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ABSTRACT

Described is the BRAILLEMBOSS, a braille page printer, which is useful as a short run braille producer and as an employment and education tool for the blind and deaf blind. Examples of applications are given, including its use by computer programers, students, taxpayer service representatives, and news broadcasters. The machine is, for blind users, a braille counterpart of the familiar teletype page printer used by the sighted. TACCOM, a wireless signalling device for the deaf blind, is also described. Making use of a radio-activated pocket-size vibrator, TACCOM is reported to permit remote paging of deaf blind persons and give them a number of ancilliary capabilities such as the sensing of ambient sound and light cues and communication of simple messages from a distance. Also given is a status report of the PATHSOUNDER ultrasonic mobility aid for the blind. (Author)

FINAL REPORT

DEVELOPMENT AND DEMONSTRATION OF COMMUNICATION SYSTEMS FOR THE BLIND AND DEAF/BLIND.

Braille Communication Terminals and Tactile Paging Systems.

Project No. 14-P-55016/1-03

by

George F. Dalrymple
Sensory Aids Evaluation and Development Center
Massachusetts Institute of Technology
77 Massachusetts Avenue (31-063)
Cambridge, Massachusetts 02139

February 26, 1973

Significant Findings for Rehabilitation (and Social Service) Workers.

The BRAILLEMBOSS, a braille page printer, can make both remote computers and wire transmitted material available to the blind, thus opening employment of the blind in the areas of.....

computer programming
customer service
reservation
news broadcasting.

The BRAILLEMBOSS, can produce single copy (or a few copies) of Braille material. The material can be prepared by.....

a typist, unskilled in braille, typing straight text into a computer that uses DOTSYS III to produce Grade II braille, or

a skilled braillist using a modified Perkins braille writer and a paper tape punch, or

a skilled braillist using a specially modified teletype.

TAC-COM is a wireless paging device for the deaf/blind. It can be used.....

as a signaller in a fire alarm system
as a doorbell
as an end-of-line device
as a sound probe
as a light probe

by a deaf/blind individual.

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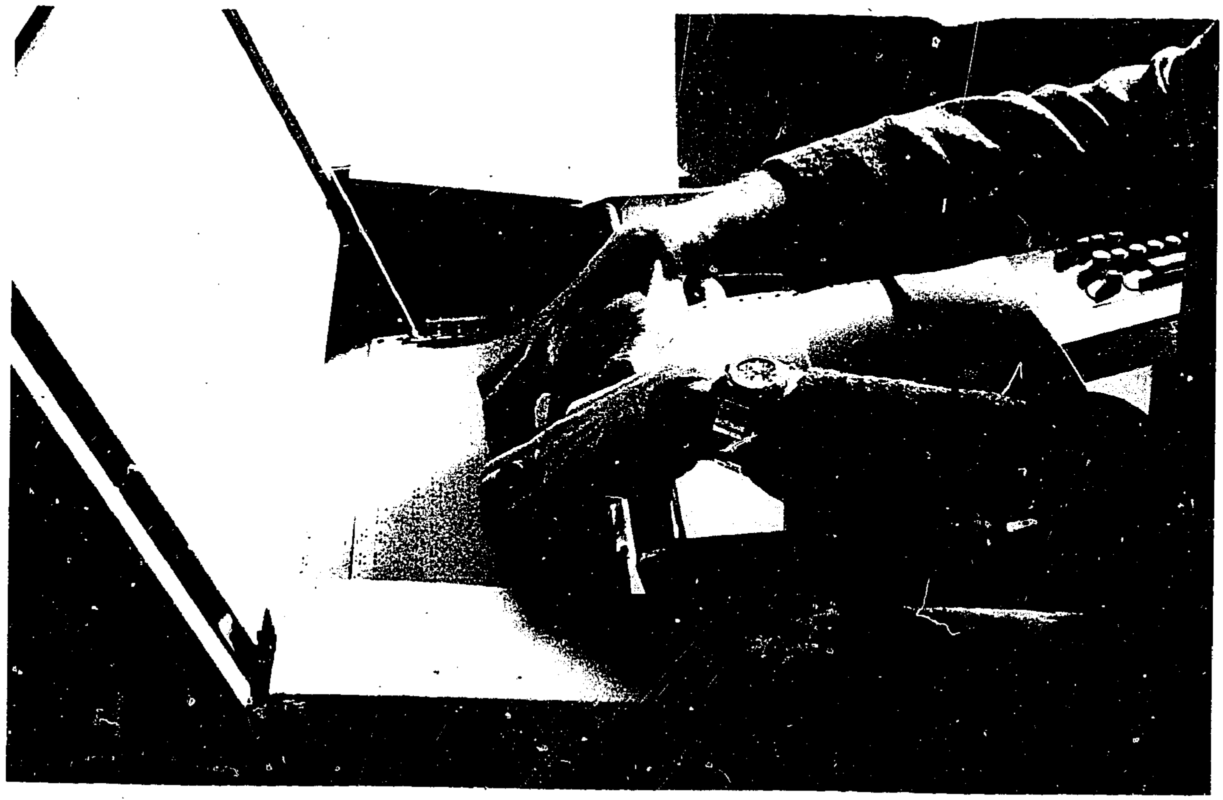

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Acknowledgement

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Abstract

Described in this report is the BRAILLEMBOSS, a braille page printer, which is useful as a short run braille producer and especially as an employment and education tool for the blind. Examples of the latter applications are given, including its use by computer programmers, students, taxpayer service representatives, and news broadcasters. The machine is, for blind users, a braille counterpart of the familiar teletype page printer used by the sighted.

TACCOM, a wireless signalling device for the deaf-blind, is also described. Making use of a radio-activated pocket-size vibrator, TACCOM permits remote paging of deaf-blind persons and gives them a number of ancilliary capabilities: sensing of ambient sound and light cues, communication of simple messages from a distance, etc.

Also given is a status report of the PATHSOUNDER ultrasonic mobility aid for the blind.

Introduction

The Sensory Aids Evaluation and Development Center has been exploring three devices to enhance the communication capability of the blind and the deaf/blind (d/b). The first device is the Braillemboss, a braille page printer, i.e. a braille producing teletype. The second is TAC-COM, a wireless communication and paging system for the deaf/blind. The third is the Pathsounder, a device that communicates to the blind traveler a blockage of the path ahead.

The BRAILLEMBOSS has been demonstrated in two basic ways. One is an output device for a computer. The other is as a braille production device. There is overlap for example when the BRAILLEMBOSS is used as the output device for a computer braille translation system.

The most significant use of the BRAILLEMBOSS is as a tool used in routine day-to-day employment. It has been used as the communication device from a computer to professional computer programmers. It has also been to give customer service personnel access to computer data. Further it was used as a newswire printer to give a blind television newscaster access to that service.

The BRAILLEMBOSS has been used in small-scale braille publishing activities. These have included several pamphlets, a chapter of a book, and a book. One pamphlet was done as a cooperative effort with the National Braille Press for one of their clients. Two other pamphlets are SAEDC Technical Description Sheets. The chapter of the book was done in cooperation with Technology Community Association and the M.I.T. libraries for the blind students at M.I.T. and other colleges in the Boston area. The book was done for the Library of Congress.

The BRAILLEMBOSS was selected by the national IR-100 Industrial Research contest as one of the 100 most innovative and significant "products" produced in America in 1972.

TAC-COM is a wireless communicator for the d/b. Each user carries a small receiving unit that vibrates when signalled by inductive coupling (wireless). The system is effective in an area defined by the signal loops connected to a fixed station transmitter. Two installations are presently in use - one at the National Center for Deaf/Blind Youths and Adults, New Hyde Park, Long Island; and one at the SAEDC, building 31 at M.I.T.

BRAILLEMBOSS

The BRAILLEMBOSS (Figure 1 and 2) operates in a similar fashion to a teletype, i.e. it converts coded electrical signals into embossed braille. The BRAILLEMBOS d as an output device only and when used in an interactive role it must be used in conjunction with a device containing an appropriate keyboard.

The BRAILLEMBOSS is the product of a long range M.I.T. program [1, 2] involving many M.I.T. people, students, faculty, engineers working in the Mechanical Engineering Department, Sensory Aids Evaluation and Development Center and the Draper (Instrumentation) Laboratories. The development was supported at various times by the Office of Vocational Rehabilitation[3], Vocational Rehabilitation Adminstration[4,5,6], Social Rehabilitation Administration and the Social and Rehabilitation Service[7,8,9] of the Department of Health, Education, and Welfare, and by the John A. Hartford Foundation.[10]

The BRAILLEMBOSS earliest beginning was in a design engineering course 2.671 as a result of a series of "Sensory Aids Discussions," a series of lunch time seminars. These seminars brought together members of the M.I.T. community, some of those who have worked with the blind and members of the blind community to explore the ways technology can help the blind. From the initial senior theses by Lichtman[11] and Eglinton[12] were written based on the sesign of a braille printer and typewriter input device for it.

The first operational braille embosser was built by Kennedy[13,14] as his masters thesis. This model was further refined and six units were built at the SAEDC. Two of these units were loaned to users; three were used by students for additional thesis projects; and one retained at the SAEDC for its use. It later served as a test bed for the changes incorporated into the BRAILLEMBOSS.

The three student projects braille embossers were built into braille telecommunication terminals by Armstrong[15] as his masters thesis. One of the terminals was then incorporated in a computer Grade II braille system, by Greiner[16] as his masters thesis project and saw limited use at Perkins School for the Blind. The other two units were used in design improvement projects by Scott[17] and Sturgis[18].

The SAEDC engineers and technicians in conjunction with an engineer and design draftsman of the Draper Laboratory re-examined the design and made changes to improve its reliability and accuracy and to reduce its cost of manufacture. As a part of this effort twenty BRAILLEMBOSSes were constructed.

As the BRAILLEMBOSS is presently configured it used "brailler code"[19] as its input data. This code is an eight level or eight bit code. That is, there are eight yes-no elements, or bits, per character or data word. This code was designed to have maximum correspondence to the braille cell. If the eighth level, machine function, is a zero (no) then the first six levels are embossed in braille; i.e. level 1 data becomes dot 1; level 2, dot 2 through level 6, dot 6. If the machine function is a 1 (yes), then the codes in levels 1 through 7 determine the machine function to be performed. The functions are space, new line (carriage return), new page and line feed.

The BRAILLEMBOSS was built to use the existing "standard" brailler code for braille equipment. It was recognized early in the development of the BRAILLEMBOSS that maximum flexibility had to be built into the device as it was expected that uses for the BRAILLEMBOSS other than remote production of literary braille via computer would be found. Provision was therefore made in the BRAILLEMBOSS cabinet and electronics for an interface unit to adapt the BRAILLEMBOSS to the desired application. The flexibility will not be needed if large numbers of BRAILLEMBOSSes are built for any given application as the control electronics can be optimized for the data transmission code used.

For most of the present applications of the BRAILLEMBOSS three data transmission codes are used: 5-level newswire (TTY), 7-level EBCDIC, and 8-level teletype (ASCII). The most common interface unit used ASCII data transmission code and has input conversion equipment to permit the BRAILLEMBOSS to operate in parallel with all of the present 8-level teletypes - Models 33, 35, 37, and 38 regardless of version be it Receive Only (RO), Keyboard Send-Receive (KSR) or Automatic Send Receive (ASR).

An interface unit for newswire (TTY) has seen service at a TV station. This interface unit includes a time buffer and format control circuitry to provide clear format material. Also an interface unit has been built for EBCDIC, the code used by IBM for its remote terminals. Preliminary testing of this unit is complete, but it has not seen field service.

Conventional English braille, either the letter for letter Grade I or the highly contracted Grade II forms are not directly usable with computers, as many of the symbols used in the ASCII or EBDIC character set are simply not defined in braille. Also several characters are ambiguous; i.e. " (" and ")" use the same braille symbol. Further, numbers are not directly defined in braille but use a number sign before the letters "a" through "j" to represent the numbers 1 through 0.

A new braille system was defined for use with the BRAILLEMBOSS when used. Each symbol in the Fortran character set has a unique braille symbol defined in this system by computer programmers. This code, called "one-cell" braille uses the same pattern for the alphabet. It takes identical pattern for the numbers defining the same bit arrangement as "a" through "j" but using the lower four dots of the cell.

Then the most important sysmbols in the Fortran character set; i.e. =, +, -, *, /, (, and) are assigned the least ambiguous braille cells. Finally the remaining characters used in the ASCII (teletype) character set are arbitrarily assigned the remaining braille characters. This one-cell braille has a one-to-one correspondence between each printing character of the ASCII character set used in teletypes and the 63 possible printing characters in the braille cell. This allows any system based upon the ASCII transmission code to transmit Grade II braille since each braille symbol has a printing ASCII code to represent it. One cell braille has also been defined with the 5-level code with not all braille symbols represented. One cell braille is also defined for the 7-level EBDIC but with only 62 printing characters.

Interface units have been built to one-cell braille containing translators for each of these three codes. There have been special features included in some of these interface units, such as a data controlled on/off switch, and with a time buffer and format control circuitry for newswire use.

Time-shared Computer Programmer Terminal.

The BRAILLEMBOSS is presently being used by programmers and system analysts with time-shared computers at a U.S. government agency, two companies, three universities and a residential school for the blind.

At each of these installations the BRAILLEMBOSS is connected to a teletype such that both the BRAILLEMBOSS and the teletype page printer produce the received material simultaneously.

This form of interconnection was selected for several reasons. First, it insures that the installation will not be restricted to blind users, but can also be used by the sighted. This provides maximum flexibility and usefulness of the terminal. Second, it limits the amount of special equipment at the terminal that must be maintained differently than the equipment used regularly. It also reduces the complexity of the BRAILLEMBOSS.

Sensory Aids Evaluation and Development Center Installation.

The first BRAILLEMBOSS built (serial #10) was connected to a Model 35 teletype at the SAEDC and was first used by a graduate student in his ergometric studies. This first terminal was used chiefly with a CTSS, a time-shared computer system at M.I.T. based on an IBM 7090 computer. This particular BRAILLEMBOSS is not presently in use, but could be upgraded easily and put back in regular service if desired. Two BRAILLEMBOSSes (Serial #26 and #27) have been and are being maintained on line at the Center for use of M.I.T. students and for computer braille experiments and demonstrations.

Dr. John Morrison, NASA/DOT, Cambridge, Massachusetts.

The first BRAILLEMBOSS (Figure 3) in the field was installed at NASA Electronic Research Center (ERC) here in Cambridge. The BRAILLEMBOSS and teletype were installed in Dr. John Morrison's office during October 1969.

ERC was disbanded in June of 1970 and the facility transferred to the Department of Transportation. Dr. Morrison transferred to DOT's Transportation Research Center in the former ERC facility. In October of 1970 the Mass Commission for the Blind purchased a BRAILLEMBOSS for Dr. Morrison's use and DOT installed a Model 33 teletype. At that time the SRS supported equipment was removed.

Dr. Morrison has written two reports on his use of the BRAILLEMBOSS. They are included as Appendix I and II. It should be noted that the last service call except for lubrication was in early 1971 to install a convenience switch and to adjust the electronic timing to eliminate the occasional random dropping of characters. The BRAILLEMBOSS and teletype have been moved at least twice by DOT and telephone personnel without assistance from the Center.

Programming Course, Perkins School for the Blind, Watertown, Mass.

For several years Perkins School for the Blind has offered a course in computer programming for students in the upper school during their junior and senior year.[20] The object of the course was best expressed by Mr. Benjamin F. Smith in a report to "The Blind in Computer Programming, an International Conference"[21] describing the reasons for use of a time-shared computer.

> "Secondly, we concluded that this computer plan offered considerable promise as a tool in the classroom of some of the subject areas in our senior high school department. We felt that the application of the computer to classes in mathematics and science would be particularly effective both as a means of greater efficiency in the learning process and also as a means of motivating our students to greater interest and effort."

> "Finally, since it had already been well demonstrated that blind people can be highly successful vocationally as computer programmers, we concluded that we should give our students experience on the computer with a view to exploring both vocational interest and vocational aptitude."

An M.I.T. BRAILLEMBOSS was transferred to Perkins and was connected to a teletype previously rented by Perkins. The initial time-sharing computer service was provided by General Electric. The Babson College Hewlett Packard 2000C time-shared computer system presently is used.

The Perkins students are taught both how to use a time-shared computer and how to program with programming language. During the 1972-73 school year there are seven students, including five braille users in Computer I and five students, including four braille users in Computer II. The computer terminal room is now left open during certain afternoons and evenings each week for use of both students and members of a computer club.

The BRAILLEMBOSS has operated reliably and efficiently with only two service calls in the period March 1970 through January 1973. Its performance and student acceptance has demonstrated that a reliable, maintenance-free braille terminal is an essential adjunct to teaching blind students computer programming via a time-shared computer.

Alan Downing, Systems Programmer, Honeywell Information System, (HIS) Cambridge, Mass.

Mr. Downing is an example of the importance of an interactive braille terminal to a motivated, intelligent blind student or computer professional. During his junior year at M.I.T., 1970-71, Alan took an introductory course in Fortran programming. He was not content to have other students read his output or proofread his input. He therefore arranged with the SAEDC to use one of the BRAILLEMBOSS terminals at the Center as his terminal and arranged with the department offering the course to support his use of the IBM 360/67 time-shared computer at the M.I.T. computation center. This proved satisfactory and was continued during his senior year.

Mr. Downing obtained summer employment at Intermetrics, Inc., a "software house," contingent upon a braille terminal being available to him at their office. The SAEDC then agreed to loan him the terminal shown (Figure 4) until a cooperative agreement could be reached with the Mass. Commission for the Blind. The MCB, through a similar arrangement as that for Dr. Morrison, underwrote the transfer of a BRAILLEMBOSS for Alan's use. A new BRAILLEMBOSS was installed for his use and the temporary BRAILLEMBOSS returned to the Center.

During his senior year Alan continued employment at Intermetrics on a two day a week basis and upon graduation he was offered full-time employment. He decided however that he would rather work on development of the operating system of a large scale computer and obtained employment at HIS. The BRAILLEMBOSS was moved to his new location and has continued to give good service.

<u>Mr. Donald Keeping, Supervisor, Programming Course for the Blind, University of Manitoba, Winnipeg, Manitoba.</u>

The BRAILLEMBOSS was procured through a grant from the Canadian National Research Council for use of both teachers and students in the Programming Course for the Blind. The BRAILLEMBOSS was shipped during October 1971 and was installed by University of Manitoba personnel during November. At the present time the BRAILLEMBOSS is used only by Mr. Keeping, as all of the present students while legally blind have sufficient vision not to require braille.

The BRAILLEMBOSS is used with a teletype as a terminal on an IBM 360/65 system using TSO (Time Sharing Option). Mr. Keeping estimates that he uses it 4 or 5 hours per week, chiefly before and after normal working hours and on weekends.

It is presently also being used in a small scale program to generate French braille for a group in Toronto. The programming associated with translating Grade I French braille is comparable to Grade I in English and much simpler than Grade II English Braille.

The University of Manitoba experience can best be summarized as follows:

> "As you know, we have recently installed here at the University of Manitoba an M.I.T. BRAILLEMBOSS. Outside of a few minor mechanical problems, we have found the system quite satisfactory. We have here a suite of conversational mode programs which are excellent on such a device."[22]

<u>Mr. Terry Hicks, Programmer, Bristol Engine Division, Rolls Royce (1971) Bristol BS12 7QE Great Britain.</u>

A BRAILLEMBOSS was transferred during March 1972 to Rolls Royce Ltd. for use by Mr. Terry Hicks, a blind programmer in their Bristol Engine Division. A letter from Dennis C. Boston, Head of Mathematical Services Department to Milton Graham of the American Foundation of the Blind describing their use of the BRAILLEMBOSS is appended (see Appendix IV). This BRAILLEMBOSS was converted to 117 volt 50Hz power and was tested on 50 Hz power at the Maynard Plant of the Digital Equipment Company (DEC). Since the BRAILLEMBOSS is being used on the DEC PDP-10 computer at Rolls Royce, DEC crated, shipped and installed the BRAILLEMBOSS.

Phillip Hall, Student, Worcester Polytechnical Institute, Worcester Area Collegiate Computation Center, Worcester, Mass.

Through a cooperative agreement negotiated by the SAEDC between the Mass. Commission for the Blind and the New Hampshire Division of Blind Services, a BRAILLEMBOSS owned by MCB has been loaned to WACCC. It is presently being used by Phillip Hall, a blind student at WPI from New Hampshire. The BRAILLEMBOSS was installed by the staff of the SAEDC and is located in the terminal/keypunch room at WACCC.

It is connected to one of the four teletype terminals of the PDP-10 located in the main Center. This terminal is available to any of the users of the WACCC PDP-10 but it is the only one usable to Phil. He does not have absolute priority to this terminal but has to wait his turn if all the terminals are in use. When another terminal becomes free, the user of the teletype/BRAILLEMBOSS terminal is asked to move the other terminal so Phil can use the BRAILLEMBOSS.

For the second semester of the 1972-73 academic year Holy Cross College is planning to install a new teletype in the terminal/keypunch room at WACCC for the use of a blind HC student. The BRAILLEMBOSS will be reconnected to this teletype. This will give the blind students a terminal that will give them absolute priority over all other users.

The WACCC serves a consortium of colleges and universities in the Worcester area. There are approximately 10 blind students in these colleges and WACCC is expecting 5 or 6 of them to make use of the teletype/BRAILLEMBOSS terminal during the second semester this year. It should be noted that HC is not now a member of the consortium.

Customer Service Computer Terminal

In the past several years the computer has become an important part of many non-technical jobs. One of these is that of customer service, where a customer's questions are answered. These questions can either be about their account or on company policies. Another type of job is the making and confirming or reservations, whether it be airline, hotels, motels, rental cars, etc. In many of these jobs the contact with the public is via the telephone. Some special equipment is required for a blind person to fill these jobs. Perhaps most important he must have access to the computer output. The BRAILLEMBOSS is capable of being used as an output device with essentially any computer used in the customer service field. In certain cases telephone indicators may be required. The typical working blind person either has most of the additional equipment required or it is regularly supplied to him by existing rehabilitation agencies.

Jack McSpadden, Taxpayer Service Representative, Internal Revenue Service, District Office, Little Rock, Arkansas.

The IRS has employed many blind persons as TSR's. The TSR function is to assist the public in obtaining information on the tax codes, rules and regulations, and to answer questions concerning the taxpayer records. Presently most of the some 40 Braille using TSR's are limited to answering questions on the tax code, rules and regulations unless they have sighted help to obtain the required data on taxpayer accounts.

In certain regions the taxpayer records are now available on the Integrated Data Retrieval System (IDRS), a large regional based computer. Each district office in the region with IDRS has Cathode Ray Tube, (CRT), television like, displays on which lines of data are displayed for the sighted TSR. Each office also has a Receive Only (RO) teletype to provide a hard copy; i.e. a copy that can be saved when needed.

A BRAILLEMBOSS (Figure 5) was connected to the RO teletype such that a braille copy as well as an inkprint copy can be made when requested. Mr. McSpadden, a blind TSR in the Little Rock office, now has access to the braille equivalent to the other TSR's hard copy in the office. His access to the data is only slightly slower than the other TSR's when they are not using the hard copy.

Mr. McSpadden is an enthusiastic BRAILLEMBOSS user. He is reported by his supervisor to be performing all functions essentially as the other TSR's in that District office. It should be noted the BRAILLEMBOSS has removed the restriction of sighted help or of limiting Mr. McSpadden's services to only answering tax code questions.

Newswire

A serious hindrance to the blind performing as radio or television newscasters is the absence of usable direct braille copy of the newswire service; i.e. United Press International or the Associated Press. The BRAILLEMBOSS, with a suitable interface unit has demonstrated it can provide this service. To develop and demonstrate this capability several steps were accomplished.

The first step was to produce newswire braille in non-real time to determine the utility of the braille copy and to explore the system before a final design was undertaken.

The initial step (Appendix V, TDS No. 12) to demonstrate program feasibility required that the following be available: a newswire service with a tape reperforator, a 5-level TTY code to One Cell braille translator, a paper tape reader and a BRAILLEMBOSS. The first items were available for a limited period at Electronic System Laboratory (ESL), a part of the Department of Electrical Engineering. They were performing some studies on computer storage and retrieval of news sponsored by the American Newspaper Publisher Association. Available to them was a UPI newsprinter and reperforator which could produce 5-level punched paper tape for our use.

The SAEDC had all the remaining necessary equipment with the exception of the translator. The translator was designed and fabricated by the Staff Engineer, and easily installed in one of the M.I.T. BRAILLEMBOSSes located at the Center. A pilot program was then initiated, punched tapes were acquired from ESL, brought to the Center, and translated into braille via the BRAILLEMBOSS system.

The braille material produced by this method was distributed to three blind readers for examination and use. Approximately five hours of newswire services (produced on a daily basis), were converted into braille each day. The conversion of the newswire service information into braille took approximately three hours on the system. The pilot study was performed during May and June 1970 and terminated when the UPI reperforator service was discontinued at ESL.

The next step was started when Paul Caputo (Figure 6) of Westfield, Massachusetts obtained a job as a television newscaster at WWLP, Channel 22, in Springfield, Massachusetts with the provision that the Mass. Commission for the Blind would obtain newswire braille for his use.

A BRAILLEMBOSS was installed at WWLP-TV Channel 22 during May 1971. The interface unit for this installation had to be significantly different from the one used previously for the news demonstration.

In the news demonstration above, punched paper tape was used as a convenience but it also served as a timing buffer to accommodate the generally longer carriage return time of the BRAILLEMBOSS. Using this method as an operational system is inappropriate since the paper tape adds another expendable (paper tape), as well as requiring a tape reader and tape punch. A full reel of paper tape lasts only 5 or 6 hours, while a box of braille paper lasts several days. This complicates the operation and requires much more attention by the user than is desired.

To simplify the system an integrated-circuit storage system was designed and built to provide the necessary timing buffer, eliminating the need for the intermediary paper tape. Two shift registers, both 128 words long with 8 bits per word, are used. While one register is being loaded from the newswire the other register is used to drive the BRAILL-EMBOSS. When the register being loaded is full, the system interchanges the registers. Sufficient time generally exists to unload a register into the BRAILLEMBOSS while the other register is being loaded.

Included in the interface unit are format control circuits. A space counter and line control circuits are used to divide the 72 character line of the teleprinter at a space near the 38-cell length of the BRAILLEMBOSS line. This generally eliminates dividing words randomly at the end of the line. Also paging control circuits were included to prevent embossing on the perforations.

This newswire BRAILLEMBOSS installation was a cooperative program with the Mass. Commission for the Blind. The Center adapted a BRAILLEMBOSS to the UPI newswire by designing and constructing the interface unit. The Mass. Commission supplied funds for the necessary hardware.

Unfortunately Mr. Caputo's relationship with WWLP Channel 22 was severed during October 1971. The BRAILLEMBOSS performed well during the period and provided him with excellent braille copy that he could read rapidly and accurately while on camera.

There is some dropping of characters in the timing buffer used in the newswire interface unit when a long series of short lines are received. Developments of computer memory technology since the newswire interface unit was designed should permit significantly better buffer performance for approximately the same cost as the original buffer.

Interactive Grade II Braille Production

A computer program for Grade II braille translation, DOTSYS III,[23] was written by the MITRE Corp. under contract to the SAEDC. (This contract was supported from a multi-sponsored M.I.T. account). The program is written in COBOL (COmmon Business Oriented Language) such that it can be transferred from one suitably equipped computer to another with minimal changes.[24,25,26]

Additions have been made to DOTSYS III to use the BRAILLEMBOSS as an output device. This modified program is called DOTSYS III and is stored in the time-shared computer of Interactive Data Corp., in Waltham, Mass., a commercial computer facility.

A teletype, connected by telephone line, is used as the input/output device of the computer. The BRAILLEMBOSS is connected via an interface unit to the teletype.

The material to be brailled is typed into the computer where a data file is created. This file can be proofread and corrections made. Then by a single command the material is translated by the computer and brailled on the BRAILLEMBOSS.

The initial interface units did not include a computer controlled brailler on/off switch such that they could be used with the computer translation program. A redesign of the Model 33/35 interface unit permits the BRAILLEMBOSS to be used as a time-shared computer terminal for a blind programmer or by throwing a switch, be used as the braille output unit for DOTSYS III.

National Braille Press Demonstration. The first substantial use of DOTSYS III by the SAEDC was the brailling of an IRS publication for a client of NBP in December 1971. The material to be brailled was typed into the computer using the necessary format controls thereby forming the input file. The input typing was done by personnel of both NBP and the

SAEDC. As sections of the input file were completed, these sections were individually translated, brailled, and proofread. Typographical errors in the input file were corrected and small changes were made in the translation table of the program to remove program braille errors. After the input file was completed and all known errors corrected, the entire publication was translated, embossed by the BRAILLEMBOSS, bound by NBP and delivered to their client.

This system shown in Figure 7 was demonstrated to a large group of possible employers and workers for the blind on January 31, 1972. An employee of NBP produced several pages of braille. Following the typing and correction of the input file the remote computer translated the material which was then brailled on the BRAILLEMBOSS.

"In Darkness." On January 5, 1972 Howe Press of Perkins School for the Blind issued a purchase order "... to do a single copy at M.I.T. of the novel In Darkness using a paper tape prepared by computer and to provide Howe Press with a paper tape to drive the sterograph machine..." Scheduling commitments with the above demonstration at NBP delayed the start of the work until February 1, 1972. The same steps were employed in the translation as at NBP including two proof readings except that a punched tape was prepared when a copy was being produced by the BRAILLEMBOSS. The proofreading was performed by NBP personnel under a purchase order on a time available basis.

The unbound braille copy was delivered to Howe Press on April 12, 1972. The SAEDC staff then worked with Howe Press personnel in testing, adjusting, and repairing the APH paper tape driven sterotype. The SAEDC staff then operated the sterograph and otherwise assisted in producing the embossed zinc plates for press braille production. This sterotype's reliability could be improved by replacing the relay control system with solid state logic, as used in the BRAILLEMBOSS.

The experience gained by the regular staff of the SAEDC, supplemented by proofreaders, has demonstrated that the existing computer program and equipment can produce computer translated braille. It cannot be done efficiently, however, unless the work is performed by an organization fully and completely committed to braille production. The overall national production and timely availability of braille would be improved if several regional computer braille production facilities were established to supplement the work presently being done by The American Printing

House, the many volunteer agencies and the braille libraries. These regional facilities could be either new organizations or extensions of existing braille agencies.[27]

Technical Description Sheets

Two TDS's have been translated by DOTSYS III and are stored in punched paper tape form such that copies can be produced on demand.

The first one translated was TDS #2, The Braillemboss, a Braille Page Printer (Appendix V). In inkprint it is two full single spaced type-written pages and in braille it is six plus pages. A typist with some previous experience typing in material for DOTSYS spent approximately an hour typing the material, proof reading and correcting the input file that was produced. It then took 20 minutes of terminal time to translate and braille the material.

A total time of 80 minutes was required for a person familiar with the DOTSYS format control convention (Appendix V TDS No. 11) to produce this report. It was not necessary for that person to know Grade II braille; however, the user should have some knowledge of braille to check for obvious operator, computer transmission or terminal error.

TDS #1, Folding Canes (Appendix V) has also been translated by DOTSYS III. It is a little shorter than TDS #2. It is five and one/half braille pages long and took 45 minutes to produce.

Both of these TDS's are available in braille on request to the SAEDC.

The Social Beaver

The SAEDC in conjunction with Technology Community Association (TCA), the M.I.T. Libraries, and the Howe Press has embossed 25 copies of The Social Beaver, a chapter of HoToGAMIT (How To Get Around M.I.T.) HoToGAMIT is a paperback student guide to M.I.T. as well as the Boston area. The chapter entitled The Social Beaver, is a guide to enjoying yourself in and around Boston and is applicable to all, not just M.I.T. students.

Through a fortunate set of circumstances catalyzed by Steve Shladover of TCA this braille volume was made possible. Lindsay Russell volunteered to produce the braille coded punched paper tape necessary to produce the copies of braille economically on the BRAILLEMBOSS.

The BRAILLEMBOSS has been used previously to produce braille materials from manually prepared punched paper tape. In the work described in Appendix V TDS No. 7, the punched tape was prepared by a professional braillist using a modified Perkins Braillewriter connected to a paper tape punch.

The Center has a special teletype, modified by Mr. Ray Morrison, a telephone pioneer, that produces braille coded punched paper tape directly from its keyboard. This teletype contains all the Grade II braille symbols in its character set.*

Bertha Kasetta of the Howe Press and two blind young people presently or formerly M.I.T. students proofread the material. The book was then brailled by the BRAILLEMBOSS operated by TCA volunteers under the direction of the Center Staff.

The M.I.T. Libraries undertook the distribution of copies of the finished volume to other universities and colleges in the Boston area. A copy has been given to each blind student at M.I.T. The libraries also underwrote the cost of binding the volumes by the Howe Press.

Rehabilitation Agency, Arkansas Enterprises for the Blind, Little Rock, Arkansas.

A BRAILLEMBOSS was made available to Arkansas Enterprises for the Blind to be used in their rehabilitation and training programs. It was installed during September 1972. AEB has obtained a minicomputer and paper tape equipment to be used with the BRAILLEMBOSS.

AEB's applications include training of IRS TSR students on the IDRS system. They will also use the BRAILLEMBOSS to train other students in computer interaction. The minicomputer can be used both as a simulator of the larger IRS IDRS or as a small computer for actual operating and programming experience by other AEB trainees.

Another AEB application of the BRAILLEMBOSS is the braille duplication of instructional materials. A paper tape punch/Perkins Braillewriter combination was borrowed from Howe Press to support this effort. The

* This teletype is similar in concept, but different in detail, to the Tyco brailler developed previously by Woodcock.

Howe Press equipment was used by an expert braillist to produce a punched paper tape which is then used to operate the BRAILLEMBOSS to produce as many braille copies as desired. This same paper tape equipment was used at an earlier time by M.I.T. to produce a pamphlet for Perkins upper school students to establish the accuracy of reproduction by the BRAILLEMBOSS (Appendix V, TDS #7).

TACCOM

TACCOM (for "tactile communication") is the name given a system of signalling to deaf, blind, or, most importantly, deaf-and-blind persons. The focal device of the system is the TACCOM pocket receiver - see figure 8 - a six-ounce instrument which vibrates in response to a radio signal. Carried on the person, in a shirt pocket typically, the receiver functions as a pager, not unlike the pocket pagers in common use by physicians in a hospital or executives in an office building. Instead of beeping in response to a call, though, the TACCOM receiver vibrates; held in the hand, when it is activated it feels rather like an electric toothbrush running.

Two purposes established the initial scope of the TACCOM project, both related to needs of the deaf-blind:

(1). To develop something to serve as a fire alarm;

(2). To develop something to serve as a doorbell.

The financial support for this project has two roots: an initial purchase of hardware by the National Center for Deaf-Blind Youths and Adults* with a view primarily toward fulfilling the above two needs; later, support over a three-year period by the Social and Rehabilitation Service of the United States Department of Health, Education and Welfare, with the objective of augmenting and broadening the usefulness of TACCOM beyond this initial rather limited scope.

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*Referred to subsequently in this report as the "National Center," it is located at 105 Fifth Avenue, New Hyde Park, N. Y., and administered by the Industrial Home for the Blind, Brooklyn, N. Y.

Background

To summon a person who is both deaf and blind, to alert him that there is a fire, or that he is wanted elsewhere, or that a particular moment has come (e. g., end of lunch hour) is not an easy thing unless one is close enough to touch him and communicate by physical contact. A person who is blind but hears normally can be alerted in the usual auditory ways: doorbell, fire gong, even by calling out to him. On the other hand, a deaf person, if he has sight, can be signalled visually by the turning on or off of a light or in any other way that will catch his eye. In the case of the double handicap - deafness and blindness together - there seems to have long been a need for some scheme that could call a person from a distance without needing either his eye or ear. Such devices have been used as stamping on the floor or starting an electric fan (to create an air current) but they have obvious limitations in range and dependability.

Although it is this double handicap to which TACCOM is primarily addressed, there come to mind ways in which a person afflicted with deafness or blindness alone could make use of a vibratory signaller. A deaf person can be alerted by turning on a lamp, but only if it is assured that he will be looking where the light can be seen, a difficult requirement, perhaps, when he is in his yard. A nonauditory signal could be useful to a blind person under many circumstances one could envision: when a soundmaker would embarrass him, annoy others nearby, drown out other sounds he must hear, etc. Thus while the need of the deaf-blind are the main objective of TACCOM and its (by now) many adjuncts, there has been attention given that potential benefits to those with either single handicap do not pass by our view unheeded.

Technical Description

Radio frequency induction is the signalling means of the TACCOM system. Technically this is not true radio communication; indeed it is a form of signalling that historically antedates radio. The transmitted signal is a 25 kilohertz alternating magnetic field set up by energizing one or more loop antennas placed typically on the walls of the building or rooms to be covered. Figure 9 shows the transmitter proper, an all-solid-state unit housed in the kind of cabinet used for audio amplifiers or small public address systems.

Creation of the ringing field is accomplished by pressing a button on the front of the transmitter. "SHORT RING" is a momentary-contact pushbutton; "LONG RING" evokes an activation of fixed duration, typically set at five seconds. The latter feature is primarily for insurance against missed calls due to an overbrief button push on the part of the caller. Pushbuttons at other locations can be wired to terminals on the back of the transmitter so that it can be activated from a remote location if more convenient.

Five small jacks on the front of the transmitter are outlets for recharging batteries within the TACCOM receivers; this is done each night - thus five receivers can be recharged simultaneously.

Receiver

The characteristics of the TACCOM pocket receiver are as follows.

Weight	6.3 ounces
Size (approx.)	2 1/2 x 7/8" x 5"
Battery	Four Burgess "CD-3"
Ringing time	45 minutes starting fully charged
Listening time*	150 hours " " " "

The components are all in a small aluminum case, except for the loopstick receiving antenna, which is potted in silicone rubber at the bottom. When the transmitter is activated and a ringing field established, a weak 25 kilohertz signal is induced in this loopstick; it is amplified by circuits within the receiver, detected, and if above a certain minimum threshold, causes to be energized a tiny electric motor within the instrument. The vibration is brought about by a tiny eccentric on the motor shaft. The mechanical inertia is low, and the vibration starts and stops within milliseconds of the starting and stopping of the ringing field.

*"Listening" means the quiescent situation where the receiver is switched on to be able to respond to a call, but is not actually being called. There is very low battery drain (compared with "ringing"); hence the many hours of life when the receiver is on but not activated.

Transmitting Loop Antenna

All installations to date make use of transmitting loops in vertical planes, so that the magnetic field lines therefrom will be substantially horizontally oriented in the service area. The receiver loopstick will normally be oriented more-or-less horizontally too, for example, in the pocket of a sitting or standing person, so that its alignment is appropriate for the exciting field. If this exciting field were generated by a single loop antenna, however, a null direction would exist where the loopstick, though horizontal, would be perpendicular to the magnetic flux lines. (Anyone who has rotated a transistor radio in his hands will have observed corresponding nulls that it, too, exhibits in certain directions).

To avoid the risk of missed calls due to a user's possible unfavorable orientation when being paged, a second loop is used, also connected to the same transmitter, but whose exciting current is in time quadrature with that of the first loop, and whose physical placement is at right angles. This arrangement effects essentially null-free coverage, since the null direction of one loop's field will be nearly at the maximum of the other's, and the time quadrature relating the two will prevent destructive interference at intermediate angles.

Why Magnetic Induction?

A word or two ought to be said regarding the choice of this low frequency induction scheme, especially considering that there are true radio systems as alternatives. For example, why not use Citizen's Band channels or possibly even private frequencies of one's own assigned by the Government?

Easily the most negative feature of the induction system chosen is the need for the transmitting loops; for strong coverage the wires comprising them must run the length and breadth of the coverage area. Whether this factor makes the installation of a TACCOM system troublesome and expensive depends on the building involved, whether the wires must be totally out of sight, and so on. There are ways of avoiding some of these problems, about which more will be said in the next few pages.

The positive features are technical simplicity and freedom from radio interference problems (false rings, etc.). The receiver uses only five transistors, and its simple circuit lends itself to substantial further miniaturization should such an end be sought. The noise level at its detector is more than 50 decibels below the signal present upon receiving a ringing signal; the transmitter, with only several watts output, provides considerable "overkill." In short, there is a high strength or safety factor in this system; only the most rare and unlikely circumstances could be envisioned wherein it would interfere with or suffer interference from other radio services.

Installations to Date

TACCOM signalling systems have been installed in four separate buildings:

(1). The M.I.T. Sensory Aids Center at 292 Main Street, Cambridge, Mass.

(2). The M.I.T. Sensory Aids Center at 77 Mass. Avenue (Building 31), Cambridge, Mass.

(3). The Headquarters of the National Center for Deaf-Blind Youths and Adults, New Hyde Park, N. Y.[29]

(4). The apartment of a deaf-blind National Center staff member at Kew Gardens, N. Y.

The M.I.T. Installations

The TACCOM installations at M.I.T. (two, because the Sensory Aids Center moved from its old to its new location in 1971) were set up not only to prove out the system in an initial way, but to gain the experience of many months of continuous operation - a designer's life-test, so-to-speak. Both installations were accomplished without difficulty; the coverage area in each case was about 4000 square feet, and it was null-free. The one transmitter involved has run about three years and has been without breakdown. It can be keyed (to page receivers in the area) by pressing a button either at the Director's desk or that of his secretary. One staff member has for several years made it a habit to keep receiver in his pocket at all times while at work; to gain him a secondary benefit (besides the main one of life-testing the equipment involved), the transmitter has been wired to the Center's telephone switchboard so as to signal incoming calls, and to an "electric doormat" to signal that someone has entered the front door. Since the reception area and switchboard are unattended at off hours, the arrangement permits him to work in remote areas of the Center without missing incoming calls or visitors.

The New Hyde Park Installation

This TACCOM system was installed at National Center Headquarters and put in operation in July, 1970. A semi-institutional setting wherein a number of deaf-blind clients are served in various rehabilitative and sheltered work programs, it has been here at the National Center that the bulk of experience has been had with the kinds of handicapped people TACCOM is designed to serve.

The system is in use at this Center as a fire or evacuation alarm (initially for testing and demonstration, but now for "real") and has been wired to a timeclock to signal each hour's rest break and return to work. The system has functioned as it was designed to do, although a number of problems have turned up; the main ones and their solutions are summarized as follows.

1. Vibration amplitude. Many clients find a severe startle factor in the TACCOM stimulus. This is not surprising; experience across a broad front suggests that a person deprived of one or more senses is startled by a relatively minor stimulus in a remaining sense, especially when the stimulus comes on suddenly. Thus, the TACCOM vibration, which seemed just adequate to its designers for being reliably felt through a layer or two of clothing, was excessive to most deaf-blind people, and many objected to wearing the early receivers for that reason. The problem is easily corrected by reducing the rotor mass eccentricity in the receiver's motor; a number of receivers were recently so-modified on a trial basis for the National Center by M.I.T.

2. Inadequate pocket retention. A second problem was that receivers dropped out of users' pockets with considerable frequency, sometimes being damaged on striking the floor and needing subsequent repair. The early units had pocket clips more suitable for securing a pencil than a 6 ounce receiver; the retaining method was improved some by cementing abrasive patches to press against the pocket wall, but even the improved units had only marginal retention. On the basis that each receiver would probably get dropped sooner or later anyway, more rugged mounting means were arranged for the batteries and motor inside, which were the components

that generally got dislodged from a bad drop. Each receiver returned to M.I.T. for repair was sent back not only fixed, but with more secure internal construction. The problem, then, while not solved completely on a hard-and-fast basis, was considerably alleviated. Further work should include a stronger clip yet, perhaps special pockets sewn on the clothing of users for whom nothing else will work, possibly mounting on a belt or other similar strategem. Finally, miniaturization of the receiver would make the task easier no matter what the scheme of mounting.

3. Installation of loops. A third TACCOM system attribute needful of improvement is the nuisance factor (and possible cost) of installing the transmitting loop antennas. The number of loops needed and their placement depend on the geometry of the service area, and it is not feasible at present to prepare a blanket manual of instructions. The magnetic flux paths are not straight lines but curve away at some distance from a loop, so that, for the moment, engineering judgment is needed to prescribe for a particular setting. For this reason, and with a limited number of installations envisioned at present, it has seemed a wise policy for the Sensory Aids Center at M.I.T. to examine each setting and suggest an antenna arrangement. A way has been found to simplify the loop requirement now, and is described further on (see "Horizontal loop").

4. Miscellaneous improvements. Several things of a more minor nature were suggested by National Center personnel - improvements which would diminish nuisance value and result in greater convenience to the deaf-blind users.

One would be a short-stop button on the receiver; pressing it during a ring would terminate or abort the remainder of that ring. A timeclock signal, for example, might last ten seconds; the user who "got the message" during the first second could press the short-stop button and not be subjected to nine seconds' additional vibration.

Also desirable: a more convenient recharging method than the present one of connecting the small charging plug to the receiver. Perhaps the electric toothbrush scheme could be used - the receiver would merely be dropped into a slot or receptacle and recharged my magnetic induction - no connections needed.

Kew Gardens (apartment) Installation

A "doorbell" installation was put in use on a test basis at the apartment of a National Center deaf-blind staff member. The transmitter was placed atop a refrigerator in the kitchen and two loops were affixed to kitchen walls at right angles. The coverage was adequate in most of the two-bedroom apartment, though just marginal at extreme ends of the furthest rooms. The loop arrangement was responsible for the marginality; it was a compromise which avoided time-consuming work of an electrician in snaking wires through walls, etc. The transmitter was actuated by the apartment front-door intercom "beeper" by means of a sound switch (described further on) placed against the tiny intercom loudspeaker in the user's livingroom. Results of this TACCOM setup were reported to be satisfactory; it was taken down, though, when the user moved to a new location.

Ancilliary TACCOM Devices

A considerable part of the S. R. S.-supported TACCOM work was the study of ways to augment TACCOM's usefulness beyond the simple paging or calling function that was its initial task. A number of techniques were studied and devices designed to that end; many of the studies resulted in working hardware, and some of this hardware was placed into service with deaf-blind clients (at the National Center) during the period of the contract. These subsidiary studies are described as follows.

Standby Battery

An emergency standby battery pack was developed for the 115 volt transmitter to enable it to continue running in the event of power failure. If the TACCOM system were used as an emergency or fire alarm, it is apparent that the very circumstances that might call most urgently for activation of the alarm could be accompanied by a failure of the A. C. power; hence the need for the battery backup.

The standby pack is retrofittable into existing transmitters; that is, the pack fits entirely into the present transmitter cabinet. The battery, a set of nickel-cadmium cells, is kept on trickle charge under normal conditions, so as to be always on call fully charged; a sensing relay responds to failure of the main power and within a second throws the battery onto the transmitter's internal D. C. bus to supply energy if a ring is called for. The battery will provide thirty minutes of ringing, enough, obviously, to warn of an emergency.

Long-playing Battery

Something quite separate, and not to be confused with the above, is a small rechargable battery pack not much bigger than a TACCOM receiver. It is typically kept in one pocket, and the receiver in another, with a tiny cable running between. Its function is to give the receiver a substantially longer ringing time than the 45 minutes it normally gets from a full charge on its own internal battery. Reason: sometimes a receiver is to be used for many hours a day in situations involving much ringing, and if operated on its own battery alone, would run down long before the day ended. An example is in training deaf-blind clients to walk a straight line (correcting veering tendency); the trainer signals him when he veers via his TACCOM by keying a hand sender (described below).

Hand Sender

The hand sender (Figure 10) is a short range (about three feet) battery-operated transmitter. One of its uses is to demonstrate the TACCOM system to visitors or to the handicapped clients. One hands such a person a receiver and then makes it ring by pressing the signal button on the hand-held sender several feet away. The advantage of the short range, of course, is that one does not ring all the receivers in the area, as would happen if he keyed the main transmitter. Thus a rehabilitation counsellor can work with a particular client in an institutional setting, make use of the short range TACCOM feature for some purpose or other, and not disturb other clients by making their instruments ring too.

End of Line Signal

Another specific use for the short range signal is to create a vibratory equivalent to the end-of-line bell on a typewriter. It works this way: the user of the typewriter wears his TACCOM receiver in the usual way, and the hand sender is placed on the table alongside the typewriter with a small cable connecting the two. As he approaches the end of a line, the instant the warning bell rings, the hand sender is keyed for about one-half second, so the pocket receiver gives a brief burst. Thus, although the typist can neither hear the bell nor see the line he types, he gets his warning anyway, and he need not keep stopping to feel the carriage position to sense when he is near the end of his line. The complete system is shown in Figure 11.

To so aid him requires that the typewriter have installed on it a tiny switch at the bell hammer and also a small connector on the back of the machine so that the hand sender can be connected or disconnected according to whether the system is to be in use. The typewriter is not encumbered in any way, then, when the new feature is not in use. So far as can be ascertained, most makes of machines can be equipped with the bell-switch, and, importantly, so can a Perkins Braillewriter. A latter instrument, so-equipped, was furnished to a deaf-blind braille user for a trial.

Selective Ringing

The TACCOM system at present is an "all-ring" system; receivers are identical and all respond in unison when the 25 khz. activation field is present. One can envision circumstances wherein it might be desirable to signal one receiver of another out of a group, paging one particular individual without disturbing any others. A brief study was made of ways to achieve such selective ringing. A straight-forward way would be to tune receivers in the area to different frequencies and modify the transmitter for multi-frequency operation. Subcarrier or tone modulation schemes would be another.

The selective ringing problem was studied briefly on a theoretical basis (conclusion: it would cause considerable complication of present equipment but nonetheless be quite feasible), but no hardware was built. No user or using agency to our knowledge felt a need for incorporating such a feature into his existing programs, while hardware for other TACCOM ancilliaries (e. g., soundswitch) was needed - first hardware priority was given where need existed.

Sound Switch

The sound switch Figure 12 is a microphonic device connected to the 115 volt transmitter to cause the keying of the transmitter is response to ambient sound. One can demonstrate its function to a visitor holding a pocket receiver, for example, by giving a loud whistle; the receiver will vibrate for the duration of the whistle. (The sound will have been picked up, causing the transmitter to be keyed and thus activating receivers in the area.)

Useful sound switch applications are probably rather evident. The device can be placed near a telephone to signal its ringing to a deaf-blind person in the area. The same can be done with a doorbell. No electrical connections need be made, a fact that can be surprisingly advantageous. In the case of the Kew Gardens installation described earlier, for example, the usual city apartment situation was found: a street entrance with a row of intercom buttons to "beep" each unit, and the apartment in question some flights up. It would have been a costly task for an electrician to run secondary lines down to the street entry, install a special button, etc., to say nothing of getting the landlord's permission. As it was, however, a sound switch was strapped across the livingroom intercom speaker to pick up a visitor's "beep" - no connections whatsoever had to be made to the existing building wiring.

Further uses might be to pick up the buzz of a kitchen timer or the cry of an infant waking in the night (the sound switch could be suspended over the crib). The sensitivity can be varied over a wide range so as to make the switch respond only to loud nearby sounds or, if wanted, to much fainter sounds. In fact, the sensitivity can be increased to the point where it will key the transmitter intermittently from the sounds of a radio playing in the same room.

Light Probe

A corresponding device, used to detect ambient light instead of sound, was designed and breadboarded. This unit ought to be thought of as a TACCOM-like instrument for having a vibratory display, but beyond that, it has no direct connection either to the receiver or transmitter. It is, in fact, a totally self-contained unit resembling a small flashlight. Instead of casting light, though, it responds to light; aim it at a source of light and it vibrates like a TACCOM receiver; aim it where there is no light and it is still. It embodies a lens, photo-transistor, solid state amplifying circuitry and a vibration motor.

The light probe could be used by a deaf-blind person to ascertain whether lights were on or off in a room, whether a pilot lamp glowed to show that an appliance was turned on, and so forth. Also it might have application in travel, permitting one to home in on a front door light at night, etc.

Horizontal Loop

When it became apparent that a simpler antenna would be a worthwhile system improvement, a modified pocket receiver was designed whose loop-stick was oriented vertically. Figure 13 shows this receiver; the loop-stick is held in a bulge or "blister" on the front.

With this kind of receiver in use, the transmitting antenna can be a single loop in the horizontal plane; it would run around the perimeter of the area to be covered (which could be quite large - some acres, in fact), going up-and-over to get by doors, and need not run across floorways in the interior, a bothersome point with the present system.

This new system would have been used at the outset, were it not for the thought that the receiver design would have been complicated and its shape slightly less advantagious for pocket carrying. Also it was thought that the original system would give the user somewhat more latitude in bending or stooping, where the receiver could depart many degrees from verticality, and still have little risk of missed calls.

These problems seem not to be so troublesome as originally thought, and the new system now seems preferable - a step in a good direction. If and when more TACCOM systems are installed, the one-horizontal-loop arrangement will probably be recommended for its simplicity.

Signalling Codes

Just as a bell or buzzer can be used for simple messages ("go to the door"), it can also be used to convey information of much greater scope, for example by using Morse Code. A similar extension of the TACCOM system has always seemed an exciting possibility; the receiver responds swiftly to keyed signals, and the transmission of Morse, albeit at a slow rate, should be possibly by simply connecting a telegrapher's key to the transmitter. Thus one could "talk" to a deaf-blind person at a distance, something not readily feasible at present so far as is known.* With a sound switch appropriately placed near a telephone receiver, Morse could be sent a deaf-blind person at his home via telephone.

At least the beginnings of coded signalling are now in view: Clients at the National Center distinguish the long slow ring for the hourly rest break from the rapid short rings of a fire drill. Also, visitors to the earlier-mentioned deaf-blind apartment dweller would identify themselves at the door by individual codes - two shorts, one long, etc. At the Sensory Aids Center an all-solid-state code keyer has been breadboarded with which, by pressing a button, various ten-element sequences of dots and dashes can be initiated.

How useful such techniques might ultimately be is not known. To view the matter conservatively, a Morse signalling system might find little usefulness to most deaf-blind persons; indeed, on the basis of conversations with rehabilitation workers, there seem not to be many deaf-blind people who have learned Morse. On the other hand, the personal communication barrier is the dominant impact of this tragic double handicap, and anything that might help penetrate the barrier must have potential value.

PATHSOUNDERS

Approximately three years ago five PATHSOUNDERS[30] (ultrasonic mobility aids) were purchased under Contracts SAV 1057-67 et al., predecessors to the current SRS contracts at SAEDC. The PATHSOUNDER is shown in Figure 14.

A follow-on effort has continued in the evaluation of these devices; this has involved a minimal expenditure, simply that needed for maintenance, responding to inquiries, and occasional acts of assistance to users and their instructors. The follow-on seems to have been highly worthwhile; though it may have required only a tiny fraction of the SAEDC effort. The following is a brief summary of the status of each PATHSOUNDER, with mention of the school or agency concerned.

The first unit is in use by a young woman blinded (totally) and

*It is understood that experimental systems directed toward this end do exist, notably one proposed by Bell Telephone Company.

deafened (partially) by a recent attack of meningitis. The rehabilitation counsellor, in overseeing cane-travel instruction for this client, requested a PATHSOUNDER because of the difficulty she was having in bumping into above-the-waist objects and because of her inability to localize objects by sound. She reported the instrument most helpful and her lessons ended, she now retains it on long term loan. (Vision Center, Columbus, Ohio)

The second unit has been used in an effort to effect some limited travel independence for a fifteen-year-old boy blind from birth and confined to a wheelchair by cerebral palsy. The PATHSOUNDER and appropriate training have got him "on his feet" to a modest extent, and his instructor reports encouragement. (Ohio State School for the Blind, Columbus, Ohio)

The third PATHSOUNDER is in use by a blind Brooklyn resident, a cane-traveler who, according to the agency concerned, was trained with it, found it helpful in walking to work in a city environment, was allowed to retain it, and continues to use it. (The Jewish Guild for the Blind, New York, New York)

The fourth PATHSOUNDER is in use by a twenty-one-year-old girl totally blind from birth and confined to a wheelchair by cerebral palsy. She graduated from a residential school where she was given PATHSOUNDER training; because of her travel progress the staff elected to have her retain an instrument, and she is now reported to be traveling independently and effectively in her new environment. (The Oak Hill School, Hartford, Conn.)

The fifth PATHSOUNDER has been on loan to a college for use by teachers-in-training in its Orientation and Mobility Program. A rather thorough evaluation of the device's effectiveness was performed by several students, in particular, the effectiveness in easing a cane-traveler's course through fairly dense pedestrian traffic in downtown city areas. The results were favorable, and in fact, most encouraging; their publication by the investigators is anticipated. (University of Pittsburg, Pittsburgh, Penna.)

Thus, all five SRS-owned PATHSOUNDERS continue to be beneficially employed, and the productive liaison between this Center and the schools and agencies involved should be evident.

Personnel

The Staff of the SAEDC during this grant included Vito A. Proscia, Research Associate and Director of the Center (to April 1972); George F. Dalrymple, DSR Staff Member and Acting Director; Nancy Brower, secretary (to August 1970); Evelyn Welch, secretary (August 1970 - June 1972); Susan Sokalner, secretary (since July 1972); Norman L. J. Berube, Senior Technician. Additional work was done for the Center by Lindsay Russell, consulting Electrical Engineer, and Murray Burnstine, consulting Mechanical Engineer.

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Figure 1

Model 3 BRAILLEMBOSS

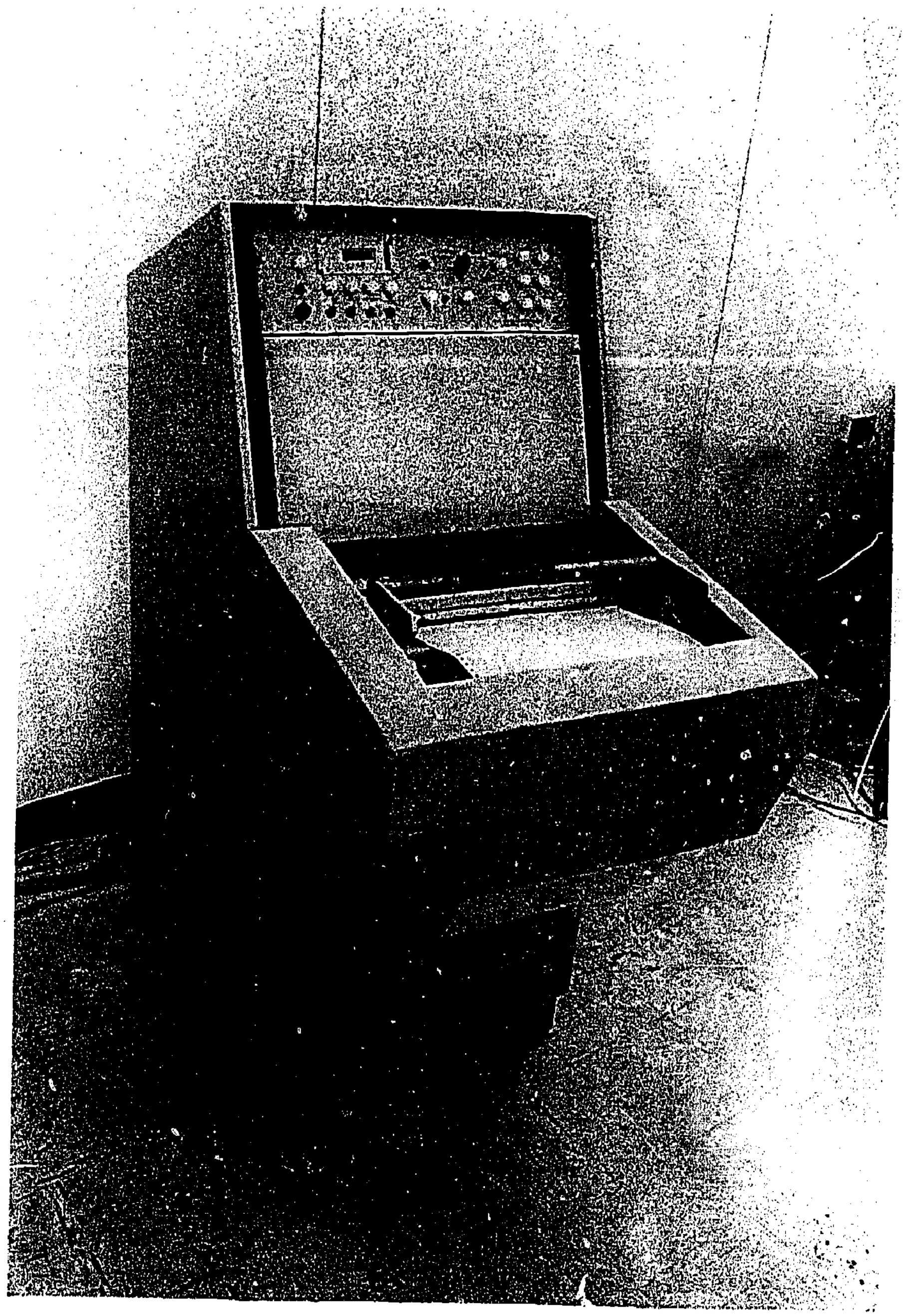
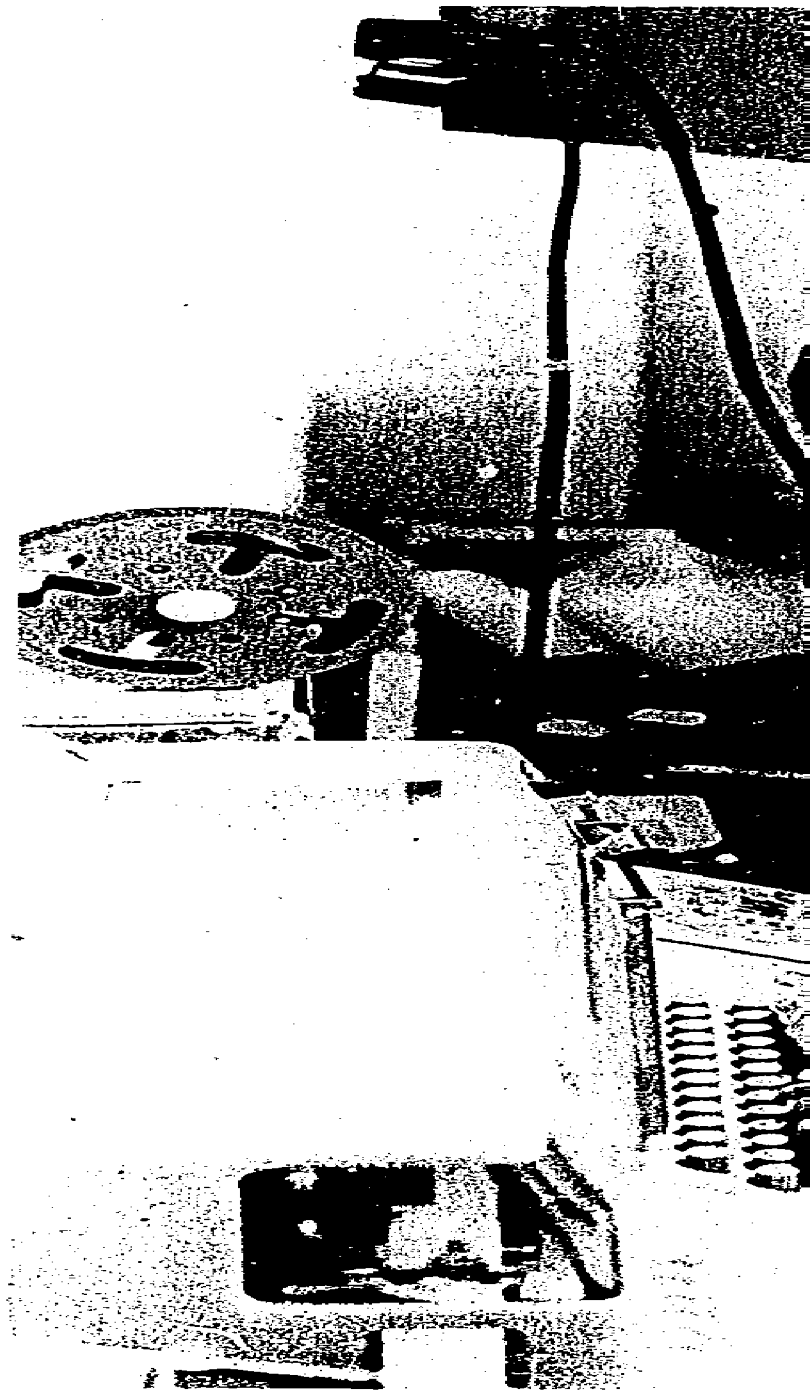


Figure 2

Model 4 BRAILLEMBOSS

Figure 3

Dr. John Morrison at his
BRAILLEMBOSS Terminal.



Mr.

Prototy

'igure 4

Downing at the
ILLEMBOSS Terminal.

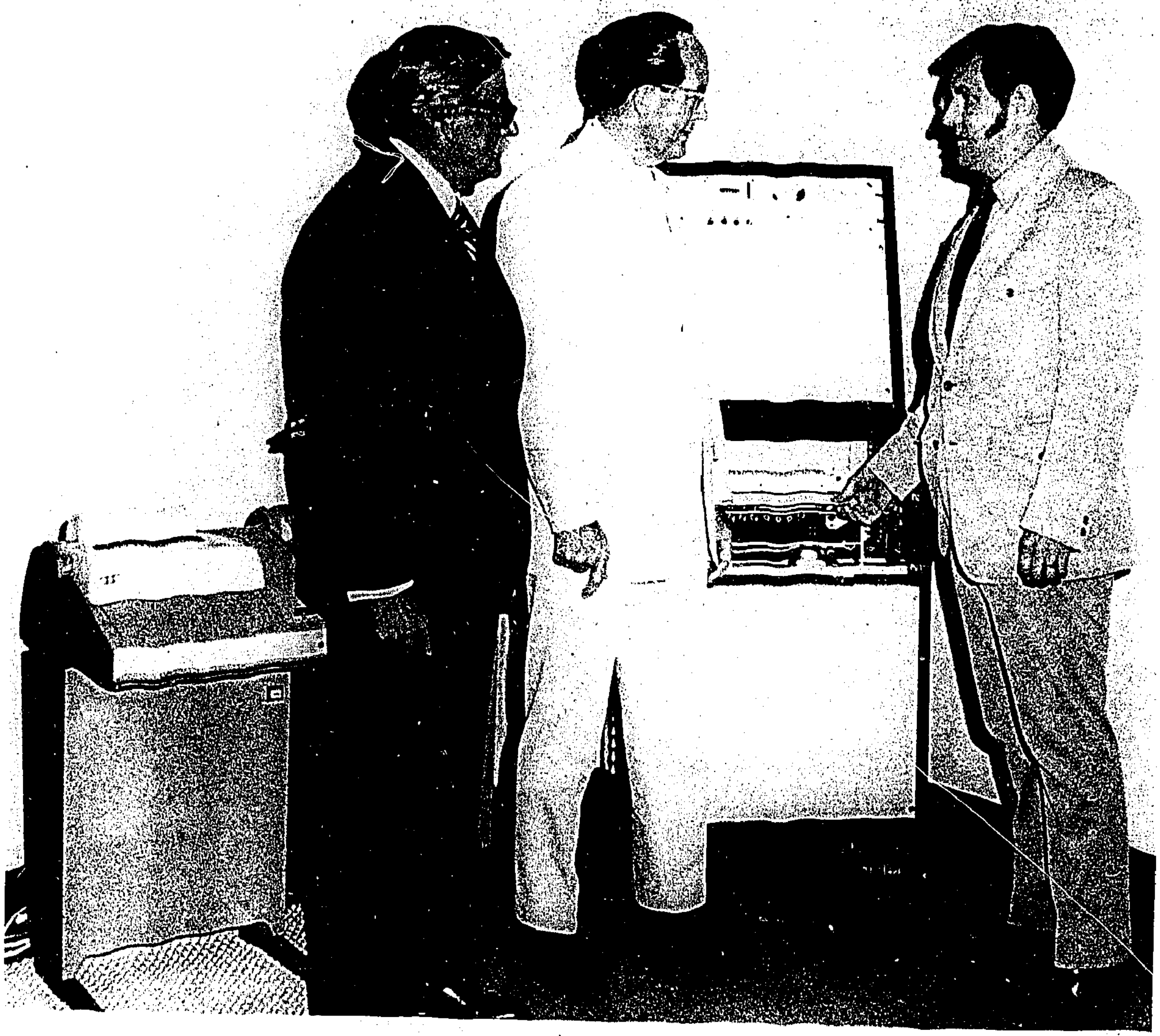


Figure 5

Mr. Jack McSpadden of the IRS Little Rock District Office Showing the MIT BRAILLEMBOSS to Mr. Johnnie M. Walker, IRS Commissioner and Mr. Albert W. Brisbin, Regional Commissioner.

Figure 6

1 Caputo Reading Braillembossed
UPI Newswire Copy.

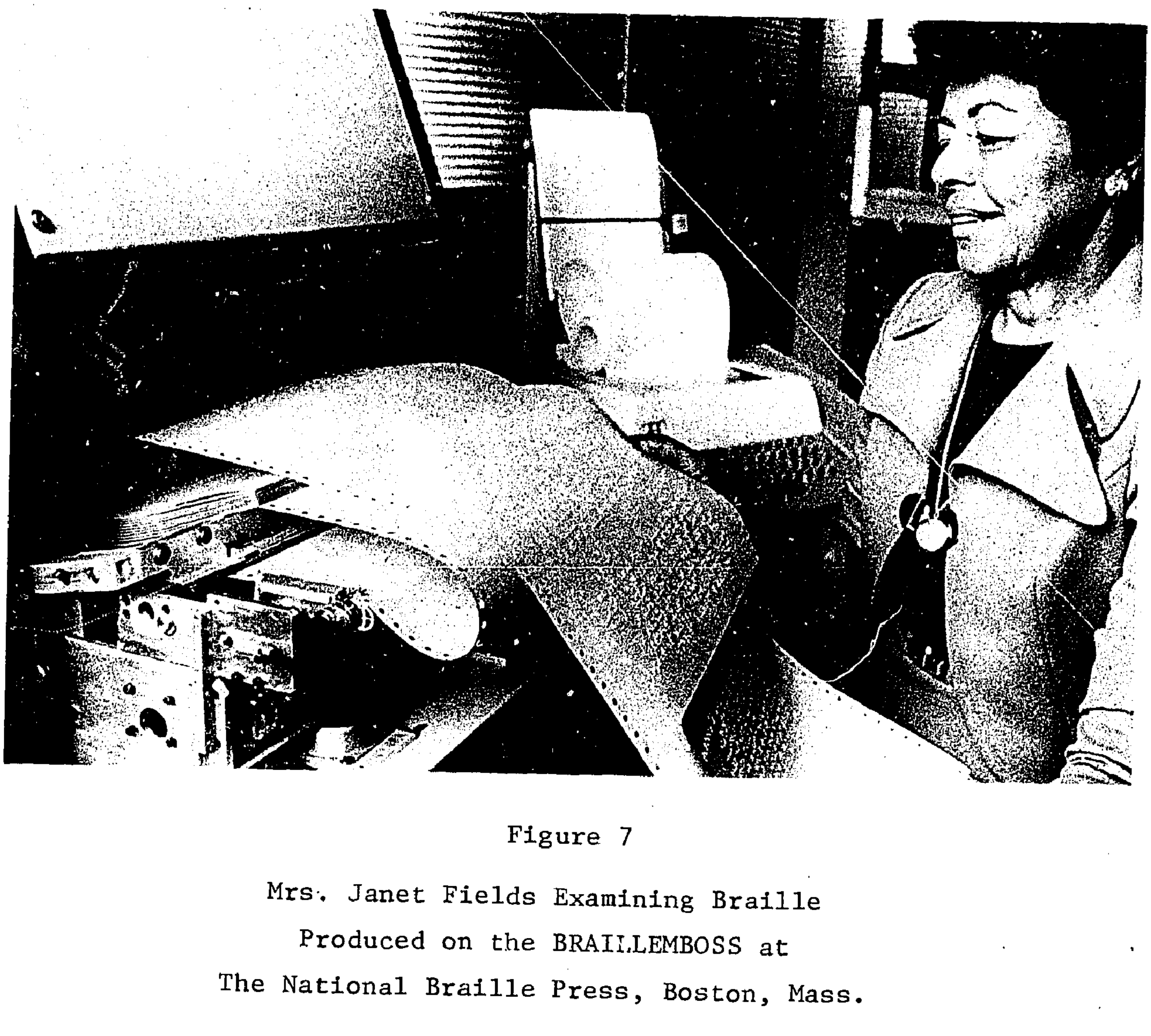


Figure 7

Mrs. Janet Fields Examining Braille
Produced on the BRAILLEMBOSS at
The National Braille Press, Boston, Mass.

Figure 8

TAC-COM Receivers
Front and Rear View.

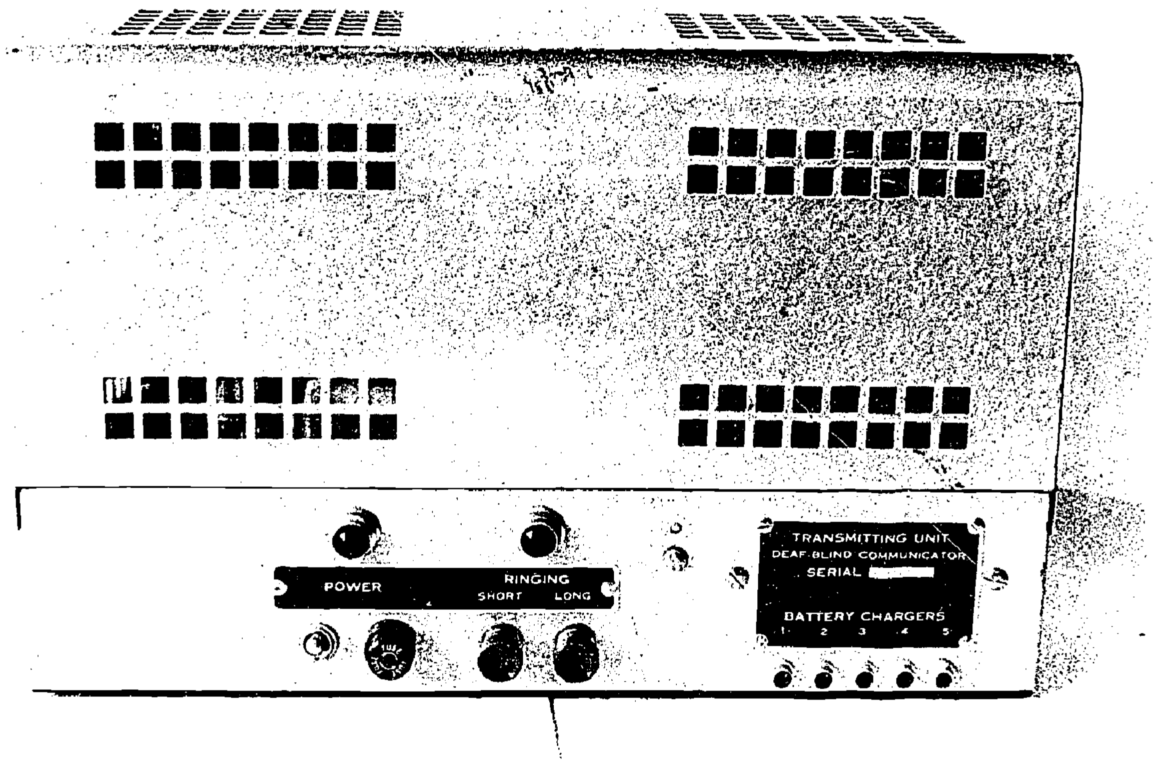


Figure 9

TAC-COM Transmitter

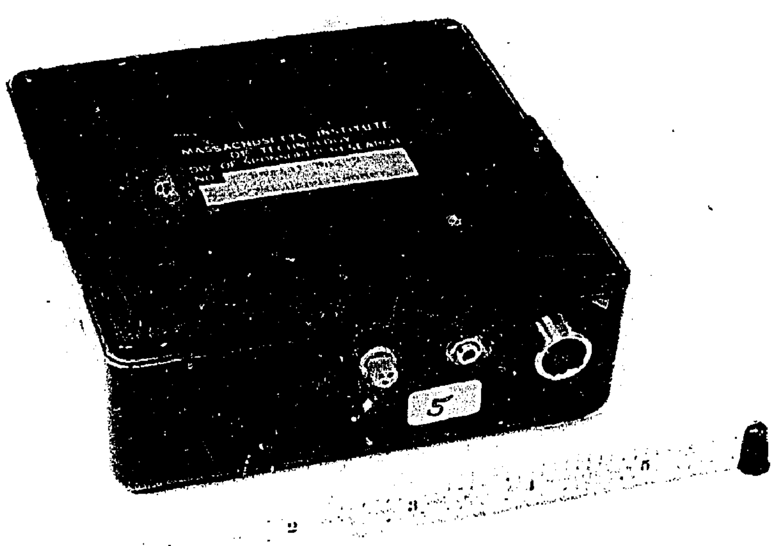
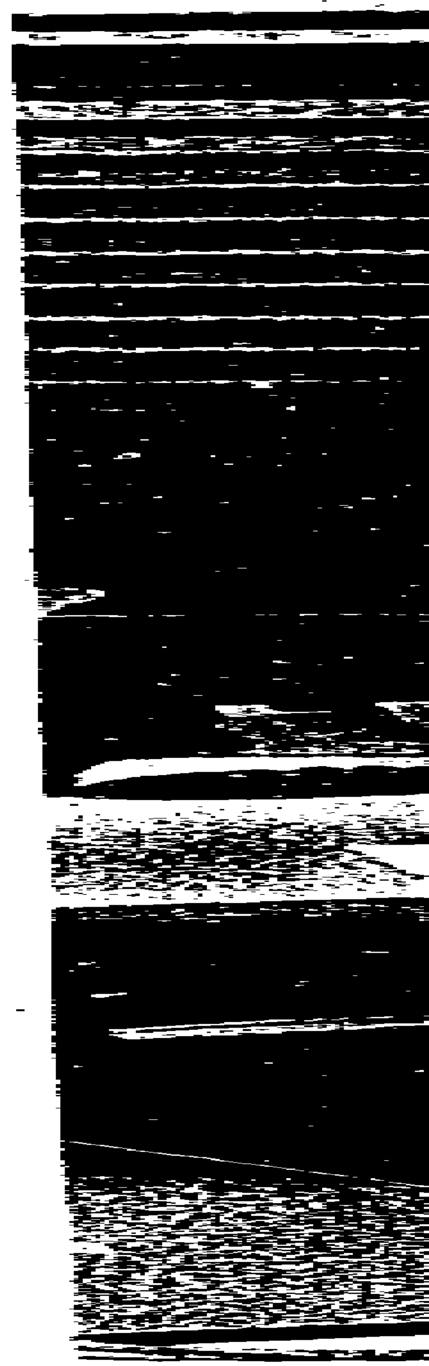


Figure 10

TAC-COM Hand Sender.



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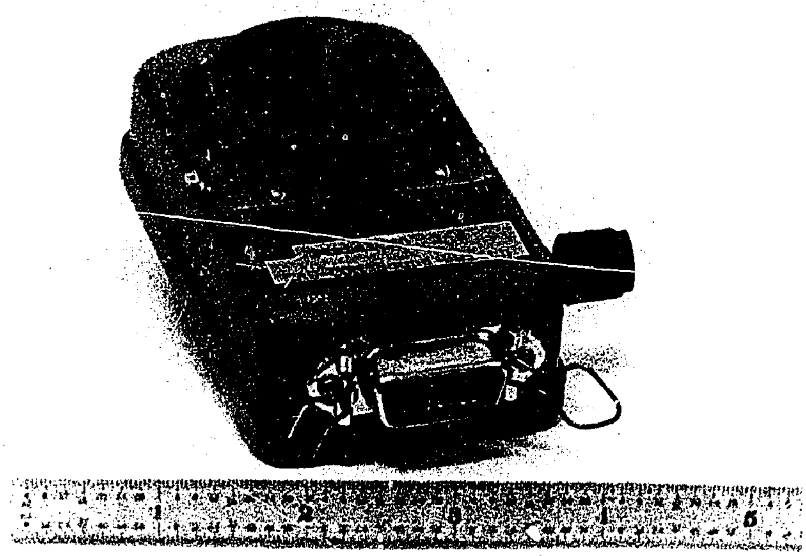

Figure 12

TAC-COM Sound Switch

Figure 13

TAC-COM for Use with Horizontal Loop.

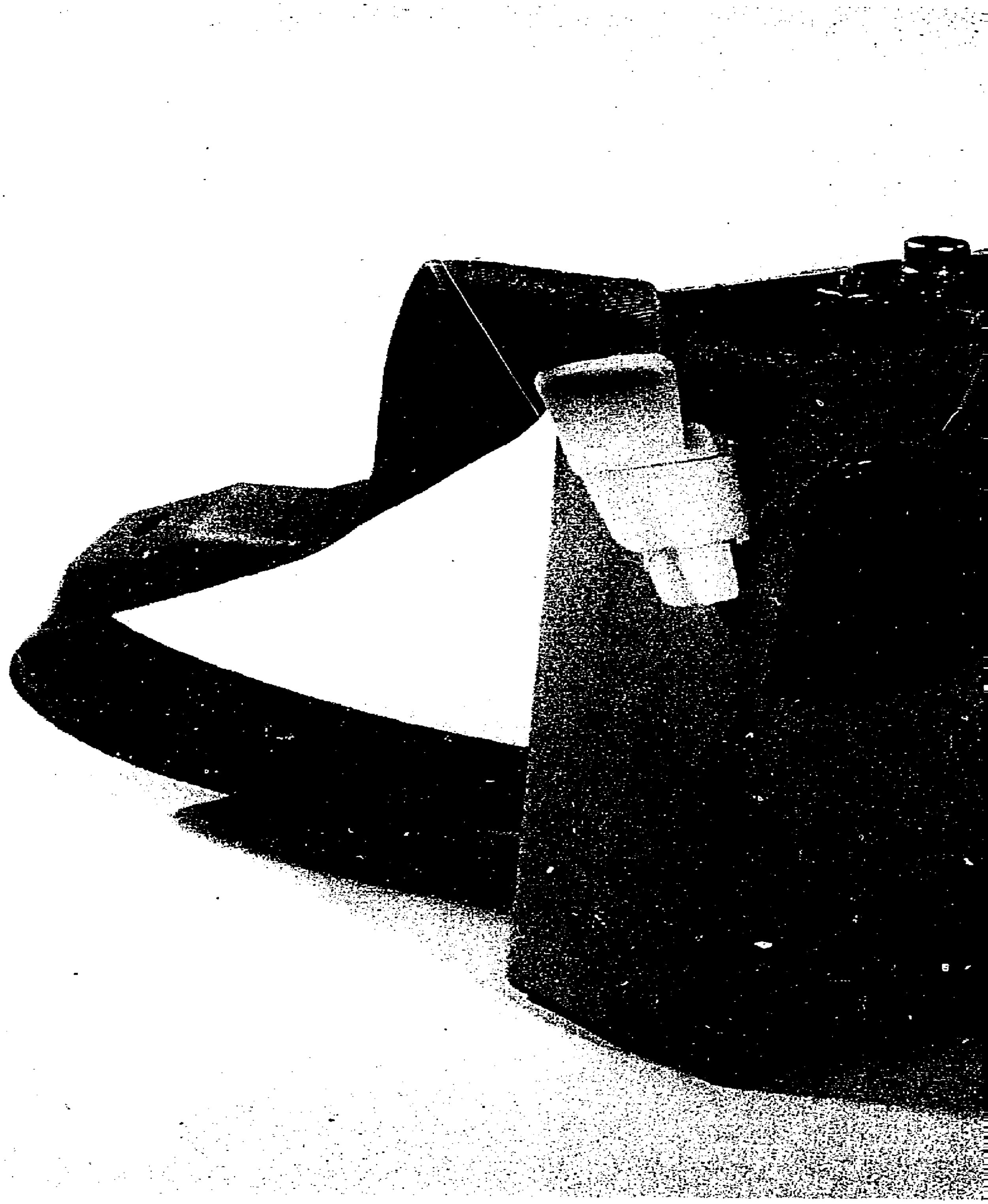

Figure 14

PATHSOUNDER

Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

APPENDIX I

Evaluation of the M.I.T. Automatic Brailler

15 January 1970

The M.I.T. Brailler has been located in my office in N.A.S.A.'S Electronic Research Center in Cambridge, Mass. for three months. The Brailler is connected to a teletypewriter which is, in turn, connected by a telephone line, to a Digital Equipment Corp. PDP-10, a digital computer. I share this office with one other person.

I am blind; my office mate is not. Both of us are PH.D., Aerospace engineers, employed by N.A.S.A. to pursue research in the application of orbital mechanics to the determination of the motion of earth satellite. The teletypewriter has been used exclusively by us.

I have been involved in this type of work for ten years. By the nature of the work, it has been essential to program the results of my research on a computer for purposes of verification of the accuracy of the calculations, evaluation of the methods employed and investigation of possible applications. As is not unusual, I have called in programmers to carry out the actual programming and running of the results on a computer. I have had to rely on others to at least scan the numerical output in order to keep abreast of progress. The whole procedure has been quite unsatisfactory. The effort, time, cost, red tape, and the inefficiency of the procedures have led, in practice, to laying aside possible fruitful avenues for investigation.

With the advent of time-sharing capability, the situation has been completely altered. A scientist can now have direct access to the computer and almost zero turn-around time. However, for a blind scientist the time-sharing capability of computers is absolutely useless without a braille output device to reproduce the teletype output. It was my good fortune that, when the time-sharing facility became available to me, almost simultaneously, the M.I.T. Brailler was put at my disposal for evaluation purposes.

From a purely personal point of view, I cannot emphasize enough the almost unanticipated boost in morale the Brailler has afforded me. For the first time, I can access the computer directly and, for the first time, I can read the results of my labor. It is no exaggeration for me to say that, for the past three months, I have spent just about every waking moment either sitting at the Brailler and teletypewriter or preparing my next numerical experiment. Needless to say, I have not nearly exhausted the backlog, built up during the past ten years, of possible uses for the computer.

From the point of view of a productive worker, my contribution to the in-house effort has kept pace with my colleagues, which would not have been the case had I not had the Brailler at my disposal. I consider it an indispensable instrument for my work. Should I be deprived of its use, my value to my employer would suffer commensurately.

In my opinion, every possible effort should be made to ensure the development and further refinement of the M.I.T. Brailler and its availability to all blind persons who can demonstrate a legitimate use for it. The potential uses for the Brailler are by no means limited to my particular applications. The least that can be said is that whatever is available to a sighted person through a teletypewriter is available to a blind person through the addition of a Brailler. This capability alone is sufficient to justify the development of the Brailler.

The M.I.T. Brailler does have some shortcomings, but they do not nearly cancel its advantages. One difficulty with the present design, and one which will take some ingenuity to eliminate, is the dropping of a character at the end of a line. This defect has been more of an annoyance to me, rather than a hindrance, since properly formatting the output circumvents line-overlap. Noise is another annoyance which can probably only be ameliorated under the present design. Some aspects of the Brailler which can be improved are: size of the machine, manner of presentation of the brailled material as it issues from the machine, and reliability.

John Morrison

Dr. Morrison wrote this report directly into the PDP-10 computer using a teletype and BRAILLEMBOSS. A text editor program, TECO (Text Editor and COrrection) was used to correct, insert, delete, and modify report as necessary. Dr. Morrison then used an auxiliary program to format the report for the line length of the BRAILLEMBOSS. Following Dr. Morrison's directions a teletype at the SAEDC was attached via telephone to the computer and the report requested. The report was printed on the teletype directly from the computer's memory. This copy was retyped from the teletype copy without further editing.

George F. Dalrymple

APPENDIX II

Semi-Annual Review

Date: 20 February 1971

To: Massachusetts Commission for the Blind

From: John Morrison
Department of Transportation
Transportation Systems Center

Subject: Operation and application of MIT-SAEDC's Embosser.

At this installation, the Braille Embosser is connected to a Teletypewriter (Mod. 33). This remote terminal can, at present, access by conventional (voice channel) telephone lines, either a PDP-10 computer (located in the building) or the Government Services Administration's computer center located in Atlanta, Ga. This latter facility is accessed by a local call to the Boston GSA office; then via leased lines through New York and Washington to Atlanta. The computer in Atlanta is a General Electric 440 Time-share system.

The remote terminal is in nowise limited in its use as a conventional Teletype by having the Braille Embosser attached to it. It is, as a matter of fact, not only used by myself, but by two or three other sighted persons. For the most part, I use the terminal to perform three functions.

The first of these--and by far the most important--is to input scientific programs into the computer and to output the results calculated by the computer. The Brailler is essential in both stages. The terminal produces a braille copy of my program, along with any errors in the program that the computer can find. This permits me to have a permanent copy of the program for future use and to make any necessary corrections. The output, of course, is most important since it contains the reason for doing the work in the first place.

The second use of the Brailler (and the Teletype) is to obtain copies (Braille and print) of manuals and shared library programs which are contained in storage in the computer systems. This facility has been especially helpful to me in learning how to use the GSA computer.

Finally, one of the computer programs (which happens to be available on both computers) is of particular interest to me for reasons other than mathematical or engineering. This program, called Runoff, was devised to assist in the preparation of reports. I write a report in braille; type it into the computer, including instructions or titling, centering, paragraphing, footnoting, etc. I get back a braille copy of just the report (without the instructions) and a typed copy in which my instructions for formatting have been carried out. From the Braille copy, I can find my inevitable typing errors. Others can review the typed copy for modifications are then made, by Teletype input, in the computer. The computer then outputs the corrected report as a final copy or draft version. This report is being generated in this fashion. I may decide to make some alterations in the print punctuation as a concession to the braille reader to counterbalance the many concessions made to the print reader.

Regarding the performance of the Brailler itself, there are four remarks:

1. Through some circuit change, the Brailler is now able to line-feed without dropping a character at the end of a line. This is a marked improvement.

2. I have requested that line-feed signals from the Teletype be interpreted by the Brailler as a space. This modification has not been made. A line-feed which does not occur at the end of a braille line always means a wasted line of braille paper. (This report is being typed in single space for that very reason.) Since a Teletype line is about double the length of the Braille line, about one-third of a braille page is empty. This is an extravagance which should be avoided.

3. The Brailler misses characters in what appears to be a random fashion. The cause has not as yet been precisely pinned down.

4. A convenience switch has not yet been provided for disabling the Brailler while non-essential material is being typed out on the Teletype.

APPENDIX III

Comments on M.I.T. Braille Embosser

The M.I.T. Braille Embosser has contributed significantly to my position in the computer field. I would say that other than my technical education at M.I.T., it has been the largest single reason that I have been able to get this far. I have been told by my employer in fact, that having an embosser was significant in my being hired.

I do feel however, that the Braille Embosser has some limitations. For example, th embosser is quite impractical for printing large quantities of material; whether it is a large core dump or just a large program. Also since the embosser prints with no special format, it does take some initiation to be proficient with it. This last problem is solved automatically when the user has had some experience with the machine. Also it is fairly trivial in most cases to supply the necessary software to produce correct format. Fortunately, for most of the applications required by a programmer, large dumps and large programs are fairly rare unless the user is a systems programmer, as in my case. I have found that in my case, I have been able to overcome this drawback by other means which are working out satisfactorily. There is no reason therefore, that a blind programmer can not make adequate use of the embosser to become worthwhile on the job.

In the future, I am hoping that a blind programmer could be equipped with both an embosser and an optacon. Between these two devices, there is practically nothing that a blind person can not do within the same time span as his sighted colleagues.

The reliability has for the most part been satisfactory. I am however concerned that in the future more emphasis should be placed on the training of persons to become repairmen. When more units are placed, it will be obviously necessary to have a team of people that can go into the field and make necessary repairs to the units. This is especially crucial for those users who are not located near the Center as I am. I feel that if enough attention is payed to servicing the embosser, that a large number of machines will be made and placed in the field.

Alan Downing
January 25, 1973

APPENDIX IV

ROLLS-ROYCE LIMITED

Telegrams: 'Bri. .air, Bristol'
Telex: 44185
Telephone: Bristol 693871 Ext 590

P.O. Box 3, Filton, BRISTOL BS12 7QE

Engineering Computing Centre.
RCP/DCB/6005

RECEIVED
AUG 7 1972
M. D. G.

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

1st August 1972.

Dear Mr. Graham,

Very glad to hear you will be in this Country next month, though naturally sorry that your timetable will not permit you to visit us.

You will be very pleased to hear that the Braillemboss has been an unqualified success. Terry Hicks is delighted with it and by its help is a fully contributing, and very capable, member of our programming team.

We have no need to make any concessions as to the type of programming work we ask Terry to undertake, though in practice we avoid giving him jobs involving unusually large quantities of output, not because Terry would be unable to cope but because the difference in speed between the Braillemboss and a standard line printer would involve his taking rather longer than others.

It has been a great source of satisfaction to us to see such a successful outcome and we have many people to thank, not least yourself.

Terry Tate, whose enthusiastic and industrious guidance of Terry Hicks has been the most significant single factor in this enterprise, would like to see more blind people exposed to this type of environment. To this end we are considering the possibility of training others, though the form and extent of this will have to be carefully thought out and be ultimately approved by our Divisional Directors who, I should add, have gone out of their way to support us in this venture.

Perhaps Messrs Tate & Hicks could arrange to meet you in London for an hour? Please let me know if this is a possibility.

Yours sincerely.

D. Boston

Dennis C. Boston

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

FOLDING CANES

Since its inception, the Sensory Aids Evaluation and Development Center has been concerned with examining and developing devices to enhance the mobility of the blind. These devices have included the Pathsounder, straight line travel indicators, compasses, the folding cane, and other devices. Early investigations established the following criteria which must be met by a folding cane.

1. The weight of the cane cannot exceed one pound.
2. The folded cane must fit into a coat pocket (5x10x5/8 inches).
3. Aside from collision damage, the cane must survive 5,000 fold extend cycles, based on one year of use by an active blind traveler.
4. The assembled unit must provide a handle and tip with similar "feel" and sound generation capabilities as those experienced by current long cane users.
5. While the extended cane length cannot be changed by the user, the design must include provisions for supplying the cane assembly in two-inch increments of length over the range of 36 to 70 inches.
6. Opening and closing input forces cannot exceed the capabilities of women and children.
7. Opening, closing, locking, and storing procedures, must be compatible with "one-hand" operation.
8. The over-all design must be simple. Fabrication of component parts should not require specialized techniques, select fitting or assembly.
9. A realistic mass market price goal was estimated at under $10.00 each. [1]

Each of the then known available folding canes were examined and several tested. None met all of the requirements, especially that of feel and durability. Earlier work at MIT had produced a design concept, a central-steel-cable compressing conical joints, which showed promise of meeting most of the requirements. Work on canes using this concept produced the "aluminum-tube, swaged-joint, central-steel-cable folding cane."

During the conference for mobility trainers and technologists,[2] the Center was urged by several of the attendees to distribute the swaged-tube central-steel-cable crook handle folding cane in its present configuration for evaluation purposes to appropriate agencies and persons.

An evaluation involving approximately 100 canes was performed. The evaluation used qualified mobility instructors to interact between the Center and each subject. The mobility instructors recruited the subjects and determined the cane length and the tip desired by each subject. The cane and a data package was sent to an instructor for each subject. The data package included both instructions and the data collecting questionnaires. The instructor taught the subject how to assemble and disassemble the cane and at the appropriate times administered questionnaires. A pre-test questionnaire was used to determine the subjects regular cane, travel skill, and travel habits, while the post-test questionnaire recorded his use, likes, and dislikes of the cane.

FOLDING CANES, (cont'd.)
page two

The cane was well received and thought by most to have characteristics similar to their regular cane. Two problems reported were namely the large size of the crook and both the small diameter and surface of the grip.[3]

Continuing work on folding cane development during the evaluation produced a straight handle cane using the same principles as the crook handle cane.[4] Several usable but different prototypes for a straight handle cane were made. Each of the prototype cane overcame the difficulties discovered during the crook handle cane evaluation while retaining its desirable characteristics.

At this stage in the straight handled cane development, it was realized that this cane met the important above requirements, and that it should be made commercially available. A search was then conducted for both a manufacturer and an appropriate agency to assist by providing the tooling and initial production costs. The Northwest Foundation for the Blind through the Center provided a small subsidy to HYCOR,[5] a local aerospace company who agreed to make and offer for sale the straight handle cane for $12.00.

With the introduction of the cable cane by HYCOR, the Center's work in folding canes has been brought to a successful conclusion. The work on the folding cane has demonstrated the essential requirements of providing a new and useful appliance for the blind, from the realization of the need, to the development of a viable concept, to the practical design, to its test and evaluation, and to the appliance commercial marketing.

The support of the Center during the folding cane work was by the Vocational Rehabilitation Administration and the Social Rehabilitation Administration of the Department of Health, Education, and Welfare.

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GFD:ew

May 4, 1971.

Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge. Massachusetts 02142

BRAILLEMBOSS

A Braille Page Printer

The M.I.T. BRAILLEMBOSS[1] is a braille page printer designed to emboss braille at similar or faster rates than teletypes. The BRAILLEMBOSS accepts electrical braille-coded signals from a variety of sources and in turn produces braille pages. When operating continuously, it produces a page of braille every 1.6 to 2.0 minutes.

The BRAILLEMBOSS lines are 38 cells long. Each page has 28 lines with 25 lines for braille and 3 blank lines for the top and bottom margin. The paper used by the BRAILLEMBOSS is 100 pound-basis manila fan-folded sprocket-drive paper. When the sheets are separated and the sprocket drive strips are removed at the perforations, each sheet is a standard 11 x 11 1/2 inches.

The heart of the BRAILLEMBOSS is the embossing heads, each head contains 6 embossing pins in the braille cell configuration and an interposer pin beneath each embossing pin. These heads are fastened to a chain and so arranged such that one head is always supported under the platen, a steel female die containing 38 braille cells.

Each embossing pin is spring loaded upward. If an interposer pin is held in, then the corresponding embossing pin produces a dot when struck by the platen. If the interposer pin is out, the corresponding spring loaded embossing pin is merely forced down by the platen and no dot is made.

Each interposer pin is controlled by a selector bar. There are 6 selector bars, one for each dot, with 3 on each side of the head. Each selector bar is parallel to the head support track and is controlled by a solenoid (250 ma @ 40 volts). When a solenoid is energized, the corresponding interposer pin in the active head is held in.

The heads are positioned by both a support track and a tooth that engages the escapement rack. The tooth is held against the rack by a spring driven by a torque motor. This combination supplies a constant force to keep the tooth engaged.

The escapement rack is composed of two one-half pitch racks displaced by one pitch length. The rack shuttles back and forth at right angles to the head track and is driven by an eccentric. Each time the rack moves from one side to the other the head advances one cell. When the active head is in the last cell location, it closes an end-of-line switch used in the Carriage Return logic.

BRAILLEMBOSS , A Braille Page Printer (cont'd.)
page two

The platen is supported by two pivoted arms and driven by cranks at both ends of the cycle shaft. The rack is also driven by an eccentric geared at one-half speed to the cycle shaft. The cycle shaft is driven by a 1/20 horsepower motor through a cycle clutch. Each time the cycle clutch solenoid is pulsed, the cycle shaft makes one revolution. The platen goes through one cycle, from top to emboss position, and back to top, while the rack moves from one side to the other side each time the cycle shaft revolves.

The fan-fold sprocket-drive paper is supported by two paper tractors mounted close to the head track and platen but on the output side. The paper tractors are driven by a Ledex Digimotor. Each time the Digimotor is pulsed (5 amps @ 40 volts), it advances the paper on braille line. A page register is also a part of the paper drive and provides one switch closure per page to enable a new page command to be accurately executed.

The emboss sequence is as follows. The electronics determine from the signals that a braille cell is to be embossed. The cycle clutch is pulsed and the appropriate selector bars are energized. The embossing is performed as the platen reaches the bottom of it's excursion, the selector bars are released and the head is advanced as the platen reaches the half way point on it's upward travel. The space sequence is identical except that selector bars are not energized. When the active head is in the last (38th) cell, at the time the selector bars are released, an automatic line feed signal is generated. This provides an automatic carriage return at the end of the line. The paper is advanced and the next head becomes the active head in the first cell position.

The Carriage Return function is controlled by a flip-flop. When the Carriage Return flip-flop is set, a self-clocking series of cycle-clutch pulses are generated and the heads are stepped around. The automatic line feed signal when in the last cell resets the flip-flop and stops the heads such that the active head is in the first cell location. The Line Feed signal pulses the line feed Digimotor.

The End-of-Page function is also controlled by a flip-flop. When the End-of-Page flip-flop is set, a self clocking series of line feed pulses are generated to step the paper. When the paper is stepped to the first line position on a page, the page register switch resets the End-of-Page flip-flop.

The electrical signals for the BRAILLEMBOSS are derived from three principal sources, manual (including a keyboard), a paper tape reader[2], or a translator[3]. The manual modes are uses primarily for test or limited addition to braille from other sources. The translator allows other devices such as model 28 or 35 teletypes, an IBM 2741, a card reader or similar devices to supply the electrical signals. A three connector adaptor has been made to permit paper tapes in other codes than brailler codes to drive the embosser through the appropriate translator.

1) <u>MIT BRAILLEMBOSS Specifications</u>. SAEDC August 1969 with latest revision.
2) Friden Model SP-2 Paper Tape Reader.
3) <u>ONE-CELL Translators, BRAILLEMBOSS Interface Units</u>. SAEDC, TDS No. 8.

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Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

DOTSYS

A Braille Translation Program

In 1964 the MIT SAEDC undertook the systems design of a programming complex adapted to a more ambitious and flexible braille utilization system, than had previously existed.[1] The system was dubbed DOTSYS (the DOT SYStem) and is described in some detail in the Proceedings of Braille Research conferences.[2.3] and by Goldish[4].

DOTSYS ability to translate teletypesetter (TTS) tapes into grade II braille was demonstrated twice during 1966. The first demonstration converted news service tapes into brailler code punched paper tapes. These tapes were then run on the MIT High Speed Braille Embosser, the predecessor of the BRAILLEMBOSS, to produce the braille. The second demonstration converted the TTS punched paper tapes used to print a textbook into stereograph punched cards. These cards were sent to the American Printing House for the Blind where interpointed zinc braille plates were made on their card driven stereograph. The braille was then embossed in the standard fashion.

DOTSYS consists of a number of program co-routines or "boxes" each which manipulates the information being processed in response to computer directed requests from successive elements in the computation chain.

This segmented approach to the programming of DOTSYS was predicated on certain projected advantages. Flexibility is achieved since new "boxes" can be introduced progressively into the system with but minor side effects on the rest of the system. Thus, new input media can be assimilated as it becomes available, the translation program can be upgraded, and new braille production techniques can be accommodated. Adaptation to computers of different sizes is facilitated since an overall processing operation can be segmented into blocks which fit the available computer, producing and storing intermediate results for batching operations. Finally, from a program writing and testing point-of-view, the "box" approach divides a very big overall job into digestible portions which individuals can program separately while maintaining effective communication with their co-workers, and the individual segments can be independently tested and debugged.

During the summer of 1967, the necessary parts of DOTSYS were written or modified to permit computer translated braille to be generated remotely from the computer. The necessary Input/Output (I/O) boxes were written for a time-shared computer (CTSS, an IBM 7094 at MIT).

The material to be brailled was typed into the computer by a typist using a model 35 KSR teletype. When the typist completed typing the material, (or when a maximum of 60 lines were typed), the typist, via a typed command, initiated the translation. The Grade II braille was sent to an MIT High Speed Braille Embosser through the teletype. (During the time the Embosser was printing braille, the Teletypewriter was printing meaningless hash.) The braille is correctly paged and of the standard format.

It was this system which was demonstrated at Perkins during the winter of 1968. The operation of the remote braille production system was taught to approximately 48 members of the upper school faculty. Enthusiastic approval of the concept around which the system was designed -- the production of braille material by an individual who is not familiar with Grade II braille -- was unanimous. Many of the teachers were familiar with special forms of braille, such as the Nemeth mathematics code, yet understood only superficially the English encoding. Others could read it quickly, but were comparatively slow transcribers. Still others simply did not have time to make several braille copies themselves and were dissatisfied with the quality and necessary waiting period for volunteer supplied braille material. The most encouraging result of the demonstration was that well over half of those who used the equipment stated that were it available, they could continue to use it several times a month, even without any further modifications.

Development of DOTSYS was not continued further for several reasons. First, the program is in Fortran Assembly Language (FAP) for IBM 704 and 709 computers. These computers are now obsolete and have been superceded by the System/360. FAP is a machine language and cannot be readily transferred between similar computers and cannot be used on the 360 series without complete re-programming or by emulation (now not readily available).

At the time of the Perkins demonstration the then current version of Embosser could operate at only one-half teletype transmission speeds and then only with frequent attention of the experimenter.

These limitations have been overcome. DOTSYS II has been written in a higher level computer language, COBOL, a nearly universal language. This language is available on most large computers regardless of manufacturer. Further, the BRAILLEMBOSS has been developed to the point where it works reliably for long periods of time at MODEL 35 Teletype Speeds.

References:

1. Dupress, J.K., Buamann, D.M.B., Mann, R.W., "Towards Making Braille As Accessible As Print", EPL Report DSR 70249-1, MIT, June 1968.

2. Proceedings - Braille Research and Development Conference, SAEDC, MIT, November 1966.

3. Proceedings - Conference on New Processes for Braille Manufacture, SAEDC, MIT, May 1967.

4. Goldish, L.H., "Braille In The United States; It's Production, Distribution and Use" Thesis (S.M.), Sloan School of Management, MIT, February 1967.

5. Greiner, W.E., "Development of Braille For Class Room Use", Thesis (M.S.), Mechanical Engineering (MIT) Febraury, 1968.

July 28, 1970.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

PATHSOUNDER

The PATHSOUNDER is an experimental mobility aid whose purpose is to "screen" the area ahead of a blind person and warn him of obstacles in his path, in particular when they come within a specified distance, usually set at six feet. It is a sonar device, making use of ultrasonic sound to probe the area under surveillance.

Used by a blind cane-traveler, it is typically worn at chest height by means of a cord around the neck. In such a manner it complements the cane in that it explores the above-the-waist region through which the user's head and shoulders will pass, thus warning of overhanging objects: mailbox, tailgate of truck, etc. With its six-foot range it gives earlier warning than the cane of things ahead and so can be helpful in crowded sidewalk travel for avoiding collisions with other pedestrians, cane pokes at their heels, etc. (The trainee is taught, upon onset of a signal, to stop or change direction slightly and seek an open path.)

The PATHSOUNDER makes no audible sound under normal conditions (no obstruction ahead), but when an object comes within the six-foot range an intermittent buzzing sound is emitted by tiny signalers on the neck-loop just under the user's ears. If the object comes to within two and one-half feet the sound changes to a high-pitched beeping to warn that the obstacle is now very close. The whole surveillance zone may be visualized as cone-shaped with the apex at the traveler's chest and an oval cross-section about 22 inches wide by 35 inches high at a point six feet in front. The device is about the size of a small camera and carries a rechargable internal battery.

Deployment of PATHSOUNDERS in the field has been effected through mobility instructors, who have functioned as intermediaries between the technical developers and the blind end-users. Many - or most - of the applications have involved clients with out-of-the-ordinary problems: blind wheelchair users, cane-travelers with faulty obstacle perception due to hearing loss or imbalance, those with injuries demanding extra upper-body protection, and so on. In several cases, normal cane-travelers (i.e. without other handicap than blindness) found PATHSOUNDERS helpful when their daily routes involved city travel on heavily crowded side-walks.

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LR:ss

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

BRAILLEMBOSS APPLICATIONS

The M.I.T. BRAILLEMBOSS[1,2,3] is an automatic braille printer operated by electrical signals derived from one of many possible sources. It can operate at speeds compatible with many computer terminals. The Model 3 BRAILLEMBOSS produces high quality braille of standard literary format. When operating continuously, it produces a page of braille every 1.6 to 2.0 minutes.

The most common BRAILLEMBOSS application to date has been as a time-sharing computer terminal. As such it has made several blind professionals more productive and has helped them work more nearly at their potential. For this use the BRAILLEMBOSS is connected in parallel with the page printer of an existing computer terminal. This arrangement permits the terminal to be used by either the blind user or his sighted colleagues.[4] It also reduces the complexity of the BRAILLEMBOSS by not requiring an internal keyboard or data modems. The BRAILLEMBOSS can be used with any computer that uses 110 Baud ASCII console typewriter or terminals.

The BRAILLEMBOSS has been demonstrated as an output device for a computer data base system, the Internal Revenue Service (IRS) Integrated Data Retrieval System (IDRS). As such it provides a blind Taxpayer Service Representative (TSR) with access to the complete IDRS data base. Most of the TSR interaction with the taxpayer is done over the telephone. In most cases the blind TSR functions as well as his sighted co-workers and the taxpayer has no knowledge that he is dealing with a blind TSR. This demonstration has shown that the BRAILLEMBOSS, operated as a computer terminal permits the blind to fill a variety of public service jobs requiring interaction with a computer data base. These jobs include reservations of all types, i.e. airlines, rental autos, hotels, motels, etc; credit and account information; and inventory control.

The initial use of an earlier version of the BRAILLEMBOSS was the production of single copy (or a few copies) of computer translated Grade II literary braille. In this application, a typist unfamiliar with braille can produce Grade II braille merely by typing plain English text, including a few easily learned format control characters, into the computer. Such a system has been demonstrated at Perkins School for the Blind in Watertown, Massachusetts by William Greiner.[5] This system consisted of the BRAILLEMBOSS, Model 35 TELETYPE, braille translation program DOTSYS,[6] and an IBM 7094 timesharing computer at MIT known as CTSS. Applications for this mode of operation include public schools with blind students and agencies producing a limited number of braille copies. In both cases the computer translated braille increases the number of people capable of preparing braille to include those who are not expert Braillists.

A new and more versatile Grade II computer translation program, DOTSYS III[7] has been written. DOTSYS III is written in COBOL and as such can be made available on a large number of computers including but not limited to time-sharing systems. DOTSYS III and the BRAILLEMBOSS has been used to produce a braille book, <u>In Darkness</u>, for the Library of Congress.[8]

Another application of the BRAILLEMBOSS is the short run production of braille materials using punched paper tape as the storage medium. The BRAILLEMBOSS has provision for a paper tape reader, Friden SP-2, as an input device. The punched paper tape for demonstrations has been prepared by several means. One demonstration project used tape punched on a modified Perkins Brailler by an expert Braillist.[9]

BRAILLEMBOSS APPLICATIONS (con't.)

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Another method of preparing paper tape is by typing on a special TELETYPE converted by Mr. Ray Morrison. Grade I braille tapes can be prepared by any typist, but an expert Braillist must be used to produce Grade II braille tapes. Still another method of generating tapes is by computer.[10] Each of these methods has been used and has been proven useful for particular applications.

Twenty (20) BRAILLEMBOSS units have been produced at the Center with the support of the John A. Hartford Foundation. Earlier developmental work was supported and continuing demonstrations are supported by the Social Rehabilitation Administration of the Department of Health, Education, and Welfare.

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2. M.I.T. BRAILLEMBOSS Specifications. SAEDC, August 1969 (with later revisions as applicable).

3. BRAILLEMBOSS, A Braille Page Printer. SAEDC, TDS No. 2.

4. Lichstein, M.L., Braille Computer Output. (M.I.T.-SAEDC). August 1969.

5. Greiner, W.E., "Development of a Braille System for Classroom Use." (S.M. Thesis, M.E. Department, M.I.T.). February 1968.

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7. Interactive Braille. SAEDC, TDS No. 11.

8. "Transcription of In Darkness via DOTSYS III and the BRAILLEMBOSS," SAEDC, November 7, 1972.

9. The American Revolution, A Short Run Braille Pamphlet Demonstration. SAEDC, TDS No. 7.

10. Conversion Table, Inches to Millimeters: A Braille Computer Generated Mathematical Table. SAEDC, TDS No. 10.

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Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

DOTSYS and The East Indiaman

The Braille edition of THE EAST INDIAMAN, by Ellis K. Meacham, (Little Brown and Co.), the first to be produced from teletypesetter input, was published in November 1968, only a few weeks after the ink-print edition. The master Braille plates were produced with a minimum of human intervention, using a series of computer programs. The procedure can be described in three parts:

1. Conversion of the TTS codes into BCD codes and the insertion of the special format codes required for Braille.
2. Editing and correcting the BCD tape thus created.
3. Translation of the BCD tape into Grade II Braille.

The TTS input tape was translated to a formatted BCD tape by a modified DOTSYS[1,2] system of programs. The following boxes were used: INBOX, TELCON, UNICON and UNIPER. These programs, originally written to operate on the CTSS system at M.I.T. were modified for the 709 at the American Printing House for the Blind. This involved rewriting those parts of the programs which were CTSS-dependent.

The UNICON box was rewritten and expanded to perform some of the functions formerly handled by TELCON and TELCON was thereby considerably simplified. A major objective of DOTSYS is to minimize the reprogramming required to handle new forms of input and output. The UNICON box is independent of the medium which supplies its input. It is a permanent section of DOTSYS which performs the analysis and interpretation necessary to conform to the Braille rules. TELCON is just one of a possible set of conversion programs designed to translate compositors media into Universal code. There could be boxes written to convert Monotype, Linofilm, etc. Each of these boxes would be independent of the Braille conventions and would perform only that interpretation required because of the particular typesetting equipment and the conventions which govern its use.

The six channel paper tape which had been used to set the first galleys for THE EAST INDIAMAN was copied onto magnetic tape. This step, performed in New York on an IBM 360/40 was necessary because the APH 709 has no paper tape reading facility. (Ironically, this operation which is technically the simplest, took an inordinate amount of time. Both the TTS tape and APH's 200 bit-per-inch magnetic tape are, in a sense, non-standard in terms of current technology and finding the appropriate machine configuration to accomplish the conversion proved quite difficult).

The magnetic tape containing the TTS codes served as input to the modified DOTSYS which produced an intermediate BCD tape and a line-numbered listing suitable for editing. This first phase would remain essentially unchanged for producing any other book which had been set by paper tape

DOTSYS and The East Indiaman (con't.)

Page Two

controlled line-casting equipment. To publish a Braille edition from another composition medium would require that TELCON be replaced with another box. The initial conversion step might or might not be necessary.

Phase two, the editing phase, would remain unchanged no matter what sort of compositors tape is used. The number of iterations through the editing procedure vary depending on the completeness and correctness of the tape. In the case of EAST INDIAMAN the paper tape was used to set the first galley proofs. From that point corrections to subsequent galleys and page proofs were made by hand in the metal and these corrections had to be detected and made on the intermediate BCD tape.

A new box, called EDIT, was added to the system to facilitate error correction. This program reads correction cards, locates and changes the erroneous information on the intermediate BCD tape and writes a new tape incorporating the changes. Under console control the new tape may be printed completely or in part.

It is interesting and gratifying to note that the proof-reading and error-correction proceeded quite efficiently, despite the fact that the Printing House personnel involved had had no prior experience with this kind of work. Because there was some concern about how quickly they would learn the techniques required, it was decided that only two of the four Braille volumes would be edited in this fashion. The balance of the book was corrected by key-verifying the cards which were punched from the intermediate BCD tape. It is difficult and unfair to compare these two procedures. However, the general impression was that the new method worked quite well and could be expected to become even more efficient with practice, some modifications to the EDIT box, and, of course, cleaner input tapes.

The third phase was the translation of the corrected BCD tape to Braille using the Braille Translation program which has been operating at the American Printing House for several years. Because DOTSYS supplies the format code and special character codes usually added to the text by the key-punch operator, this BCD tape 'looked' the same as it would had it been produced by keypunching. Thus, the translation phase, and the subsequent steps in the production of the book itself were those which have become conventional at the Printing House.

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1. Proceedings - Braille Research and Development Conference, SAEDC, MIT, November 1966.
2. DOTSYS, A Braille Translation Program. SAEDC, TDS No. 3.

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Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

A Pamphlet, "The American Revolution",
A Short Run Braille Production.

One application of the MIT BRAILLEMBOSS is the short run braille production where only a few copies of a specialized work are required. Brailling of the pamphlet, "The American Revolution" presented an opportunity to demonstrate this application.

The BRAILLEMBOSS in the present state of development can routinely produce a page of braille every 1.0 to 2.0 minutes given the proper input signals. At the time of this demonstration only Machine #6, an experimental unit was available. This was a unit from the original braille production. All of the specified changes in the BRAILLEMBOSS required for improved accuracy, had been incorporated on this machine when the demonstration was performed. The only form of input available for this machine was punched paper tape.

The Howe Press of the Perkins School for the Blind has a paper tape punch controlled by a modified Perkins brailler. The pamphlet was brailled essentially the regular way on this braille writer by a Stereograph Operator at the Howe Press while at the same time a punched paper tape containing the braille codes was being generated. The paper tape was then hand edited and made into tape loops, each containing a single page.

The tape loops were individually run on the High Speed Braille Embosser (BRAILLEMBOSS). The section of the pamphlet reproduced contained 32 pages of braille, and 25 copies of each page were reproduced for a total of 800 pages. The total BRAILLEMBOSS operating time was 20 hours spread over six working days.

Fifteen copies were given to Perkins Upper school students for their examination and use. The students were asked to record and report every error found. Several errors were spotted that existed in every copy. These errors which escaped detection in the tape editing process were later discovered in the tape. Sometimes weak cells occurred in the last cell of a line. This was corrected in the redesign of the BRAILLEMBOSS, but was not incorporated in the experimental machine. Eleven random errors were discovered; one random error per 43.6 pages, or 24 errors per million characters.

Other methods could be used for both input data preparation and storage. Relatively simple digital magnetic tape units are now available and could be used. A time-shared computer could be used to edit, translate into Grade II, determine the line and page division, and control the BRAILLEMBOSS directly.

This program demonstrated the application of the BRAILLEMBOSS for the production of a limited number of braille copies. The usual process of braille duplication requires the preparation and use of zinc or iron embossing plates to produce braille. However, this demonstration showed that a single punched paper tape could be used to produce several copies of the material, thereby substituting one paper tape for many zinc embossing plates. The program also demonstrated one way the BRAILLEMBOSS fills the gap between the large-run braille printing system and the hand-transcribed braille production.

Technical Description Sheet No. 7
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Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

ONE-CELL Braille Translators
BRAILLEMBOSS Interface Units

The M.I.T. BRAILLEMBOSS[1] requires electrical signals in the brailler code to drive the BRAILLEMBOSS. The various information transfer codes, while most are in a similar format to the brailler codes, cannot be used directly to drive the BRAILLEMBOSS as the resulting braille symbols would have meanings completely different than that commonly used. A translator unit is required to map the input codes into the brailler code.

The existing Grade I or Grade II literary braille codes are inadequate for computer programming for at least two reasons. First, several of the symbols required in computer programs, plus, equals, etc., are simply not defined in literary braille. They are written out when required. Secondly, format is very important in computer programming, therefore it is necessary that there be a one-cell braille-equivalent for each inkprint character used in the computer character set. The resulting code--developed in consultation with several people--uses the same characters for the alphabet as does literary braille, the lower four dots in the same combination as previously for the numbers, just like the Nemeth convention, but without the number sign and then the remaining characters in the 63 character ASCII character set are defined with the least ambiguous braille codes representing the more important inkprint characters.

There is an additional requirement on the translator, that of matching the electrical requirements of both the input device, a TELETYPE for example, and the BRAILLEMBOSS. With a TELETYPE these inputs can be either switch closures on each code level or a serially coded current switching waveform. With other input devices still other inputs may be used which the translator must match.

Several different types of translators[2] have been designed, built, and operated. One of them is the "ASCII(63)/ASCII(67)-ONE-CELL Braille Translator." This translator is designed to connect either a Model 33, Model 35, or Model 37 TELETYPE to the BRAILLEMBOSS. It has the ability, by choice of cards in the input section of the translator, to receive either the current-switching waveform or switch closures on each code level from either a Model 35 "stunt box" or from an LRS 800 Receiving Selector. This translator also has the ability to map the lower case letters into the upper case letters such that a Model 37 TELETYPE can be used as an interface unit. Further, there is a remotely controlled on/off switch in the translator to permit the computer to control embossing. This can be employed if embossing of only computer output is desired and not computer input.

Another translator, the ASCII(63)-ONE-CELL/DOTSYS translator, operates only with switch closures as inputs, but in two modes. The first translates the codes of the Model 33 or Model 35 TELETYPE into ONE-CELL braille while the second mode translates the special transmission codes used in DOTSYS[3] into brailler code.

A third operational translator is for the Teletypewriter code (TTY) used in the United Press International wire service 5 level code. This translator presently accepts only switch closures from a tape reader. Designed, but not yet tested, is the required input circuitry to operate on the serial current switching waveform. This translator has been used in a Braille News Demonstration.[4]

Translators have been designed but not yet built for 6-level Teletype Setter (TTS) codes and for Hollerith punched cards. It is planned to design translators for IBM EBCDIC and IBM MT/ST codes. These will be reduced to practice as both time and budget permit.

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1 BRAILLEMBOSS, A Braille Page Printer. SAEDC TDS No. 2 and BRAILLEMBOSS APPLICATIONS, SAEDC TDS No. 5.

2 M.I.T. BRAILLEMBOSS Specifications. SAEDC, August 1969 (with later revisions as applicable).

3 DOTSYS, A Braille Translation Program. SAEDC, TDS No. 3.

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July 17, 1970.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY *CAMBRIDGE, MASSACHUSETTS 02139*
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

TACCOM
A Communication System for the Deaf-Blind

TACCOM (for "tactile communication") is a wireless remote paging system designed for the deaf-blind in particular, but with possible applications for the singly-handicapped deaf <u>or</u> blind.

The TACCOM pocket receiver is the core of the system; it functions like the pocket pagers carried by physicians in a hospital, but with one important difference: instead of beeping to alert its user, it <u>vibrates</u>. (It feels like an electric toothbrush running.) The receiver has the appearance of a tiny transistor radio and measures 2 1/2" x 7/8 x 5". It weighs 6.3 ounces. It employes rechargable batteries and is normally plugged into a battery charger at night when not in use.

Two primary applications are: (1) To provide an effective "doorbell" for a deaf-blind person who may be alone in his house; and, (2) To effect an alarm system (e.g., for fire, etc.) in an institution or other setting where a number of deaf-blind persons may be spread about and must all be summoned at once.

The equipment involved includes the pocket receivers (one for each user), the centrally-located 115 volt transmitter, and a loop antenna which runs around the area to be covered by the radio signal. This service area can be fairly large - one hundred thousand square feet or more. The transmitter can be connected to push buttons at convenient locations, fire alarm boxes, time clocks - whatever suits the end purpose.

Ancilliary attachments make possible other TACCOM applications:

1. End-of-line indicator for brailler or typewriter.

2. Auditory cue indicator (phone ringing, baby crying, etc.)

3. Ambient light indicator.

4. Message system (Morse code signalling, etc.)

5. Teaching/training aid.

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Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

CONVERSION TABLE, INCHES TO MILLIMETERS
A BRAILLE COMPUTER GENERATED MATHEMATICAL TABLE

An example of the use of the BRAILLEMBOSS[1,2] as an output device of a time-sharing computer was the production of a braille inches to millimeters conversion table. Such a table was recently prepared for a rehabilitation client of the Massachusetts Commission for the Blind. The client has been trained to repair and rebuild foreign car automatic transmissions, but the only braille micrometers immediately available to him used inches. The transmissions are measured in metric units, i.e., millimeters.

The table was produced using the CTSS (an IBM 7094) time-sharing computer, running a FORTRAN II program, a teletype, punched paper tape reader, Translator[3] and the BRAILLEMBOSS. The table was embossed in "one-cell" braille, developed for computer programmer use. This braille system has a one-to-one correspondence between the braille and inkprint characters. The inkprint characters are those used in the 63 character ASCII (American Standard Code for Information Interchange) character set used in the model 33 and 35 teletype.

Approximately one-half day was used in writing the 33 statement FORTRAN-II program. During this time four minutes of computer time was used to input the program from the teletype, compile, test, debug, and recompile it.

Punched paper tape was used as a buffer between the computer terminal and the BRAILLEMBOSS for several reasons. The first was to make a machine readable master such that multiple braille copies could be produced without incurring the costs of additional computer and terminal time. In addition, it facilitated the writing of the program, since BRAILLEMBOSS timing considerations could be handled by an asynchronous punch paper tape system instead of special programming techniques not readily available in FORTRAN II. The BRAILLEMBOSS carriage return (CR) time is in general much longer than the time for the teletype and computer CR time, such that data would be lost during the time the BRAILLEMBOSS is executing a CR. All other functions of the BRAILLEMBOSS, except the end of page function, are accomplished in less time than with the teletype.

The compiled program was loaded into the computer, and the initial and final page numbers were typed in, one page number per line. The Model 35 ASR teletype was set to the KT mode such that it produced both punched paper tape as well as printed copy. After the first page had been run on the computer, the end of the paper tape was loaded into the tape reader and the BRAILLEMBOSS started. The normal tape reader input to the BRAILLEMBOSS uses the Brailler code, not the ASCII used by the teletype; therefore, a cable adapter was used such that the tape reader was driven in its normal mode, but the output signals were fed into the teletype input jack of the BRAILLEMBOSS. The BRAILLEMBOSS

CONVERSION TABLE, INCHES TO MILLEMETERS (cont'd)
Page two

running time was slightly longer than the terminal running time (in spite of the fact that the BRAILLEMBOSS is operated at a faster rate than the teletype) since each BRAILLEMBOSS carriage return took longer than with the teletype. The terminal running time used for this table was 2.5 hours, but the computer time used was 1.9 minutes. It also took approximately three hours to run the program and to emboss the first copy.

The table as produced by the BRAILLEMBOSS is embossed on one side only. If interpointed braille is desired, a suitable converter could be constructed such that the APH Automatic Sterograph at Howe Press could use the ASCII tapes to emboss the zinc plates for press use. Alternatively, the translator in the present embossing system could be used to drive a tape punch to produce paper tapes in the Brailler code used by the sterograph.

This demonstration has shown that the M.I.T. BRAILLEMBOSS, when properly interfaced with a time sharing computer, can produce mathematical tables, in Braille, of any mathematical functions that can be programmed into a computer.

1. BRAILLEMBOSS, A Braille Page Printer, SAEDC TDS #2.

2. MIT BRAILLEMBOSS SPECIFICATIONS, SAEDC, August 1969 with Revisions

3. ONE-CELL BRAILLE TRANSLATORS, BRAILLEMBOSS Interface Units SAEDC TD # 5 and 8.

July 20, 1970.
Revised August 14, 1970.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

INTERACTIVE BRAILLE
Remote computer translated Grade 2 Braille

A person with typing skills but with a minimum knowledge of Braille can produce a high quality Grade 2 Braille with ease and dispatch, using the Interactive Braille System. The necessary components of the system are:

(1) A time-sharing computer with DOTSYS3 stored in it.
(2) A teletype or other time-sharing computer terminal.
(3) A BRAILLEMBOSS attached to the teletype.

It is not necessary for the computer to be located at the same place as the terminal and BRAILLEMBOSS.

The BRAILLEMBOSS is a Braille page printer[1,2] used to produce the output. DOTSYS3 is a version of DOTSYS III modified to use the BRAILLEMBOSS[3] as output unit.

The material to be brailled is typed into the computer and stored in a data file. The material is typed in almost as it is written in normal inkprint. The teletype has only upper case so a control character is required to tell DOTSYS3 when to capitalize. A single equal sign (=) is typed preceding each word to be initial capitalized, two equal signs before each word to indicate that the word is solid capitals. Most punctuation is typed in directly.

Additional format control characters are required to tell the program when to start paragraphs, when the typist demands a new line to start not in the regular progression of text. Other format control symbols are used to indicate headings and titles. The most used symbols and format controls are listed on a single sheet (see over).

Some training is necessary for the typist to learn to create and manipulate the data files in the computer. This training can be accomplished in a few hours using manuals prepared by the time-sharing computer people.

After the input file is created, proofread and corrected if necessary, the computer is told by a single typed in command to produce the Braille. The computer translates the material and will either store the Braille to produce multiple copies or the computer can immediately output the Braille to produce only one copy.

This is essentially the system used at the National Braille Press and demonstrated there on January 31, 1972.

This Interactive Braille System is designed to be used in places where skilled Braille transcribers are not available, such as in a public school system with a few blind students enrolled. It can also be used in an agency environment to supplement the existing skilled transcribers or to free them from the relatively simple literary Grade 2 Braille to more specialized Braille which is more demanding of their skills.

1. BRAILLEMBOSS, A Braille Page Printer, SAEDC TDS #2, August 4, 1970
2. Final Report to John A. Hartford Foundation, "Development of a High-speed Brailler System for more Rapid and Extensive Production of Informational

LE CONTROL AND FORMAT CODES DOTSYS III on IDC 360/67
WITH TELETYPE AND BRAILLEMBOSS TERMINAL
(029 KEYPUNCH)

or initial capital of following word
or all capitals of following word

) TTY)

rscore (_) before each word for one, two or three words
underscores before four or more word italics, and
underscore before last word

ring Italics, Capitals, Accent, Delineator

llegal contraction

efore and _/ after letters

ion

ithin the letters to be contracted

y be used for both left and tight if no quotes within a quote is used
or left double quote within a quote
for right double quote within a quote
or inner opening quote
for inner closing quote

ift M) TTY (12, 11, 0, 5, 8, Keypunch)*

a left bracket [
a right bracket]

ign $SV

gn $LV

ot Sign $FT

$CS

nt control symbol on keypunch hold down Mult Punch key and
5, and 8 keys before releasing. The Mult Punch key automatically
to numbers mode. Do not release the Mult Punch key until all
k.

Null Symbols	$/ Null replacement symbol generally used to prevent contraction
Forced Blanks	$B
Termination Symbol	$T
Paragraph	$P
New Line	$L
Skip Multiple Line	$Slnnb (2 digits + blank) skip nn
New Page	$PG
Tabs	one tab $TAnnb (start at position nn) multiple $STABmLnn (set tab m at position nn) L for left justification, R for right justification D for decimal justification $#m before each item to be tabulated
Titles	$TLS before and $TLE after each title produces centered title on each numbered page
Heading	$HDS before and $HDE after for centered one line headings
Poetry	$PTYS before and $PTYE after all poetry text
Octal Braille	$OCTaabbccdd for 4 codes Allows individual braille cells to be inputed arrangement dot 1 = 10, dot 2 = 20, dot 3 = 40 dot 4 = 1, dot 5 = 2, dot 6 = 4
Computer Braille	$CPBxxxx will print 4 codes each represented by graphic x in the computer braille code (ASCII to one-cell)
Letter Sign	;
Self Checking	The symbol $SCON$/$/$/$/$/ is used to turn self-checking on and $SCOFF is used to turn self-checking off. Delineator is ^(circumflex, ShiftN) on TTY, or | (vertical bar) on keypunch.

Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

BRAILLE NEWS DEMONSTRATION

For several weeks the SAEDC translated into braille, a portion of the news stories carried by the United Press International news wire. The resulting braille copy was distributed to several blind people close to the Center. Through this service these blind professional people have been presented a new window to the world -- a window very different from the one normally available to them. The news in depth was available to them when they desired it and in a form they could either skim or examine in detail at their convenience.

This has been done through the help and courtesy of Prof. J. F. Reintjes R. S. Marcus, and R. B. Polanski of the Electronic Systems Laboratory of the Electrical Engineering Department of M.I.T. A UPI wire service 5 level page printer and reperforator was available for their use on a project (DSR 70149) sponsored by the American Newspaper Publishers Association.

The braille was produced by the M.I.T. BRAILLEMBOSS[1] equipped with a TELETYPE Translator[2] and driven by the paper tape which was punched on the UPI repreforator.

The page printer of the UPI wire service has a maximum line length of 72 characters while the line length of the BRAILLEMBOSS is 38 cells. The BRAILLEMBOSS has an automatic new line feature such that when the 38th cell is embossed, the paper is advanced and the carriage returned (advanced) ready to emboss the succeeding character at the beginning of the next line. With the difference in line length almost every inkprint line is embossed on two braille lines, sometimes three. The word at the end of the first braille line will be divided arbitrarily in almost every case. A simple modification was installed on the BRAILLEMBOSS such that the next space after N cells have been embossed causes a carriage return command to be generated. The number N was set to 32 cells but can be changed over the total range of 1 to 38 cells.

The carriage return command is treated differently by the wire service page printer and the BRAILLEMBOSS. The wire service page pr ter carriage return command does not advance the paper, only returns the arriage to the first printing location. It requires a separate command to advance the paper. The BRAILLEMBOSS treats the carriage return command as a new line command; i.e., returns the carriage and advances the paper.

These two differences produce a braille page with an unusual format. Each line of inkprint becomes a group of two or three braille lines separated by a blank line. This blank line can be deleted by modifying the BRAILLEMBOSS to require a line feed command after every external ...

The reperforator was operated each day, from the time ESL personnel arrived for work until the roll of paper tape (2000) feet was exhausted, generally about 5 hours. The tape was then run on the modified BRAILLEMBOSS equipped with the TTY translator. The BRAILLEMBOSS running time for a roll of paper tape was about 3 hours. A typical run produced approximately 200 pages of braille.

References:

1. BRAILLEMBOSS Applications, A Braille Page Printer. (SAEDC, TDS No.5)

2. ONE-CELL Braille Translators, BRAILLEMBOSS Interface Units. (SAEDC, TDS No. 8).

July 17, 1970
Revised July 28, 1970

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

Braille Production by
DOTSYS III and the BRAILLEMBOSS

The BRAILLEMBOSS[1,2] and DOTSYS III[3] combination has been used to produce several volumes of literary braille. Examples of this usage are "In Darkness",[4] IRS Publication 29, TDS #1, and TDS #2. This combination has also been used to produce in braille a poem "In Memoriam" by Frederick Silver.

The usefulness of this combination is not limited to literary or text materials only. A series of braille actuarial tables have been produced using the BRAILLEMBOSS, DOTSYS III and computer-generated input material. The DOTSYS III poetry option was used to obtain the desired braille line format, i.e. each line of the inkprint table is started at the left hand margin of the braille and the braille continuation lines are indented 3 spaces.

A FORTRAN program was written to generate the input material. The necessary format control characters for the poetry line control were included as literals in the FORTRAN format statements. Text material for the title and headings could be generated by the use of literals in the format statements; however in this case the titles and headings were done separately using punched paper tape loops. The body of the tables were translated by DOTSYS III and stored in the computer disk files. The following steps were performed to braille out the table: Run the tape reader to place the heading and page number on the page, then the required number of lines of the table were read out from the computer, the heading placed on the next page, the required number of lines for the next page were read out from the computer, etc. until the entire table was read out. With some minor changes in the handling of titles the entire operation can be done automatically. A punched paper tape copy of the tables was also made for future reference and multiple copies if desired.

The computer generation of the tabular material relieved a typist of the task of inputting the material into the computer or a braillist manually producing each page.

One of the ground rules during the development of DOTSYS III was that it should be capable of producing any type of braille when suitable input material is provided. It was assumed that a suitable pre-processor program could be written to provide appropriate input material to DOTSYS III to produce mathematical braille. There exists a system of tabs and tab control for tabular material with each braille line less than the braille [illegible] longer lines. For example a suitable pre-processor can be written to take a simple suitable input file and convert the file into form that DOTSYS III will then translate into mathematical braille.

For tabular material there are two options presently available with DOTSYS III. If the table line-length is less than the braille line-length then the DOTSYS III system of tabs can be used. If the line is longer, then the poetry format should be used.

Braille copies of TDS #1, TDS #2, and "In Memoriam" are available on request from the SAEDC.

References:

1. Final Report to John A. Hartford Foundation, "Development of a High-speed Brailler System for more Rapid and Extensive Production of Informational Material for the Blind," SAEDC, September 29, 1970.

2. BRAILLEMBOSS, A Braille Page Printer. SAEDC, TDS No. 2.

3. Interactive Braille. SAEDC, TDS No. 11.

4. Dalrymple, G.F., "Transcription of In Darkness via DOTSYS III and the BRAILLEMBOSS." SAEDC, November 7, 1972.

February 15, 1973

GFD:ss

Massachusetts Institute of Technology
SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER
292 Main Street, Cambridge, Massachusetts 02142

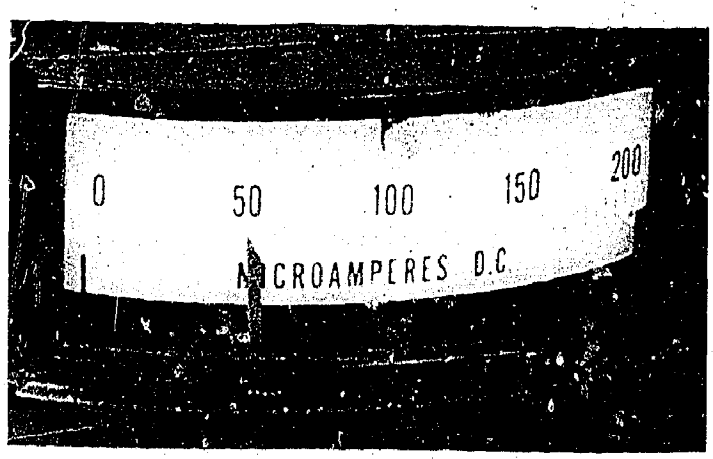
ELECTRO-TACTER
A Tactile Panel Meter

An electrical panel meter has been devised for a blind user. The meter features a movable tactual indicator with a scale, an audible indication of coincidence between tactual and visual indicators, and complete isolation both electrically and tactually between the meter movement and the readout.

The meter uses an API model 371K Compack II controller whose basic movement is a contactless optical meter relay. A tactual scale is added to the meter below the set point adjustment lever. (For initial demonstration a 60^{o} segment of a protractor was cemented to the set point lever guide. Each degree mark was filed to form an easily felt notch. Every 10th notch has an additional mark.) A tone is used to determine the agreement of the location of the visual indicator, and the location of the set point adjustment lever.

To read the meter, a momentary switch is held closed, activating the audible indicator. If no sound is heard, the set point lever is moved down scale until a tone indicates meter closure. The set point lever is then carefully adjusted for the exact point of the relay closing. The position of the set point lever is down scale when the reading cycle is initiated, the tone tells the reader to move up scale to the closure point.

A demonstration package has been assembled using a 200 microamp meter, a meter current source, and a Mallory Sonalert as the tone generator. Experiments with a blind subject has shown that accuracies of 2% can be obtained. The package is 5 x 8 x 12 inches and requires AC power to operate. Provision is included for an external current source to be measured by the meter.



Meter Face Showing Tactile
Scale Below Set Point Lever

MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139
77 Massachusetts Avenue (31-063)
Sensory Aids Evaluation and Development Center

APPENDIX VI

BRAILLEMBOSSes in Use

0.1 Sensory Aids Evaluation and Development Center (SAEDC)

serial no. 10 (prototype)		June 69 - May 70
serial no. 27-4		May 70 - present

0.2 SAEDC

serial no. 26 - LP		Feb. 70 - June 71
serial no. 18		June 71 - Sept. 71
serial no. 26 - LP		Sept. 71 - present

1. Mass Commission for the Blind (MCB)
   Dept. of Transportation
   Dr. John Morrison

serial no. 11	loan	Oct. 69 - Nov. 70
serial no. 13		Nov. 70 - present

2. Perkins School
   Programming Course

serial no. 12		Feb. 70 - present

3. MCB
   WWLP, Springfield
   Paul Caputo

serial no. 22	newswire	May 71 - Oct. 71

Worcester Polytechnical Institute
Philip Hall (Client, NH, DBS)

serial no. 22	ASCII	Sept. 72 - present

4. MCB
   Honeywell
   Alan Downing

serial no. 26	loan	June 71 - Sept. 71
erial no. 24	Intermetrics	Sept. 71 - Aug. 72
	Honeywell	Aug. 72 - present

5. Un rsity of Manitoba
   Don Keeping
   serial no. 28-4 — Oct. 71 - present

6. Bristol Engine Division, Rolls Royce
   T. Hicks
   serial no. 29-4 — March 72 - present

7. MIT
   Internal Revenue Service
   Little Rock, Arkansas
   Jack McSpadden
   serial no. 18 loan — April 72 - present

8. MIT
   MITRE
   Demonstration
   serial no. 19 loan — July 72 - present

9. MIT
   Arkansas Enterprises for the Blind
   Training
   serial no. 15 loan — Sept. 72 - present

10. Penn State University
    Ronald Morford
    serial no. 23 — Feb. 73 - present

February 16, 1972

GFD:ss

END

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ERIC

DATE FILMED

References:

1 BRAILLEMBOSS, A Braille Page Printer. SAEDC TDS No. 2 and BRAILLEMBOSS APPLICATIONS, SAEDC TDS No. 5.

2 M.I.T. BRAILLEMBOSS Specifications. SAEDC, August 1969 (with later revisions as applicable).

3 DOTSYS, A Braille Translation Program. SAEDC, TDS No. 3.

4 Braille News Demonstration. SAEDC, TDS No. 12.

July 17, 1970.

for a deaf-blind person who may be alone in his house, and, (2) to effect an alarm system (e.g., for fire, etc.) in an institution or other setting where a number of deaf-blind persons may be spread about and must all be summoned at once.

The equipment involved includes the pocket receivers (one for each user), the centrally-located 115 volt transmitter, and a loop antenna which runs around the area to be covered by the radio signal. This service area can be fairly large - one hundred thousand square feet or more. The transmitter can be connected to push buttons at convenient locations, fire alarm boxes, time clocks - whatever suits the end purpose.

Ancilliary attachments make possible other TACCOM applications:

1. End-of-line indicator for brailler or typewriter.

2. Auditory cue indicator (phone ringing, baby crying, etc.)

3. Ambient light indicator.

4. Message system (Morse code signalling, etc.)

5. Teaching/training aid.

SAEDC Technical Description Sheet No. 9.
July 31, 1970
Revised February 8, 1973

LR:ss

... character ASCII (American Standard Code for Information Interchange) character set used in the model 33 and 35 teletype.

Approximately one-half day was used in writing the 33 statement FORTRAN-II program. During this time four minutes of computer time was used to input the program from the teletype, compile, test, debug, and recompile it.

Punched paper tape was used as a buffer between the computer terminal and the BRAILLEMBOSS for several reasons. The first was to make a machine readable master such that multiple braille copies could be produced without incurring the costs of additional computer and terminal time. In addition, it facilitated the writing of the program, since BRAILLEMBOSS timing considerations could be handled by an asynchronous punch paper tape system instead of special programming techniques not readily available in FORTRAN II. The BRAILLEMBOSS carriage return (CR) time is in general much longer than the time for the teletype and computer CR time, such that data would be lost during the time the BRAILLEMBOSS is executing a CR. All other functions of the BRAILLEMBOSS, except the end of page function, are accomplished in less time than with the teletype.

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