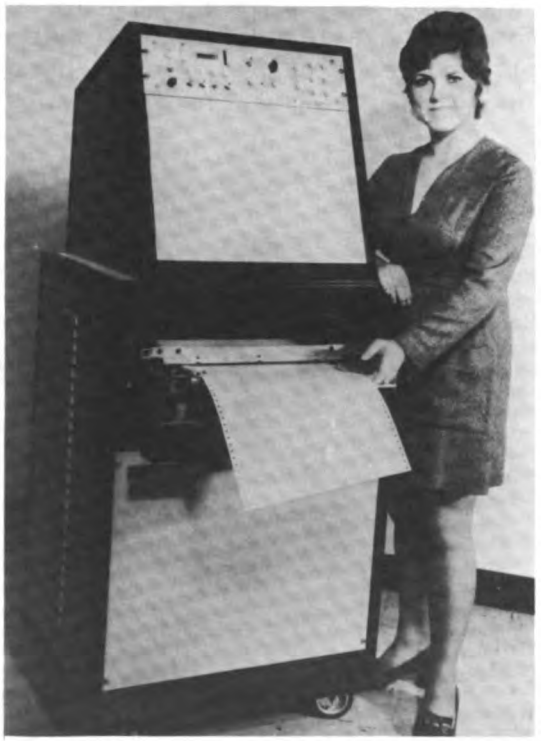
Source: Sensory Aids Evaluation and Development Center, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, Massachusetts 02139

Purpose or Application: A braille page printer which is a braille counterpart of the teletype page printer

Approximate Price (10/73): $5,000 - $7,000

Description: This output device converts coded electrical signals into embossed braille on a one to one character basis. Input data consists of eight bit coded characters which correspond to single characters, symbols, or abbreviations. Presently, programs have been written to handle three transmission codes: 5 level teletype (BAUDOT), 7 level (EBCDIC), and 8 level teletype (ASCII).

M.I.T. has designed a COBOL computer program for contracted braille called DOTSYS III. A teletype is used as the input/output device, and a computer translates the English language text into contracted braille. An interface is available to connect the BRAILLEMBOSS to the output of the computer. In this way, material can be typed into the computer, converted into braille, and embossed on the BRAILLEMBOSS.



Device: Vibration Paging System

Source: Bell and Howell Communications Company, 186 Third Ave., Waltham, Massachusetts 02154

Purpose or Application: A portable paging system and doorbell device for deaf-blind persons

Approximate Price (10/73): $400

Description: This system consists of a transmitter and a receiver, each the size of a king-sized package of cigarettes. When a signal is received, the receiver activates a vibration mechanism. The receiver can be clamped to a pocket or belt by its large clip. A doorbell attachment is also available to trigger the transmitter when the doorbell button is pressed. The device uses VHF FM transmission of a two-tone coded triggering signal to activate the receiver vibrator.

A limitation to the use of this device is an FCC required, built-in, 30 second delay between transmissions. Also, the receiver can only respond with one type of pulsing vibration. Thus, it is not possible to use coded signals to denote various occurrences such as a doorbell or fire alarm rings, etc.

Each transmitter-receiver system uses a unique access tone pair to avoid interference between adjacent systems. Unfortunately, this immediately limits the usefulness of the system since several people cannot be signaled at the same time from a single transmitter. The transmitter works on an 11.2 volt non-rechargeable mercury battery. The receiver uses a 4.2 volt rechargeable battery.

Device: M.I.T. Tactile Communication System (TAC-COM)

Source: Sensory Aids Evaluation and Development Center, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, Massachusetts 02139

Purpose or Application: A signaling device for paging deaf-blind people and for use as a fire alarm alert.

Approximate Price (10/73): N/A

Description: This device consists of an induction loop transmitter and one or more receivers (which are approximately the size of a large, king-sized package of cigarettes). The receivers are powered by rechargeable batteries and vibrate when a signal is received. The receiver can be worn in a pocket or shoulder harness, or it can be clipped onto an article of clothing. The induction loop mode of transmission was used because M.I.T. felt that:

1. Interference due to external sources and extraneous systems would be considerably reduced.

2. Transmission of the signal would be confined to small locations and would not violate FCC regulations.

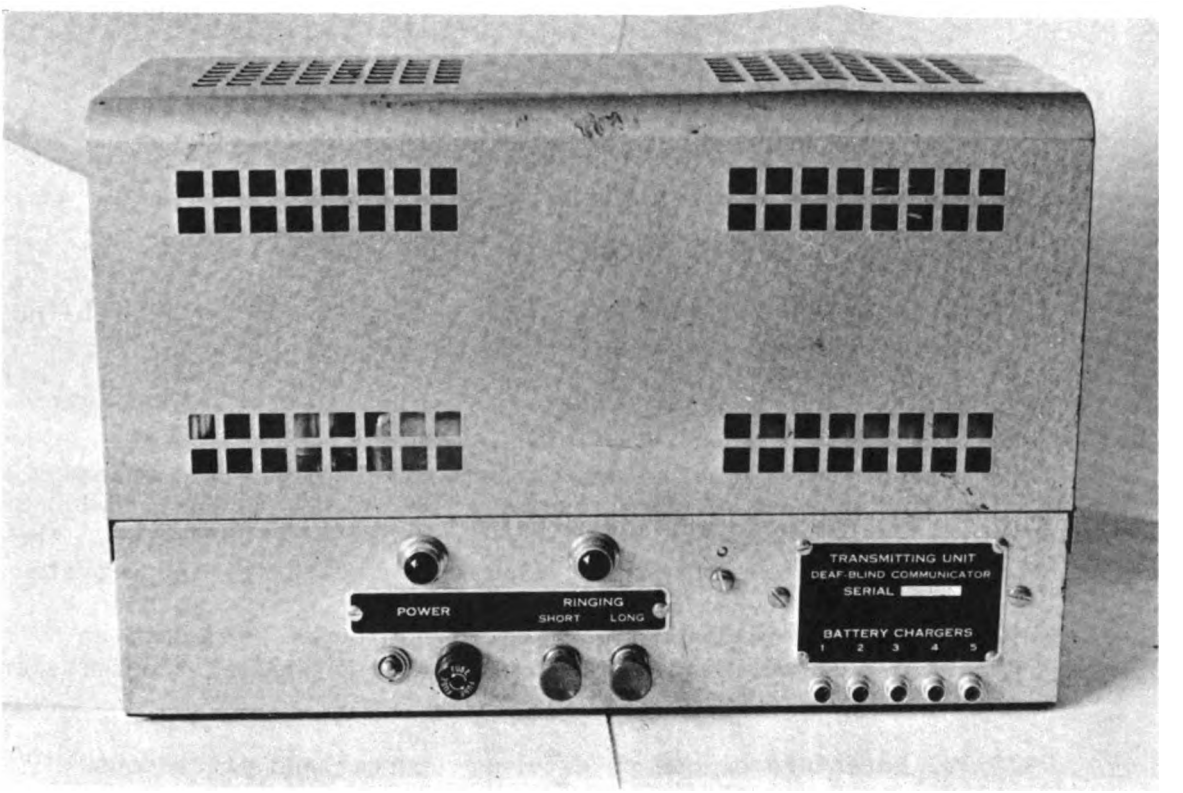
3. Relatively low power would be required to transmit the signal.

4. The system could easily be constructed and required no exotic engineering techniques and circuitry.

All the TAC-COM receivers can be triggered at the same time by a single transmitter. Several different coded signals can also be sent by slowly keying the transmitter on and off in a predetermined manner.

Research conducted at the National Center and interviews with the deaf-blind trainees at the Center have shown that one problem with this system is the need for wired loops about the desired "active area". This results in a limited range and a lack of portability of the transmission system.

Most important, however, is the fact that the device is quite fragile and is quite likely to be made inoperative by a fall from as little as a 3 foot height. The device requires a skilled technician to install and tune it initially.



TAC-COM Transmitter

TAC-COM Receivers

Front and Rear View.

Appendix C-12

Device: Wrist-Com

Source: National Center for Deaf-Blind Youths and Adults, 105 Fifth Avenue, New Hyde Park, New York 11040

Purpose or Application: This is a miniaturized wireless signaling device for paging deaf-blind individuals.

Approximate Price (10/73): N/A

Description: This device is still in the design stage. It is an attempt to combine the best features of other paging devices, while eliminating the problems encountered with each of them. As its name implies, the Wrist-Com is being designed to be worn as a large "mod" bracelet, thus eliminating problems such as frail clips and the need for pockets. The design will incorporate the ability to receive diverse messages, i.e., it will be able to reproduce the pattern of the transmitted signal. For example, one signal could be used to indicate the ringing of a telephone, while another would indicate a doorbell, etc. Induction loops would not be used, thus insuring complete portability. Other design plans include making the device shock resistant and waterproof.

It is hoped that the final model of this device, or a commercially produced unit containing its features, will be ready for use at the National Center's permanent facilities. There, it is proposed that the Wrist-Com can also be used to signal a fire when the deaf-blind person is up and about, or in the shower, so that he will always be within reach of a fire alarm signal.

Device: Deaf-Blind Induction Loop Communication and Doorbell Device

Source: The Royal National Institute for the Blind, Great Portland St., London N.W. 9. England, United Kingdom

Purpose or Application: A doorbell signal for the deaf-blind

Approximate Price (10/73): N/A

Description: This device consists of three parts: the transmitter with an induction loop circuit, a receiver, and a vibrator. The first is a permanent fixture in the home. The user wears the receiver and vibrator which, together, weigh a few ounces. Besides responding to induction loop signals, the manufacturer says that the receiver has a built-in microphone which can pick up sound and convert it to vibrations which are distinct from those of the doorbell.

The vibrator is actually a specially designed, waterproof, bone conduction hearing aid transducer which is worn as either a ring or a watch. If several people are within the range of the same induction loop, they all will receive the same signals. Slow speed Morse or other codes can also be used with this device. The sending key would be connected to the transmitter. The receiver can be set to respond to inductive input, acoustic input, or both. Coding can also be used to denote different visitors' doorbell rings.

Some difficulties found with this device are: (1) All of the devices use the same transmission frequency, thereby causing interference problems to adjacent system installations, (2) The system is sensitive to interference generated by fluorescent lighting fixtures and other electrical devices, and (3) The vibration is weak.

Similar devices have been designed and are available from Sweden and West Germany.

Appendix C-14

Device: Warning System for the Deaf-Blind

Source: Scandinavian Control and System Engineering, Bergen, Norway

Purpose or Application: A doorbell signal, fire alert, and telephone alert for the deaf-blind

Approximate Price (10/73): N/A

Description: This is a system based on radio control. It consists of a small radio transmitter which works on the citizens' band (27 megahertz). The receiver is worn in the pocket and is the size of a cigarette package. The transmitter is attached to the doorbell.

When the doorbell is rung, the transmitter is activated and the receiver vibrates. According to the manufacturer, a fire warning detector can be attached to the system, as well as a microphone which can pick up environmental noises. Also, a telephone relay can be connected to the system to alert the individual to the ringing of the telephone. Different systems can be operated on adjacent frequencies with no interference.

In the United States the citizen band frequencies are quite crowded with voice communications stations, and the likelihood of interference is very great. Because the device uses a radio transmitter, an F.C.C. license must be obtained by every user, and the transmitter must be either type-approved or certified by the manufacturer.

Device: The Arcaid

Source: The Royal National Institute for the Blind, Great Portland St., London N.W. 9, England, United Kingdom

Purpose or Application: A communication aid for the deaf-blind and to print braille

Approximate Price (10/73): N/A

Description: This device is smaller than a portable typewriter and consists of a typewriter keyboard and a braille printing device. For conversation, the deaf-blind person places his finger on a braille cell to the left of the Arcaid.

For braille printing, paper tape is used. The typewriter keys are depressed, causing the appropriate braille letter to be embossed on the tape. This allows a permanent record of a conversation to be made, if desired by the deaf-blind person.

The designer claims that no special skills are necessary to use this machine. A typist can use it to transcribe braille for the deaf-blind at high speed. There are also 3 keys on each side of the keyboard which are like those on a Perkins Brailler. These can be used to print Grade I or contracted braille.

Device: Optacon

Source: Telesensory Systems, Inc. 1889 Page Mill Road, Palo Alto California 94304

Purpose or Application: Enables blind and deaf-blind people to read regular printed material by converting the image of the print letter into a tactile image which can be felt by one finger

Approximate Price (10/73): About $3,500

Description: This device consists of three parts: (1) a miniature opto-electronic camera, (2) an electronics section, and (3) a tactile stimulator array. Power is supplied by a rechargeable battery or AC.

The camera is mounted in a housing equipped with rollers so that it can be moved along a line of print. It has a zoom lens which compensates for differences in type size. The tactile stimulator array is composed of 144 tiny metal rods in a 6 by 24 matrix which covers an area of about ½ inch by an inch. Each rod can vibrate independently. These three sections create a point to point conversion of the printed original image to a vibrating image.

The manufacturer also sells several accessories for the Optacon. One of these is a visual display which has 144 lights corresponding to each of the rods in the tactile stimulator array. This display allows the instructor to see the pattern and thus help his student. Another is a tracking aid which is used in the early training stages to keep the camera properly aligned on a page. A master/slave cable is also available to permit two Optacons to be connected such that both tactile stimulator arrays can present the image from one camera.

Training in the use of the Optacon requires several months of practice.

Device: Electrotactile Sound Detector

Source: Smith-Kettlewell Institute and the Department of Visual Sciences, University of the Pacific, 2232 Webster Street San Francisco, California 94115

Purpose or Application: To enable deaf people to detect and localize sounds

Approximate Price (10/73): N/A

Description: The Electrotactile Sound Detector is composed of a portable, battery operated prototype which is mounted on a headband. Sounds are picked up by bilaterally placed microphones and converted to mild electrical stimuli applied to the forehead. Provision is made for the user to turn the unit off and on and individually set the gain on each of the two channels. The manufacturer reports that the device does not interact with other electrical devices or hearing aids, that it does not cause interference, and that changes in skin resistance do not affect the stimulus intensity level.

Although no information on independent objective evaluation of the device is available at this time, the manufacturer has said that two deaf users have been able to respond to sudden sounds, such as a horn, by using this sound detector. These two people have also claimed that they could discriminate the rhythmic patterns of certain sounds, e.g., doorbells. The designer plans to perform further tests with deaf children to more fully evaluate the usefulness of this device for the deaf.

Appendix C-18

Device: "Seeing-Eye" System

Source: Smith-Kettlewell Institute and the Department of Visual Sciences, University of the Pacific, 2232 Webster Street, San Francisco, California 94115

Purpose or Application: Enables a blind person to "tactually" perceive objects

Approximate Price (10/73): N/A

Description: A television camera picks up the image of an object and converts it into corresponding dot pattern within a 20 by 20 matrix. For each dot present there is a teflon-tipped contact pad which vibrates on the individual's back, allowing him to feel the dot pattern and thus perceive the image.

The designer reports that after training the individual "begins to forget about the image on his back and instead to think of the object as being in front of him." The manufacturer also says that people learn to judge distance by the size and position of the objects.

The designer's future plans call for miniaturizing the system into a lightweight, portable, battery-powered unit. This would include a small television camera worn on the head and a vest with electrodes that would transmit the dots onto the individual's back.

Device: Pathsounder

Source: Sensory Aids Evaluation and Development Center, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, Massachusetts 02139

Purpose or Application: A sonar travel aid to be used as a complement to the cane

Approximate Price (10/73): N/A

Description: The Pathsounder is battery operated (rechargeable) and worn on the chest. It is attached by a neckstrap and warns the individual of other people and above-the-waist objects which are in his path. The manufacturer warns that this device is still in the experimental stage and is by no means an established mobility aid for the blind. Yet, it does allow the user to be warned of objects not usually discerned by a cane, e.g., overhanging tree branches.

The Pathsounder provides an audible warning when there is something within 6 feet ahead at a height between the user's waist and top of his head. The signal is a buzzing noise when an object is within 72 inches and changes to a high-pitched beeping at 30 inches. There is also a switch to control the volume of the sounds.

The sonar mechanism is in actuality an echo locating device. The device continually emits a high pitched burst (too high to hear) and a microphone picks up the echoes. The further away an object, the longer is the wait for an echo. The waiting interval is electronically measured so that the distance can be calculated. There are some objects which cannot be detected because enough ultrasonic energy is not returned to the Pathsounder, e.g., very small objects. Filters have been installed to eliminate electrical interference.

Although this device was designed for use by a blind person, a modified version is currently being developed for use by deaf-blind people. It will make use of vibrating signals in place of tones.

Device: General Electric Deaf-Blind Communication Aid (Prototype)

Source: General Electric Company, Valley Forge Space Center
P.O. Box 8555, Philadelphia, Pennsylvania 19101

Purpose or Application: Attempts to enable deaf-blind individuals to receive speech from persons not trained in any special communication technique and can provide the deaf-blind individual with some sensory feedback to monitor his speech.

Approximate Price (10/73): N/A

Description: The unit contains five small, uncovered diaphragms, each set to respond to different bands of sound frequencies within the speech range. The deaf-blind person places a finger on each diaphragm in order to perceive the resultant vibrations. Speech input is achieved through a microphone.

The National Center has conducted preliminary research which suggested that only words with strong vibration patterns can be recognized with this device. Words whose enunciation depends primarily on tongue and lip movements cannot be read in this way. These results suggest that it does not seem to be effective as a general communication aid for the deaf-blind. Future research will determine its value as a speech therapy tool.

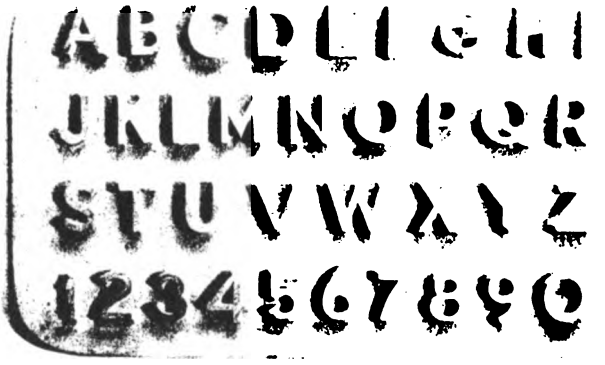
Device: Alphabet Plate

Source: National Center for Deaf-Blind Youths and Adults,
105 Fifth Avenue, New Hyde Park, N.Y. 11040

Purpose or Application: To allow deaf-blind persons who do not know braille to communicate with people who know neither signs nor the manual alphabet

Approximate Price (10/73): Free

Description: This is a 4 inch by 6 3/8 inch, lightweight plate made of an aluminum alloy. On it, in alphabetical order, are large, embossed print letters arranged in 3 rows and a 4th row of raised numbers. The sighted person places the deaf-blind person's index finger on each letter as he spells out words. If the deaf-blind individual has no speech, he can reply by pointing to the letters as well.



Device: Braille Alphabet Card

Source: National Center for Deaf-Blind Youths and Adults, 105 Fifth Avenue, New Hyde Park, N.Y. 11040

Purpose or Application: To allow deaf-blind persons to communicate with people who know neither signs nor the manual alphabet

Approximate Price (10/73): Free

Description: This is similar to the alphabet plate, but, as its name implies, it is embossed with the braille alphabet. Print letters are above each braille character. Like the alphabet plate, the deaf-blind person's index finger is placed on each letter to form words. If he has no speech, he can answer both blind and sighted persons by pointing to the appropriate letters. This card can also be made at almost no cost by anyone who knows braille.

Device: Alphabet Glove

Purpose or Application: To allow persons not familiar with the manual alphabet and sign language to converse with deaf-blind individuals

Approximate Price (10/73): Generally homemade

Description: This is a regular glove of thin fabric upon which are printed (in indelible ink) the letters of the alphabet. The letters are on the palm side of the glove, along the tips, joints, and base of each of the five fingers. Numerals from 0 to 9 are placed on the back of the glove on the fingernails and joints. While the deaf-blind person wears the glove on one hand, the individual with whom he is communicating touches the appropriate letter or number on the glove to form words, etc. The deaf-blind person has memorized the position of the letters and numerals and, through practice, can use this method of communication quite rapidly. Of course, due to differences in hand sizes, gloves must be individually marked for each user. It has been found that family and close friends soon memorize the position of the letters so that they can communicate without the deaf-blind person wearing the glove.

Appendix C-24

Device: James Remind-O-Timer

Source: American Foundation for the Blind, Inc., 15 West 16th St., New York, N.Y. 10011

Purpose or Application: To be used with a vibrator as an alarm clock for the deaf-blind

Approximate Price (10/73): $41.50

Description: There are 48 pins around the clock face, each of which controls 15 minutes of time. Double raised dots appear at 12, 3, 6, and 9 and single dots at the remaining hours. There are also single dots above the pins at each hour interval. The case is 7 inches by 7 inches; the clock face is 3½ inches in diameter. The device weighs 3 pounds.

Device: Sensicall

Source: New York Telephone Company, Telephone Pioneers, 195 Broadway, New York, New York 10017

Purpose or Application: Enables the deaf-blind person to communicate over the telephone using tactile or visual means. Incoming calls are not indicated.

Approximate Price (10/73): $19.95 for installation plus $3.58 per month (New York Telephone)

Description: Sensicall is a single package device which is directly connected to the telephone and consists of a 2-stage transistored amplifier-driver, a combination volume and on-off switch, a sensing device, and a transmitting key which produces an audio-frequency signal. The tactile version has a vibrating tactile pad as the output transducer. The visual model has a flashing lamp as its output device. The receiving circuit is responsive to the duration of voiced and/or electrical signals.

When a call is made, the handset is removed and a steady visual or tactile signal is sought (dial tone). Interrupted signals indicate a busy signal. Once a call is dialed, the deaf-blind person speaks into the phone or, if he has no speech, uses the transmitting key to send Morse code. The other party can either send back Morse code with the transmitting key of a similar Sensicall, or by voice if he does not (using "dit" for a dot and "da-a-a" for a dash).

(See also: Hadley Tactaphone)

Device: Code Com

Source: Western Electric - according to New York Telephone no longer available, but a few are in use

Purpose or Application: Enables deaf and deaf-blind persons to use the telephone, through the conversion of sound signals to vibrotactile signals, but not to be alerted to incoming calls

Approximate Price (10/73: N/A

Description: This small device contains a vibrating diaphragm, a transmitting key, a dial to regulate the intensity of the vibration, and a flashing light for partially sighted-deaf people to use instead of the diaphragm. The Code Com is directly connected to the telephone.

When a call is placed, the handset is lifted and the deaf-blind person feels the vibrating diaphragm or watches the light for one of two signals: (1) a steady signal indicating a dial tone or (2) an irregular signal indicating someone else is using the line. The manufacturer describes four distinct signals, felt on the diaphragm or seen with the light, which can occur once the number is dialed: (1) a repeated cycle of 2 seconds on and 4 seconds off, indicating that the phone is ringing; (2) a busy signal, i.e., an interrupted signal of ½ second on and ½ second off; (3) a repeated "fast busy" of ¼ second on and ¼ second off, denoting a busy circuit; or (4) when the phone is answered, there is a ringing signal followed immediately by irregular signals indicating the party's voice.

Morse code can be transmitted over the telephone with this device. The speaking individual can say "dit" for a dot and "da-a-a" for a dash, and this is discerned on the diaphragm or light. The deaf-blind person can reply in the same way if he can speak or use the sending key to transmit Morse code.

The manufacturer also suggests a second way of sending coded information. This involves preparing a list of messages and assigning each a number. The list is printed in a code book and sent to those who will be in touch with the deaf-blind person. Conversations can then be held by sending the numbers assigned to the relevant messages. If the deaf-blind person has speech, he can ask questions and be answered by "yes", "no-no", or "I don't know", resulting in one, two, or three vibrations or light flashes in the reply.

APPENDIX D

AGENDA

WORKSHOP ON COMMUNICATION AND SENSORY AIDS FOR THE DEAF-BLIND

National Academy of Sciences
National Center for Deaf-Blind Youths and Adults

November 28-30, 1973

Wednesday, November 28 — *Holiday Inn, 369 Old Country Road, Westbury, NY*

8:30 p.m.	Informal Introduction to Manual Alphabet (in Dr. Kruger's room)	Bettica, Kruger

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Thursday, November 29

National Center for Deaf-Blind Youths and Adults, 105 Fifth Ave., New Hyde Park, NY

Chairman: DeSimone

9:00 a.m.	Introduction for the National Center	Salmon
9:15 a.m.	Introduction for the Committee on Prosthetics Research and Development, National Academy of Sciences	Wilson Haas
9:30 a.m.	The Problem of Communication with the Deaf-Blind	Smithdas
9:45 a.m.	Arrangement of Participants into Groups for Rotation through Staff/Client Stations	Bettica

STATIONS

1. Mobility/Physical Therapy
2. Industrial Arts
3. Skills of Daily Living
4. Communications/Language Development
5. Speech and Hearing

	Group A	Group B	Group C	Group D	Group E
10:00 a.m.	1	2	3	4	5
11:00 a.m.	2	3	4	5	1
12:00 p.m.	Buffet Lunch for Guests and Participating Staff				
1:00 p.m.	3	4	5	1	2
2:00 p.m.	4	5	1	2	3
3:00 p.m.	5	1	2	3	4

4:00 p.m.	Questions and Discussion of Day's Observations	Kruger
4:30 p.m.	Telebraille Demonstration	Kruger

Appendix D-2

Workshop on Communication and Sensory Aids for the Deaf-Blind

Holiday Inn

6:00 p.m.	Informal Meeting of Guests and Staff	
7:00 p.m.	Dinner Meeting of Guests and Staff	

Friday, November 30 *Holiday Inn*

Chairman: Haas

8:30 a.m.	Definition of Problems	Kruger
9:00 a.m.	Objectives - Rest of Day and Beyond	Haas
9:30 a.m.	Regional Centers for Services to Deaf-Blind Children	Das
9:45 a.m.	The Pathsounder - A Blind Mobility Aid with Tactile or Audible Output	Dalrymple
10:00 a.m.	Current Status of Basic Research on Tactile Communication	Sherrick
10:15 a.m.	Coffee Break	
10:30 a.m.	To be Announced	
10:45 a.m.	Discussion of Future Contributions of Participants	
12:00 p.m.	Lunch	
1:00 p.m.	Discussion of Future Contributions of Participants, continued	
4:30 p.m.	Concluding Remarks	DeSimone Haas Kruger
5:00 p.m.	Adjournment	

APPENDIX E

INVITED PARTICIPANTS

WORKSHOP ON COMMUNICATION AND SENSORY AIDS FOR THE DEAF-BLIND

November 29-30, 1973
National Center for Deaf-Blind Youths and Adults (NCDBYA)
105 Fifth Avenue
New Hyde Park, New York

Abbott, Edward A., Naval Research Laboratory, Code 4020 Washington, District of Columbia 20375

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Bettica, Louis J., Assistant Director, NCDBYA, 105 Fifth Avenue, New Hyde Park, New York 11040

Bledsoe, Warren, Consultant on Blindness, Rehabilitation Services Administration, Social and Rehabilitation Service, Department of Health, Education, and Welfare, Room 3322, South HEW Building, Washington, District of Columbia 20201

Courtney-Pratt, Jeofry S., Ph.D., Head, Applied Physics and Exploratory Systems Department, Bell Telephone Laboratories, Crawford Corner Road, Holmdel, New Jersey 07733

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***Culclasure, David F., Ph.D., Director, NASA Biomedical Applications Team, Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas 78206

Dalrymple, George F., Acting Director, Sensory Aids Evaluation and Development Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

***Dantona, Robert, Coordinator, Centers and Services for Deaf-Blind Children, Bureau of Education for the Handicapped, United States Office of Education, 400 Maryland Avenue, S.W., Washington, District of Columbia 20202

Appendix E-2

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Freiberger, Howard, Electronics Engineer, Research Center for Prosthetics, Veterans Administration, 252 Seventh Avenue, New York, New York 10001

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*Hanley, Mary, Administrative Assistant, NCDBYA, 105 Fifth Avenue, New Hyde Park, New York 11040

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*Janson, Liz, Homemaking and Skills of Daily Living Instructor, NCDBYA, 105 Fifth Avenue, New Hyde Park, New York 11040

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Kruger, Frederick M., Ph.D., Director of Research, NCDBYA, 105 Fifth Avenue, New Hyde Park, New York 11040

Laenger, Charles, J., Sr., Senior Biomedical Research Engineer, NASA Biomedical Applications Program, Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas 78284

Levitt, Harry, Ph.D., The City University of New York, Graduate Center, 33 West 42nd Street, New York, New York 10036

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Stewart, Alan, Ph.D., Deafness Research and Traini Center, New York University, School of Education, 80 Washington S re East, New York, New York 10003

Thomas, Floyd P., Manager, Government Affairs, Gr n Health Systems, 534 Broad Hollow Road, Melville, New York 1174

***Traub, Joseph E., Consultant, Rehabilitation Engineering, Office of Research and Demonstrations, Social and Rehabilitation Service, Room 5320, South HEW Building, Washington, District of Columbia 20201

Vaughan, William H., Ph.D., Naval Research Laboratory, Code 8438, Washington, District of Columbia 20375

*Ward, Fran, Mobility Instructor, NCDBYA, 105 Fifth Avenue, New Hyde Park, New York 11040

***Williams, Boyce, Ph.D., Director, Office of Deafness and Communicative Disorders, Room 3414-HEW, Switzer Building, 3rd and C Streets, S.W., Washington, District of Columbia 20201

***Wilson, A. Bennett, Jr., Executive Director, Committee on Prosthetics Research and Development, National Research Council, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, District of Columbia 20418

Zimmerman, Robert R., Program Manager, Biomedical Applications, Technology Utilization Office, Code KT, National Aeronautics and Space Administration, Washington, District of Columbia 20546

*Attended Thursday only

**Attended Friday only

***Did not attend

APPENDIX F

REGIONAL CENTERS FOR SERVICES TO DEAF-BLIND CHILDREN

Khogendra N. Das
Mid-Atlantic (North) and Caribbean
Regional Deaf-Blind Center

Thank you for this opportunity to discuss the programs of the Mid-Atlantic (North) and Caribbean Regional Deaf-Blind Center in terms of its responsibilities for deaf-blind children and their families in the states of Delaware, New Jersey, New York, and Pennsylvania, and in Puerto Rico and the Virgin Islands. This Center is one of ten Regional Deaf-Blind Centers established in 1969 through Public Law 90-247 (now P.L. 91-230) to meet the unique needs of a large number of deaf-blind children born during the 1963-1965 rubella epidemics. Since their inception, the ten centers have identified over 5,000 deaf-blind children in the 50 states and the territories.

Under the Deaf-Blind Act, the Regional Deaf-Blind Centers must provide three basic services through the coordination of activities, utilization of resources, and development of potential and new services. The three basic services are:

- Comprehensive diagnostic and evaluative services for deaf-blind children;
- Programs for their adjustment, orientation, and education, integrating all professional and allied services; and
- Effective consultative services for parents, teachers, and others who play a direct role in the lives of deaf-blind children.

As defined by the Bureau of Education for the Handicapped, U. S. Office of Education, a deaf-blind child is one "who has both auditory and visual impairments, the combination of which causes such severe communication and other developmental and educational problems

that he cannot properly be accommodated in special education programs that are developed solely for either the hearing impaired or the visually impaired child."

The Regional Center provides services to deaf-blind children and youths from birth through age 21. However, because the National Center for Deaf-Blind Youths and Adults provides services for such persons from age 16 and over, there is an overlapping of functions. Efforts are now being made to coordinate the programs of these two groups in order to provide more efficiently for deaf-blind persons.

Currently, there are 730 deaf-blind children registered with the Regional Center. About 60 percent of these are placed in 128 facilities and programs throughout the region. Twenty such programs received financial support during 1973-1974 from Title VI-C of P.O. 90-247 (or P.L. 91-230) through the Regional Center

The purpose of this meeting, obviously, is to review the usefulness of currently available communication aids for the deaf-blind, and to make recommendations for their improvement. The aids that we have seen today are designed basically for deaf-blind youths and adults who have language facility. The Regional Deaf-Blind Center, on the other hand, is responsible for the development of communication and language skills for those who *do not* have language facility.

I find it necessary to mention that scant attention has been given to the needs of deaf-blind children in terms of low-vision and communication aids. I fervently hope--and *urge*--that the National Research Council, which has been involved with the problems of handicapped adults, will review and assist in the improvement of prosthetic aids for deaf-blind children.

ABSTRACT

THE PATHSOUNDER - A BLIND MOBILITY AID WITH TACTILE OR AUDIBLE OUTPUT

George F. Dalrymple
Massachusetts Institute of Technology
Cambridge, Massachusetts

The Pathsounder is a small, chest-mounted mobility aid designed to protect the blind traveler by signaling the presence of above-the-waist objects, e.g., overhangs, other pedestrians, etc. It is a supplement to the cane in that it provides additional information.

The Pathsounder probes by an ultrasonic beam, i.e., sound waves too high in pitch for the ear to detect. The coverage area is cone-shaped with the point at the chest. At six feet the beam is shoulder width and extends from waist to head height. The Pathsounder is usually set to ignore objects farther away than six feet. The present auditory output units emit a buzz when an object is detected between 30 inches and 6 feet from the unit and an insistent beep for objects closer than 30 inches.

The earliest use of the Pathsounder was to improve travel by reducing the number of accidental contacts by the user or his cane with pedestrians or other objects. Tests with several users have shown that accidental contacts can be reduced almost to zero, and serious collisions (those requiring an apology or causing injury) can be essentially eliminated. For many good travelers, of course, this additional information or protection may not give sufficient motivation to warrant carrying the unit, recharging the batteries, etc.

There are groups of multiply handicapped blind, however, for whom the Pathsounder is a significant tool in providing some degree of mobility. In one such group are those with motor difficulties, e.g., cerebral palsy (CP). Because of the Pathsounder a blind CP young college student is able to travel relatively independently on her college campus. In another group are those with severe hearing losses, whose obstacle perception is inadequate for safe travel. A Pathsounder is being used with such a person.

Appendix G-2

The Pathsounder has been used as a motivational and confidence-building tool by blinded amputees in VA hospitals. It has encouraged and made possible the first tentative efforts at independent travel in a wheelchair before a prosthesis can be fitted. Such travel helps in establishing the amputee's confidence in his ability to travel. The Pathsounder has been used to provide additional protection and security for those who are especially vulnerable to collision injury, i.e., a person who has recently undergone brain surgery, but is yet to be fitted with a solid plate. The Pathsounder provides the necessary additional travel safety to permit travel by minimizing the possibility of serious injury.

The existing Pathsounders are not usable to the profoundly deaf since they have an auditory display. At present twelve more Pathsounders are being made with optional vibratory displays. It is anticipated that these units will be available in March of 1974.

APPENDIX H

ABSTRACT

THE CURRENT STATUS OF BASIC RESEARCH IN CUTANEOUS COMMUNICATION

Carl E. Sherrick
Princeton University
Princeton, N.J.

There are two signal inputs to the skin of major interest today. One is mechanical vibrotactile transients, e.g., bursts of sinusoidal energy, and the second is electrocutaneous transients, typically trains of pulses, both mono- and bipolar.

A great deal of basic research on the first type of signal was carried out 20 or more years ago, to answer fundamental questions in perception, such as the minimal energy required for perception of the signal, or the Weber fraction for intensity and frequency of vibration. Problems of masking, pattern perception, movement perception, requiring multiple vibrotactile inputs, led to research on design and construction of small, easily mounted vibrators.

The electrocutaneous signal is often suggested as a substitute for the mechanical, principally because power and weight requirements are reduced. The problems of pain and discomfort caused by the stimulus or apparatus have proved difficult to solve, but several laboratories are diligently pursuing the possibilities.

In more recent years, although basic problems concerning the neural coding of signal inputs remain, more research is devoted to pattern perception, numerosity perception, and tactile short-term memory storage. Attempts to create artificial skin languages such as Braille or Morse codes have been made, but have proven unsatisfactory when tested with continuous discourse. It appears presently that letter-by-letter processing is required by the languages thus far generated, and that the word- or phrase-perception commonly reported by sighted readers does not occur with any great frequency.

A problem of current interest in our laboratory illustrates the phenomenon of emergence of an unpredictable dimension resulting from the

unique juxtaposition of events in space and time. The induction of mislocalized pressure pulsed by proper timing and spacing of two or more transient signals can be used to generate readily perceived contours on the skin. The possibilities for generating various kinds of picotrial displays on the skin are being examined in our laboratory currently.

A list of recent reviews of research, and a list of laboratories doing work on cutaneous communication follow.

REVIEWS OF RECENT WORK ON CUTANEOUS COMMUNICATION

1. Bliss, J. C. (ed.), Tactile displays conference. IEE Trans. Man-Machine Syst., MMS-11:1:1-122, 1970.

2. Geldard, F. A. (ed.), Conference on cutaneous communication systems and devices. Psychonomic Society, Inc., Austin, Texas, 1974, vi + 112 pp. (in press).

3. Kirman, J. A., Tactile communication of speech: A review and an analysis. Psychol. Bull., 80:54-74, 1973.

4. Sherrick, C. E., Sensory processes. In Psychology and the handicapped child, L. L. Elliott and J. A. Swets, (eds.), U. S. Government Printing Office, Washington, D.C. (in press).

Appendix H-3

Laboratories Involved in Basic Research on Cutaneous Communication

1. Paul Bach-Y-Rita and Associates - Smith-Kettlewell Institute of Visual Sciences, San Francisco, Cal. MS, AD, Mvt, Ecut.
2. Ira H. Bernstein - University of Texas at Arlington, Tex. Mvt.
3. James C. Bliss - Telesensory Systems, Inc., Menlo Park, Cal. PT, Mvt, Ecut, MS.
4. Amiram Carmon - Yeshiva University Medical School, Israel. Mvt.
5. James Craig - Indiana University, Bloomington, Ind. Mvt, PT, MS.
6. Emerson Foulke - University of Louisville, Louisville, Ky. PT, B, Mvt, Ecut.
7. Frank A. Geldard and Carl E. Sherrick - Princeton University, Princeton, N.J. Mvt, Ecut.
8. George Gescheider - Hamilton College, Clinton, N.Y. Mvt.
9. Richard Gilson - Ohio State University, Columbus, Oh. Mvt.
10. Moise Goldstein - Johns Hopkins University, Baltimore, Md. VT.
11. John Hahn - University of Virginia, Charlottesville, Va. Mvt.
12. John Hill - Stanford Research Institute, Menlo Park, Cal. PT, MS, Mvt.
13. James Jenkins - University of Minnesota, Minneapolis, Minn. VT.
14. Wolf Keidel - I. Physiologisches Institut, Erlangen Universitat, Erlangen, Germany. VT, Mvt.
15. Dan Kenshalo - Florida State University, Tallahassee, Fla. SkT.
16. Jacob Kirman - Queens College, City University of New York, Flushing, N. Y. 11367. VT.
17. Eugene C. Lechelt - University of Alberta, Edmonton, Alberta, Canada. Mvt.
18. James Miller - Central Institute for the Deaf, St. Louis, Mo. VT.
19. Vernon Mountcastle - Johns Hopkins University, Baltimore, Md. Mvt, K.
20. Carson Nolan - American Printing House for the Blind, Lexington, Ky. B.

Appendix H-4

21. James Pickett - Gallaudet College, Washington, D.C. VT.

22. Arne Risberg - Speech Transmission Laboratory, Royal Institute of Technology, Stockholm, Sweden. VT.

23. Joseph Stevens - John B. Pierce Foundation, Yale University, New Haven, Conn. SkT, K.

24. Kenneth Stevens - Bolt, Beranek, and Newman, Cambridge, Mass. VT.

25. Thomas J. Triggs - Monash University, Clayton, Victoria 3168, Australia. Mvt, Ecut.

26. Ronald Verrillo - Syracuse University, Syracuse, N.Y. Mvt.

CODE FOR RESEARCH ACTIVITIES

AO - Auditory Orientation

B - Braille improvement

Ecut - Electrocutaneous studies

K - Kinesthesis

MS - Mobility Systems

Mvt - Mechanical vibrotactile studies

PT - Print Translation

SkT - Skin temperature sensitivity

VT - Voice Translation

COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
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Ontario Crippled Children's Centre

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