

FINAL REPORT

to

JOHN A. HARTFORD FOUNDATION, INC.

on the Grant entitled

"Development of a High-speed Brailler System for more Rapid and Extensive Production of Informational Material for the Blind."

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George F. Dalrymple-

from

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Sensory Aids Evaluation and Development Center

Massachusetts Institute of Technology

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TABLE OF CONTENTS

TNTPODUCTION		Page 1
INIKODUCIION		
BRAILLEMBOSS	DEVELOPMENT	2
BRAILLEMBOSS	APPLICATIONS	7
PERSONNEL		11
REFERENCES		13
APPENDIX I	EVALUATION OF THE MIT AUTOMATIC BRAILLER	15
APPENDIX II	BRAILLEMBOSS DESCRIPTIONS	17
APPENDIX III	BRAILLEMBOSS SPECIFICATIONS	29
APPENDIX IV	TECHNICAL DESCRIPTIONS SHEETS	
	TDS No. 2 - BRAILLEMBOSS, A Braille Page Printer	37
	TDS No. 3 - DOTSYS - A Braille Translation Program	39
	TDS No. 5 - BRAILLEMBOSS APPLICATIONS	41
	TDS No. 7 - A Pamphlet, "The American Revolution".	43
	TDS No. 8 - ONE-CELL Braille Translators BRAILLEMBOSS Interface Units	45
	TDS No.10 - Conversion Table, Inches to Milli- meters, A Braille Computer Generated Mathematical Table	47
	TDS No.12 - BRAILLE NEWS DEMONSTRATION	49



INTRODUCTION

A blind mathematician sits at a teletype and communicates with a computer. At his elbow is an MIT BRAILLEMBOSS. For each key stroke on the teletype the BRAILLEMBOSS prints the character in braille. The computer answers him and again the message is printed in braille. With the BRAILLEMBOSS he becomes a fully functioning professional with equal access to the time-sharing computer as his sighted colleagues.

A blind upper school student in a residential school, far away from a computer is learning to be a computer programmer. A teletype and BRAILL-EMBOSS are her connections with the computer. With the braille printout she also is equal with sighted students in her access to the computer.

A blind graduate student must read a memo that his professor has stored in a computer for all his students. The student sits at a teletype, dials the computer, turns on a BRAILLEMBOSS, types a few simple commands and the BRAILLEMBOSS beside him produces a braille copy literally under his fingertips. When the memo is completely brailled, he releases the computer with a few typed commands, turns off the BRAILLEMBOSS, tears off his memo and takes it home to study.

A blind radio announcer must prepare the next news broadcast. He goes to a BRAILLEMBOSS printing the wire services pre-edited newscasts. He tears off the copy, quickly scans the content, and with a pair of scissors selects the sequence of stories. He reads over the newscast and is then ready to be on-the-air with the news--without sighted help.

A clerk in a public school office is handed a report by a teacher to be duplicated for her students, one of whom is blind. The clerk duplicates the copy in the usual fashion, then sits down at a teletype, a computer is dialed, a few brief commands are typed, then the report is typed into the computer. The computer translates the material into Grade II braille and sends the translated material to the BRAILLEMBOSS. The braille material is immediately available, almost as fast as the inkprint, ready to be given to the students. The braille was produced using approximately the same effort and skills as the inkprint copies.

A volunteer braille agency is asked for ten copies of a short braille work. An expert braillist, using a special Perkins braille writer equipped with a paper tape punch, brailles a copy. The punched paper tape is then used as input to a tape reader attached to the BRAILLEMBOSS and the document is produced at the rate of approximately one page a minute. In the absence of a trained braillist, the punched paper tape could have been prepared via computer translation using a straight typist to type the material into the computer as was done in the previous example.

These examples demonstrate what can be accomplished with the BRAILL-EMBOSS. The first three are true examples of what has been already accomplished with the BRAILLEMBOSSES made under the Hartford Grant while the last three examples have been demonstrated in principle.

BRAILLEMBOSS DEVELOPMENT

The goal of the project was the development of a manufacturing model of the MIT BRAILLEMBOSS including the production of twenty test models for placement and evaluation in Boston area schools. Two basic models of the BRAILLEMBOSS have been produced in quantities as shown in Table I. One unit has been installed at a school, Perkins School for the Blind; another, in the office of a blind mathematician at the Transportation System Center of the Department of Transportation (formerly NASA's Electronic Research Center); and two are installed with computer terminals at the SAEDC.

The BRAILLEMBOSS is one of the output devices needed for a computerized Braille Information Processing System (BIPS) described previously^{1,2}. It is the product of the effort of many students, faculty and staff of the Mechanical Department and the SAEDC. The earliest studies³ lead to the original operating design⁴. The second design^{5,6,7} was incorporate into a console⁸ and demonstrated in a residential school, Perkins School for the Blind^{9,10}.

TABLE I

BRAILLEMBOSS TYPE SUMMARY

Braillemboss Type	Quantity	Purpose
Machine # 6	*	To verify certain design changes before constructing prototype unit.
First Prototype	1	To verify the design of the Model 3 BRAILLEMBOSS
Model 3	14	A Braille Page Printer with immediate but not instantaneous access to the braille page
Second Prototype	1	To verify the design changes for the Model 4 BRAILLEMBOSS
Model 4	5	A braille page printer for a time-sharing computer terminal where instantaneous access to the braille is required

*The Machine # 6 was the last of the previous group of braillers and was available for experimentation. It is still operational with paper tape input. During the course of this project five configurations of mechanical units were designed and fabricated. For the Model 3, two different units were used to verify its design. To verify the changes in the Model 3 to produce the Model 4, only one prototype was used. A summary of the configurations, their purpose, and quantity involved is shown in Table I.

The Model 3 is for applications where computer-translated Grade II braille is prepared for subsequent use; i.e., in schools for study, testing, and reference materials; in braille production agencies; for news and newspaper applications for the deaf-blind; and many other possible applications. A description of the unit is given in the appended SAEDC Technical Description Sheet No. 2. Figure 1 is a front view of the Model 3 BRAILLEMBOSS. Its lower part contains the embossing unit mounted on slides for easy servicing, the paper supply and the solenoid power supply. The upper part contains the electronics and control panel. All the external connections to the BRAILLEMBOSS are made at the rear of the Control Panel. Provision is included in the upper part for a Translator.

To connect a BRAILLEMBOSS to a teletype or other communication terminal a Translator is required to translate or map the teletype codes into familiar braille symbols. A variation of Grade I braille has been devised for computer application, called One-Cell braille. The One-Cell braille has a unique single cell dot configuration for each teletype inkprint symbol, and includes all possible braille cell combinations. This last feature permits One-Cell braille to be used to transmit computer translated Grade II braille over the teletype lines without additional decoding at the teletype. Without a Translator the required input code to the BRAILLEMBOSS is the special braille code previously adopted by a braille conference held at MIT in 1961¹¹. The Translator is further described in the appended TDS #8, One-Cell Braille Translators, BRAILL-EMBOSS Interface Units. Table II is a summary of the translators made to date physically. The translator consists of an electronic rack included just under the BRAILLEMBOSS electronics rack in the upper part of the cabinet.

The Model 4 is used in time-sharing computer applications where the user must interact on a continuing basis with the computer. Operator users



Figure 1 Model 3 BRAILLEMBOSS

Table II

Translators

Туре	No. Made	Function
ASCII/DOTSYS	4	 To provide electrical interface between Model 35 Teletypes with a stunt box or LRS 800 Receiving Selector and BRAILLEMBOSS.
		2a. To translate teletype codes into the appropriate braille codes, or
		2b. To translate DOTSYS transmission codes into braille codes.
ASCII	2	la. To provide electrical interface between Model 35 Teletypes with a stunt box or LRS 800 Receiving Selector and BRAILLEMBOSS, or
		1b. To provide electrical interface between Models 33, 35, or 37 Teletypes selector magnet driver and BRAILLEMBOSS.
		 To translate teletype codes into the appropriate braille codes.
Bardot	1	 To provide electrical interface between 5 level tape reader (Model 9 or 15 Tele- type) and BRAILLEMBOSS.
		 To translate teletype codes into the appropriate braille codes.

include computer programmers, engineers using the computer to solve engineering problems, financial analysts using computer-stored data banks and other similar operator users. Figure 2 is a view of the Model 4. The arrangement of the several units is similar to the Model 3 except for the location of the embossing unit.

7

An important consideration of the Model 4 BRAILLEMBOSS is the correct height and placement of the embossing unit for the user's convenience, comfort, and utility. A simple cabinet was designed from slotted angle to permit quick and easy changes and adjustments to optimize the location of the embossing unit and the control panel. Figure 3 is a view of the Second Prototype as it has been connected to a teletype for regular use in the SAEDC ongoing braille programs.

BRAILLEMBOSS APPLICATIONS

The first prototype was extensively operated by an Exerciser to determine and demonstrate its reliability. After it had produced over 10 million characters with little or no maintenance, it was connected to a computer via teletype and was available on-line with an MIT time sharing **computer (CTSS)** between June 1969 and May 1970. It was used both by an economics graduate student in his part-time employment as a systems analyst in the MIT Department of Economics, and for demonstrations and tests by the Center's personnel. It is temporarily disconnected while other units are being tested.

The first Model 3 machine was demonstrated via tape reader input using Teletype (ASCII) coded punched paper tape at the "Blind in Computer Programming, an International Conference", held in Cleveland in October 1969. The machine operated correctly without adjustments at the meeting after being transported 1100 miles by station wagon. After the conference the machine was taken to the office of Dr. John Morrison, then of NASA, now of Department of Transportation (DOT), and installed. He has used it extensively with a Digital Equipment Corporation PDP-10 computer studying insertion trajectories and orbits of

* The Exerciser is an input device that creates repetitious patterns as inputs to the BRAILLEMBOSS to test and exercise the unit without use of tele-types, punched paper tape readers, or computers.

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Model 4 BRAILLEMBOSS



satellites. His report "Evaluation of MIT Automatic Brailler" written online using a computer editor routine is appended. The report was transmitted to the SAEDC via teletype from the computer at DOT. This machine has embossed over 4 million characters with no maintenance except during the first few weeks when two minor problems were corrected.

The second Model 3 machine was used to produce a conversion table of inches to millimeters for the Mass. Commission for the Blind. A description of this project is contained in Technical Description Sheet #10. The unit was installed at the Perkins School for the Blind in Watertown, Mass. during February 1970. The BRAILLEMBOSS is connected in parallel to the page printer of a teletype used in a computer programming course for the Perkins upper school students. It has produced over 200,000 characters of braille at this writing. They use the commercially available General Electric time-sharing service.

Another Model 3 machine has been used experimentally to produce in braille a portion of the news stories carried by the UPI news wire. This demonstration is described in TDS # 12, Braille News Demonstration.

The Second Prototype was placed on-line during February 1970 and has been used extensively for demonstrations, braille production and computer terminal operations since that time.

The first Model 4 machine was connected to the SAEDC second computer terminal during May 1970 replacing the First Prototype. It is presently awaiting shipment to Dr. Edward Glaser, Director of the Case Western Reserve University Computation Center.

The remaining machines are complete mechanically. Five BRAILLEMBOSS machines are complete and awaiting disposition. Each unit still must have the translator required for its particular application. Two additional machines need only plug-in electronic circuit cards. The additional eight machines still require both cabinets and some electronic components.

PERSONNEL

The principal investigators were Dwight D. M. Bauman, formerly Associate Professor of Mechanical Engineering; the late John K. Dupress, Research Associate and Director SAEDC; Robert W. Mann, Professor of Mechanical Engineering; and Vito A.Proscia, Research Associate and Director of SAEDC.

The Project Engineer was George F. Dalrymple who was also the Electronic Engineer. The Mechanical Engineers were Murray Burnstine and Ranulf W. Gras. Mr. Burnstine is a consulting engineer and had worked previously on the embosser. Mr. Gras is a Staff Member of the Draper Laboratories (formerly Instrumentation Laboratory). Through Mr. Gras, the facilities of Draper Laboratories, including metallurgy, inspection, instrument machine shops and drafting were available to the project.

The Mechanical Technician was Norman J. Berube, the design draftsman was Paul A. Maccarrone of Draper Laboratories, and the Electronics Technician was Alexander Glimcher. Robert W. Reid, Mechanical Engineer, and Ernest P. Johnson, Administrative Assistant, both of Draper Laboratories have contributed to the project.



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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

BRAILLEMBOSS DESCRIPTIONS

The Model 3 BRAILLEMBOSS

The Model 3 BRAILLEMBOSS is a braille page printer designed to produce braille for later reading. It is completely contained within a single cabinet, and requires only input signals and AC power to operate. The input signals can be derived from paper tape readers, teletype (or other communication terminals), a computer keyboard, or many other similar devices.

The basic components of the BRAILLEMBOSS are the embossing unit, electronics including the control panel, solenoid power supply and paper supply. Provision is included in the cabinet for mounting the tape reader power supply when the tape reader is used as input. The Model 3 embossing unit is shown in figures III-1 through III-5. The operation of the BRAILL-EMBOSS is discussed in Technical Description Sheet #2, "BRAILLEMBOSS, A Braille Page Printer".

Many design changes were required for increased reliability, improved accuracy, and reduced noise. These changes were sufficiently extensive to require verification before incorporating them into the final design. As many changes as was possible were installed on Machine No. 6, the last machine of the previous group made. These changes were tested and the machine operated extensively. One use of the Machine No. 6 during this period is described in TDS #7 "A Pamphlet, 'The American Revolution', A Short Run Braille Production". These changes are described fully in the section, <u>Machine No. 6</u>.



Figure III-1 Model 3 BRAILLEMBOSS Right Rear Quarter View, Embossing Unit.



Figure III-2 Model 3 BRAILLEMBOSS Left Rear Quarter View, Embossing Unit.



Figure III-3 Model 3 BRAILLEMBOSS Top View, Embossing Unit.



Figure III-4 Model 3 BRAILLEMBOSS Front View, Embossing Unit.



Figure III-5 Model 3 BRAILLEMBOSS Bottom View, Embossing Unit. Additional changes were made in the design that could not be easily incorporated into Machine No. 6. These changes were tested on the First Prototype, a machine with all the operational features of the Model 3. This machine operated as a time-sharing computer terminal, and with an exerciser, for several months to test and verify its performance. These additional changes are described in the section, The First Prototype.

Machine No. 6.

This was the last machine of the previous group of braillers to be built. At the start of this grant it was able to run with a breadboard "exerciser" or driven by a tape reader using an experimental lashup, using a lot of "tender loving care". It served as a test device for the early electronic designs and to check out certain mechanical changes. The mechanical changes it checked out were the various cycle clutches and clutch brakes, the crank platen drive, the torson stiffened selector bars and the sprocket-drive paper drive.

The component that prevented the earlier braillers from meeting the speed specification of 16 characters per second was the cycle clutch. Several clutches were tried in Machine No. 6, but only a Precision Specialties, Inc. Clutch Brake, Model CB-2 demonstrated that it satisfied the requirements. This unit incorporates a brake to supply the required stopping torque as well as a cycle clutch to couple the drive torque. The clutch is assembled by the manufacturer on the cycle shaft furnished by the MIT Sensory Aids Evaluation and Development Center.

The cam drive mechanism of the platen was a major source of noise on the earlier machine. The cam followers would leave the cams as the platen overtravelled on the emboss (down) stroke. A crank drive eliminates the slap when the cam followers return to the cam after overtravel. To improve the control of the platen position, a pivot and arm mechanism was included to eliminate a sliding contact of the earlier machines.

The selector bars of the earlier machines had inadequate torsonal stiffness. The stroke of the selector bars was a function of the head position and could not be correctly adjusted over the entire range of head positions. As a result braille dots would often be missing. The addition of a tube member to the selector bars gives adequate torsional strength and makes minimal change in the machine.

A new paper drive based upon fan-folded sprocket-drive paper was used. The sprocket drive units were purchased from Kidder Press and the drive motor is a Ledex Digimotor. They replaced two critical assemblies of the old machine. The friction roller drive was very difficult to adjust for straight paper motions and the earlier drive devices were either difficult to make or adjust.

The First Prototype

This machine used a few parts of Machine No. 3, of the previous group, but it is a Model 3 machine in all operational respects. It incorporated all the changes listed under Machine No. 6 and was used to check out the final design of the escapement, head hold down system, new head design, selector bar solenoids, cooling system, and enclosure.

A true escapement was developed for head positioning; i.e., the head is constrained to move only one space for each cycle shaft revolution. The rack, built up to two adjacent double pitch racks displaced by one cell width, is moved from side to side to advance the head. The rack motion is controlled by an eccentric rotating at one-half the cycle shaft rotation speed. The earlier machines lowered the rack by a cam and lever to advance the head. The former approach required a very careful balance between the rack displacement, rack displacement time, head friction forces, and the force advancing the head to control the amount of head advance. The new method removes this set of critical adjustments and substitutes a simple set of independent adjustments.

The new escapement eliminates the "fly around" method of carriage return. The heads must now be stepped around. The "step around" method causes only a small time penalty. The carriage return time from the first cell position for the "fly around" is approximately 2 seconds versus 2.4 seconds for the "step around" system. The new escapement adds a gear box, but deletes several complicated parts and a solenoid. It also reduces the noise by eliminating a cam, cam follower and stop.

The head hold-down method has been changed to dovetails and gibs. This head support arrangement gives better positioning of the heads than the methods used previously. Also, the support track has been lengthened to provide adequate support for the head at both ends of the line.

A new head design compatible with the hold down arrangement was made. Plastics were used wherever possible to reduce the weight. A new plunger plate was designed which has lengthened skirts to prevent the head from catching on the

edge of the paper as the head moves around the sprocket onto the support track. The "back porch" of the plunger plate is recessed for possible later use of a solid Estane Platen. (The experiments with a solid Estane Platen did not produce a satisfactory braille.)

The selector bar solenoids are now Guardian T6X12 Cont. 24 V.D.C. tubular solenoids. They are modified to fit by drilling and tapping and removing the original mounting threads at the plunger end of the solenoid. The force and electrical characteristics of these solenoids are quite similar to the custom-made solenoids of the earlier machines.

The selector bar solenoid cooling was changed such that the solenoids now receive approximately equal amounts of cooling air. A small pancake fan, mounted on the baseplate, and an air duct direct the cooling air to the appropriate locations. For braille production applications each machine and its electronics are mounted in an enclosure typical of those used for electronic equipment. The Brailler, paper supply, the solenoid power supply are in the lower half of the enclosure. The Brailler is mounted on pullout slides for easy servicing. The Control Panel and electronics rack are in the turret above including space for one additional electronic rack for the translator as require

Electronics

The early electronics were made from Digital Equipment Corporation (DEC) R- and W- series modules. At the beginning of the Grant, this series of modules offered the least expensive and shortest time method to obtain working electronics which could be easily maintained using commercially available plug^{-j} circuit cards. Two sets of electronics were constructed. One still drives

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Machine No. 6 and the other is used for mechanical test purposes.

The electronics were designed to operate from four data sources -tape reader, binary divider (Bidot) exerciser, equiprobability (Equidot) exerciser, and manual input. The equiprobability exerciser embosses all possible combinations of dots before repeating. Teletype operation was not included as both the size and cost of a code translator made from this series of logic cards was prohibitive.

The final electronics uses DEC K-series modules. The K-series is slower, less expensive, has greater noise immunity and is better suited for the Brailler application than the R- and W- series. In addition, the K-series has a group of modules designed for code conversion. These have been used to construct a teletype code (ASCII(63)) to one-cell braille translator for a timesharing computer terminal with braille output. The translators are described in TDS #8, "One-Cell Braille Translators BRAILLEMBOSS Interface Units."

The number of operational modes has been increased with the K-series electronics. These modes are:

- 1. Exerciser
- 2. Manual (panel operation)
- 3. Paper Tape Reader
- 4. Teletype (through a code converter) and,
- 5. Keyboard.

The exerciser is now a plug-in unit and is not an integral part of the electronics as previously. The code converters are mounted on separate rack banels below the electronics main frame rack.

Keyboard

The braille keyboard was adapted from that designed by Greiner. The required circuitry is now included in the electronics. The Braille keyboard has seen little service as the main emphasis has been on computer production of braille, or as a time sharing computer terminal. When the BRAILLEMBOSS is used with a teletype, the teletype-in local mode-becomes a convenient keyboard.

The Model 4 BRAILLEMBOSS

For time sharing or interactive computer operation it is necessary to read the braille as it is produced or immediately afterward. The Model 4 machine therefore is mounted such that the braille is produced with the bottom of the page closest to the user at elbow height. A lifting platen enables the user to read the last cell embossed (when the machine is quiescent) without moving the paper.

The line length of the Model 4 was increased to 42 cells to enable an 80 column Hollerith Punched Card (IBM card) to be printed on two lines instead of three lines. Except for changes dictated by the line length, lifting platen and cabinet, Models 3 and 4 are the same.

Figures III-6 and III-7 are rear quarter views of the Model 4. With the platen lifted and with the platen in the emboss position to lift the platen, grasp the bar handle, lift it up and to the rear.

The Second Prototype

The Second Prototype was the first unit to incorporate a lifting platen. It has a line length of 38 cells instead of 42 cells. Its cabinet is made from Acme slotted angle to permit easy change during the early tests when the man-machine interface for the Model 3 was being investigated. The line leng and cabinet are the only differences to distinguish it from the other Model 4's.



Figure III-6

Model 4 BRAILLEMBOSS Right Rear Quarter View, Embossing Unit Platen in Embossing Position.



Figure III-7

Model 4 BRAILLEMBOSS Right Rear Quarter View, Embossing Unit Platen Lifted for Reading Massachusetts Institute of Technology SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER 292 Main Street, Cambridge, Massachusetts 02142

APPENDIX III

BRAILLER CHARACTERISTICS:

OUTPUT: Fan-Fold Paper 11 inch x 11-1/2 inch pages 25 lines of Braille per page 28 lines per page 38 cells of Braille per line

MACHINE FUNCTIONS:

Emboss. Embosses 0 to 6 dots in a 2 x 3 array per operation Time required: 62.5 milliseconds Line Feed: Moves paper one line. 100 milliseconds Time required: Automatic Line Feed: Moves paper one line after 38th cell is embossed, either space or dots. Time required: 140 milliseconds including time to emboss 38th cell. Carriage Return: Spaces to end of line and Auto Line Feeds Time required: (38-N) 62.5 + 140 milliseconds. Where N is the cell number in line 1 . . . 38 End of Page: Line Feeds to the first line of next page. Time required: (29-M) 125 milliseconds where M is the line number, 1 . . . 28

INPUTS

Exerciser: Prints selected patterns for test purposes.

EQUIDOT -- Prints all possible combinations of 6 dots

BIDOT -- Prints selected dots every 2^{N} th time where N = 1,2,3, or 4.

Manual: Prints selected dots either singly or multiples from control panel switches.

Tape Reader: Prints from special Braille coded 8-level paper tapes using a Friden SP-2 motorized tape reader.

- DOTSYS. Converts to coding used in DOTSYS teletype transmission to brailler input code.
- ONE-CELL. Converts ASCII(63) to a one-cell braille equivalent in brailler input code.
- Keyboard: Prints from an external keyboard using Perkins Brailler keyboard arrangement.

CODES:

Levels 1 through 6 are embossed as dots 1 through 6 if level 8 (machine function) is zero.

Level 7 is used as an even parity bit (for certain applications).

Level 8 indicates machine function

Carriage Return	Levels	1,	2,	3,	8	
End of Page		1,	2,	3,	7,	8
Line Feed		1,	2,	3,	7,	8
Space		7,	8			

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31

M. I. T. HIGH SPEED BRAILLE EMBOSSER (cont.)

PHYSICAL PLANNING



Front PLAN VIEW

32

M.I.T. BRAILLEMBOSS CHARACTERISTICS (cont'd) 8 June 1970

INTERFACE UNIT--ASCII(63/67)-ONE-CELL BRAILLE

PURPOSE:

To interface 8 level Teletypes (Models 33, 35, and 37) with the BRAILLEMBOSS. The unit converts each printing teletype symbol into an equivalent single braille cell. Control codes for space, line feed, carriage return, and end of page are also translated. Two control codes are available to enable or supress embossing on command.

DRAWINGS:

20039-376 Logic Diagram 20039-377 Wiring List

INPUT 'CODES:

ASCII(63) code (Model 33 or 35 TTY) Delete Card D09 (K003) ASCII(67) code (Model 37 TTY) Install Card D09 (K003)

INPUT:

Parallel code (Switch closures to +40 volts)

LRS-800 Receiving Selector Model 35 TTY Stunt Box

Serial code

Wired ORed with modem interface of current switching teletypes.

Card Assignments

Slot	Serial	Parallel
C01/02,D01/02	M706	
C03/04	M452	
D03/04	M111	K580 (P-4)
D05	K596	к134
Connector	MS 3100-12S-3S on Translator	Amph 57-40140 J-2 on Control Panel
Mating Connector	MS 3106-12S-3P	Amph 57-30140

OUTPUT CODES:

ONE-CELL braille in Brailler Code (Table ONE-CELL). Lower case letters of ASCII(67) are translated into upper case. No dot 6 indicator is given for any letter. No number sign indicator is given for any number.

M.I.T. BI

INTERFACI

OUTPUT: DEC

POWER:

The DEC

M.I.T. BRAILLEMBOSS CHARACTERISTICS (cont'd)

INTERFACE UNIT--ASCII(63/67)-ONE-CELL BRAILLE (cont'd)

OUTPUT:

DEC K-series gate expander outputs for code levels 1 through 8.

POWER:

The power is furnished by the brailler electronics through output cable DEC BC02S-3.

0 1 0 1 1 J 1 2F

ASCII(63)									ONE-CELL BRAILLE									
7	6	5	4	3	2	1	The second se	SYMBOL	OCT	1	2	3	4	5	6	7	8	
0	0	0	1	0	0	С	08		377	1	1	1	1	1	1	1	1	
0	0	0	.1	0	0	1	09		377	11	1	1	1	1	1	1	1	
0	0	0	1	0	1	0	CA	LF	305	1	0	1	0	0	0	1	1	
0	0	0	1	0	1	1	OB		377	1	1	1	1	1	1	1	1	
0	0	0	1	1	0	0	CC	FF	303	1	1	0	0	0	0	1	1	
0	0	0.	1	1	0	1	OD	CR	201	1	0	0	0	0	0	0	1	
0	0	0	1	1	1	0	OE		377	1	1	1	1	1	1	1	1	
0	0	0	1	1	1	1	OF		377	1	1	1	1	1	1	1	1	
0	1	0	0	0	C	0	20	SPACE	300	0	0	0	0	0	0	1	1	
0	1	0	0	0	0	1	21	!	056	0	1	1	1	0	1	0	0	
0	1	0	0	0	1	0	22	**	120	0	0	Q	0	1	0	1	0	
0	1	0	0	0	1	1	23	#	074	0	C	1	1	1	1	0	0	
0	1	0	0	1	0	0	24	\$	053	1	1	0	1	0	1	0	0	
0	1	0	0	1	0	1	25	%	151	1	0	0	1	0	1	1	0	
0	1	0	0	1	1	0	26	e'r	157	1	1	1	1	0	1	1	0	
0	1	0	0	1	1	1	27	1	104	0	0	1	0	0	0	1	0	
0	1	0	1	0	0	0	28	3(167	1.	1	1	0	1	1	1	0	
0	1	0	.1	0	0	1	20	3)	176	0	1	1	1	1	1	1	0	
0	1	0	1	0	1	0	2A	×	041	1	C	0	0	0	1	0	0	
0	1	0	1	0	1	1	2B	+	154	0	0	1	1	0	1	1	0	
0	1	0	1	1	0	0	2C	, '	152	0	1	0	1	0	1	1	0	
0	1	0	1	1	0	1	2D	-	044	0	0	1	0	()	1	0	0	
0	1	0	1	1	1	0	2E		050	0	0	0	1	0	1	0	0	

/ 014 0 0 1 1 0 0 0 0

Table ONE-CELL

M.I.T.

Table ONE-CELL

		A	SCI	I(6	3)		-	ONE-CELL BRAIL							LLF	LE			
7	6	5	4	3	2	1		SYMBOL	OC'I	1	2	3	L;	5	6	7	8		
0	1	1	0	0	0	0	30	0	164	0	0	1	0	1	1	1	0		
0	1	1	0	0	0	1	31	1	102	0	1	0	0	0	0	1	0		
0	1	1	0	0	1	0	32	2	006	0	1	1	0	0	0	0	0		
0	1	1	0	Ó	1	1	33	3	022	0	1	0	0	1	0	0	0		
0	1	1	0	1	0	0	34	4	162	0	1	0	0	11	1	1	0		
0	1	1	0	1	0	1	35	5	042	0	1	0	0	0	1	0	0		
0	1	1	0	1	1	0	36	6	126	10	1	1	D	1	0	1	0		
0	1	1	0	1	1	1	37	7	066	0	1	1	0	1	1	0	0		
0	1	1	1	0	0	0	38	8	146	0	1	1	0	0	1	1	0		
0	1	1	1	0	0	1	39	9	024	0	0	1	0	1	0	0	0		
0	1	1	1	0	1	0	3A	:	161	1	0	0	0	1	1	1	0		
0	1	1	1	0	1	1	3B	:	060	0	0	0	0	ji	1	0	0		
0	1	1	1	1	0	0	30	1	143	1	1	0	0	0	1	1	0		
0	1	1	1	1	0	1	3D		077	1	1	1	1	1	1	0	0		
0	1	1	1	1	1	0	3E	15	134	0	0	1	1	1	0	1	0		
0	1	1	1	1	1	1	3F	?	071	1	0	0	1	1	1	0.	0		
1	0	0	0	0	0	0	40	0	110	0	0	0	1	0	0	1	0		
1	0	0	0	0	0	1	41	Α	101	11	0	0	0	10	0	1	0		
1	0	0	0	0	1	0	42	В	003	1	1	0	0	10	0	0	0		
1	0	0	0	0	1	1	43	C	011	1	0	0	1	10	0	0	0		
1	0	0	0	1	0	0	44	D	131	1	0	0	1	11	0	1	0		
1	0	0	0	1	0	1	45	E	021	1	0	0	0	1	0	0	0		
1	0	0	0	1	1	0	46	F	113	1	1	0	1	0	0	1	0		
1	0	0	• 0	1	1	1	47	G	033	1	1	0	1	1	0	0	0		

Table ONE-CELL

		A	SCI	I(6	3)				ONE-CELL BRAILLE								
7	6	5	4	3	2	1		-SYMBOL	OCT	1	2	3	4	5	6	7	8
1	0	0	1	0	0	0	48	Н	123	1	1	0	0	1	0	1	0
1	0	0	ŀ	0	0	1	49	I	012	0	1	0	1	0	0	0	0
1	0	0	1	0	1	0	4A	Ĵ	132	0	1	0	1	1	0	1	0
1	0	0	1	0	1	1	4B	К	005	1	С	1	0	0	0	0	0
1	0	0	1	1	0	0	4C	L	107	11	1	1	0	0	C	1	0
1	0	0	1	1	0	1	4D	М	115	1	0	1	1	10	0	1	0_
1	0.	0	1	1	1	0	4E	N	035	1	0	1	1	1	0	0	0
1	0	0	1	1	1	1	4F	0	125	1	0	1	0	1	0	1	0
1	0	1	0	0	0	0	50	Р	017	1	1	1	1	0	0	0	0
1	0	1	0	0	0	1	51	Q	137	1	1	1	1	1	0	1	0
1	0	1	0	0	1	0	52	R	027	1	1	1	0	11	0	0	0
1	0	1	0	0	1	1	53	S	116	0	1	1	1	0	0	1	0
1	0	1	0	1	0	0	54	Т	036	0	1	1	1	11	0	0	0
1	0	1	0	1	0	1	55	U	145	1	0	1	0	0	1	1	0
1	0	1	0	1	1	0	56	V	047	1	1	1	0.	0	1	0	0
1	0	1	0	1	1	1	57	W	072	0	1	0	1	1	1	0	0
1	0	1	1	0	0	0	58	X	055	1	0	1	1	0	1	0	0
1	0	1	1	0	0	1	59	Y	175	1	0	1	1	1	1	1	0
1	0	1	1	0	1	0	5Λ	Z	065	1	0	1	0	1	1	0	0
1	0	1	1	0	1	1	5B	[140	0	0	0	0	0	1	1	0
1	0	1	1	1	0	0	5C	1	053	1	:	0	Ö	1	1	0	0
1	0	1	1	1	0	1	5D]	173	1	1	0	1	1	1	1	0
1	0	1	1	1	1	0	SE	4	030	0	0	0	1	1	C	0	0
1	0	1	1	1	1	1	SF	4	170	0	0	0	1	1	1	1	0

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BRAILLEMBOSS

A Braille Page Printer

The M.I.T. BRAILLEMBOSS¹ 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 sprocketdrive 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.

SAEDC TECHNICAL DESCRIPTION SHEET NO. 2.

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 reader², or a translator³. The manual modes are uses primarily for test or limited addition to braille from other sources. The translator allows other devices such as model 2% 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.

- MIT BRAILLEMBOSS Specifications. SAEDC August 1969 with latest revision.
 Friden Model SP 2 Processory. 2) Friden Model SP-2 Paper Tape Reader.

3) ONE-CELL Translators, BRAILLEMBOSS Interface Units. SAEDC, TDS No. 8.

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 Goldish⁴.

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. DOTSYS: A Braille Tranalation Program page two

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 reprogramming 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:

- 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.
- Proceedings Braille Research and Development Conference, SAEDC, MIT, November 1966.
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- Goldish, L.H., "Braille In The United States; It's Production, Distribution and Use" Thesis (S.M.), Sloan School of Management, MIT, February 1967.
- Greiner, W.E., "Development of Braille For Class Room Use", Thesis (M.S.), Mechanical Engineering (MIT) Febraury, 1968.

July 28, 1970.

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BRAILLEMBOSS APPLICATIONS

The M.I.T. BRAILLEMBOSS^{1,2} is an automatic braille printer operated by electrical signals derived from one of many possible sources. It can operate at speeds compatible with either TELETYPES or IBM 2741 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 initial use 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 previously been demonstrated at Perkins School for the Blind in Watertown, Massachusetts by William Greiner³ and a similar system is on-line at the Center at this time. The complete system consists of the BRAILL-EMBOSS, Model 35 TELETYPE, braille translation program DOTSYS,⁴ 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.

Another application of the BRAILLEMBOSS is the short run production of braille materials using punched paper tape as the storage medium. The BRAILL-EMBOSS 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. Another method of preparing paper tape is by typing on a special TELE-TYPE 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. Each of these methods has been used and has been proven useful for particular applications.

Further, by being a braille page printer for the computer terminal, the BRAILLEMBOSS opens the door of time-sharing computer to the blind programmer.⁷ The BRAILLEMBOSS is connected to the TELETYPE page printer via a braille translator unit⁸ and it faithfully duplicates in braille the inkprint output of the TELETYPE page printer. The Model 4 BRAILLEMBOSS has a lifting platen such that the programmer can read the last braille cell produced without moving the braille copy. Several computers have been operated by blind programmers using the BRAILLEMBOSS, including IBM 7094, IBM 360/67, Digital Equipment Company PDP-10 and the General Electric Time-Sharing Computer Service.

SAEDC TECHNICAL DESCRIPTION SHEET NO. 5.

BRAILLEMBOSS APPLICATIONS page two

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.

References:

- 1. M.I.T. BRAILLEMBOSS Specifications. SAEDC, August 1969 (with later revisions as applicable).
- 2. BRAILLEMBOSS, A Braille Page Printer. SAEDC, TDS No. 2
- Greiner, W. E., "Development of a Braille System for Classroom Use." (S.M. Thesis, M.E. Department, M.I.T.). Feb. 1968.
- 4. DOTSYS, A Braille Translation Program. SAEDC, TDS No. 3.
- 5. <u>The American Revolution, A Short Run Braille Pamphlet Demonstration.</u> SAEDC, TDS No. 7.
- 6. <u>Conversion Table</u>, Inches to Millimeters: A Braille Computer Generated <u>Mathematical Table</u>. SAEDC, TDS No. 10.
- 7. Lichstein, M. L., Braille Computer Output. (M.I.T.-SAEDC). August 1969.
- 8. ONE-CELL Braille Translators, BRAILLEMBOSS Interface Units. SAEDC TDS No. 8.

July 29, 1970

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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 BRAILL-EMBOSS 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 (BRAILL-EMBOSS). 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 BRAILL-EMBOSS 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 BRAILL-EMBOSS, 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 September 28, 1970.

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ONE-CELL Braille Translators BRAILLEMBOSS Interface Units

The M.I.T. BRAILLEMBOSS¹ 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 translators² 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.

SAEDC TECHNICAL DESCRIPTION SHEET NO. 8.

ONE-CELL Braille Translators, BRAILLEMBOSS Interface Units (cont'd.) Page two

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 DOTSYS³ 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.

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.

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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 3 running a FORTRAN II program, a teletype, punched paper tape reader, Translator 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

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

> July 20, 1970. Revised August 14, 1970.

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. BRAILLEMBOSS¹ equipped with a TELETYPE Translator² 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 printer carriage return command does not advance the paper, only returns the carriage 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 carriage return command. The braille continues across page lines also. A line feed counter modification similar to the cell counter could be added to start a new page after every 25 lines of braille. BRAILLE NEWS DEMONSTRATION page two

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. <u>ONE-CELL Braille Translators, BRAILLEMBOSS Interface Units.</u> (SAEDC, TDS No. 8).

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