Proposed Braille computer terminal offers expanded world to the blind

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INTRODUCTION

As professional people—engineers, scientists, programmers and managers—most of us make frequent use of the library. We keep abreast of recent developments by reading books or technical journals. If we have developed our reading skills, we can zip through a document at the rate of 1000 words per minute. But what would happen to us and our interests if we no longer had access to the library or if our supply of reading material was suddenly cut off because we became blind?

The end of the world you say! No, not quite, but it might seem so if this fate befell us. Unfortunately, more than 30,000 individuals lose their sight each year. The world hastily closes in on them. Books and magazines are practically out of reach. What alternative do they have to keep informed?

Thanks to Louis Braille and others, the Braille system of raised dots on paper provides an opportunity for written communication. Transcribing and embossing of Braille is difficult, so there is a limited amount of literary works available. This situation need not remain static. It can be improved by applying computers and programs to help translate Braille and to develop equipment for embossing Braille.

A brief tutorial on the raised-dot language of Braille is presented to illustrate some of its complexities. This is followed by an explanation of the methods used in producing Braille material. Finally, the proposed Braille computer terminal will be described and some experimental results from a feasibility model will be discussed.

THE BRAILLE SYSTEM

Braille was developed more than a century ago by Louis Braille, a French teacher of the blind, to provide some means of communication for his students. It employs a system of embossed dots on the surface of the paper, which are felt and read with the fingertips.

Braille is read from left to right, top to bottom, exactly as a sighted person reads conventional printing. The average speed of reading is about 100 words per minute. Figure 1 shows the basic cell configuration for a Braille symbol. Up to six dots (two vertical columns of three dots each) are used. The dots of the cell are numbered as shown. Sixty-three dot patterns or Braille characters can be formed by arranging the dots in different positions and combinations. One other configuration, that of no dots, is used for spacing between words.

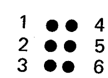

Figure 1—Braille cell dot identification

Figure 2 shows representative cell dimensions. The distance between the center of each dot is approximately $\frac{1}{10}$ inch. There are 4 cells per inch horizontally, and $2\frac{1}{2}$ lines per inch vertically. Dot height is about .020 inch.

Braille as officially approved in the United States includes several levels or grades, each level increasing in complexity with a corresponding reduction in the number of cells required. Grade I Braille provides full spelling of words and consists of the letters of the alphabet, punctuation, and a number of composition signs which are special to Braille. Figure 3 shows the basic Braille alphabet. Grade II Braille consists of Grade I plus 189 contractions in short form words and is officially known as English Braille. Grade II Braille is often compared to shorthand.

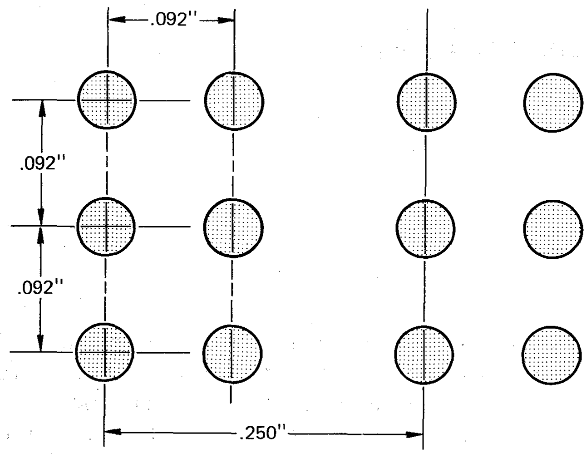

Figure 2—Braille cell dimensions

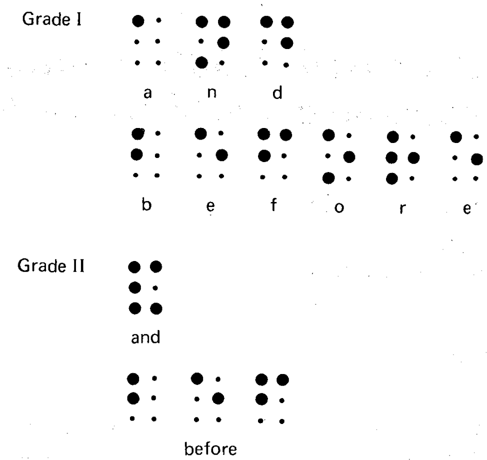

Figure 4—Word samples written in Braille

In between Grades I and II is another level of Braille which employs only 44 one-cell contractions. It is known as Grade I½. Grade III Braille is an extension of Grade II, using additional contractions and short form words and by the use of outlining (the omission of vowels). Grade III contains more than 500 contracted forms and is used mainly by individuals for their personal convenience. Several other Braille codes exist for special applications such as the writing of music and mathematics.

The majority of experienced blind readers use Grade II Braille. This is also used for most text printing because of the advantage of space saving (up to 30 percent), faster reading, and faster writing.

Grade I Braille utilizes a character-to-cell relationship. That is, each letter of a word would be reproduced as a Braille cell. This is slow reading and results in a bulky transcript. However, it is necessary to use this level of Braille for writing programs and statistics. As a point of information, there are now approximately 400 individuals who have been trained as programmers. Although handicapped, these programmers are active and productive workers in our society.

Conventional spelling is perfectly feasible in Braille and is used in some applications such as computer programming, but the more frequently used contractions are assigned their own dot configurations. Some cell combinations are used either as a whole word or part of a word or possible letter groups. In English Braille, for example, the letter "f" when alone (or adjacent to a punctuation mark, the capital sign or the italic indicator) stands for the word "from." The "ch" sign under these same conditions means "child." This method of writing is known as contracted Braille, and the characters used in this way are called Braille contractions. The method differs from regular shorthand in that by assigning actual letter group values to most

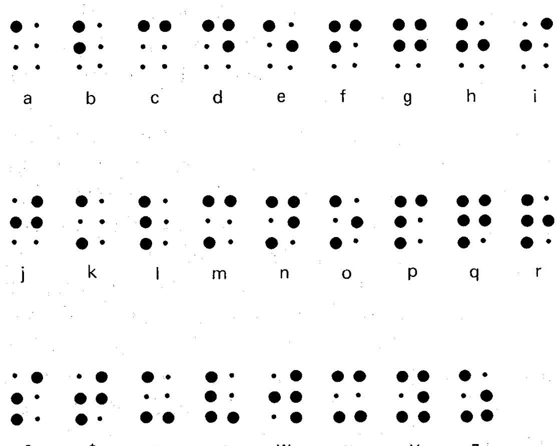

Figure 3—The English Braille alphabet

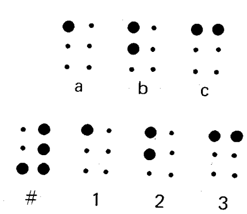

Figure 5—Use of number sign

of the contractions, conventional spelling is significantly retained in spite of the contractions.

Figure 4 gives a comparison of Grade I and Grade II Braille. Because of the many contractions used and the particular rules that apply to the hyphenation of words, the capitalizing of letters, and the displaying of numbers, it is best to consider Braille as a foreign language. It requires training, skill and practice to be a good transcriber or to write and read Braille.

Numbers are represented by using the first 10 letters of the alphabet. Figure 5 shows the "number sign" preceding the letters, the scheme for converting them to numbers. Figure 6 shows how the "capital sign" is used. A single capital sign tells the reader that the following letter is capitalized. Two consecutive capital signs indicate the entire word is capitalized. Thus, we see that interpretation of Braille is based on adjacent cells as well as the cell being read.

BRAILLE PRODUCTION

Braille documents have been produced by using a variety of devices. Some of these are reviewed here.

Braille slates

Figure 7 shows a typical Braille slate, guide and stylus. Individual cells or dot patterns are manually and singly embossed with a stylus which is guided across the writing line by a metal strip or guide. Braille embossed on a slate must be the mirrored image of the actual embossing desired, because the dots are formed on the back side of the paper. Reading the dots necessitates reversal of the paper. This is essential since the depressions cannot be felt. To make a correction, the paper is removed from the slate, and the dots are flattened with a blunt instrument or correcting tool.

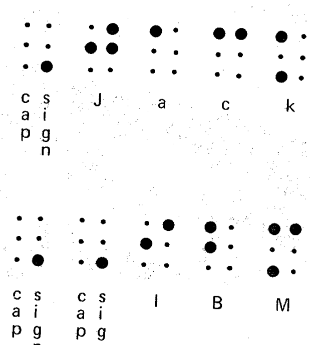

Figure 6—Use of capital sign

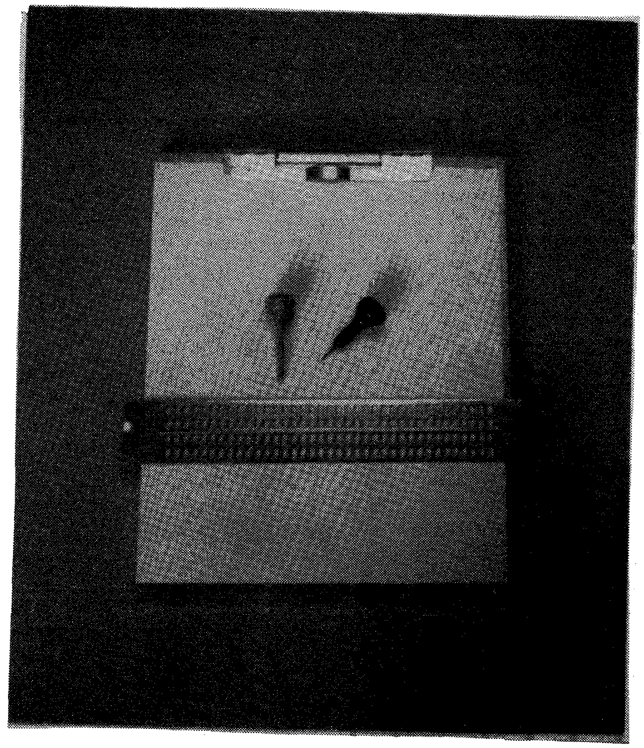

Figure 7—Braille slate

Braillewriters

These are similar to small portable typewriters. Figure 8 shows a Perkins Braillewriter made by the Howe Press Company. There is a key for each of the six possible dots. From 1 to 6 keys must be depressed

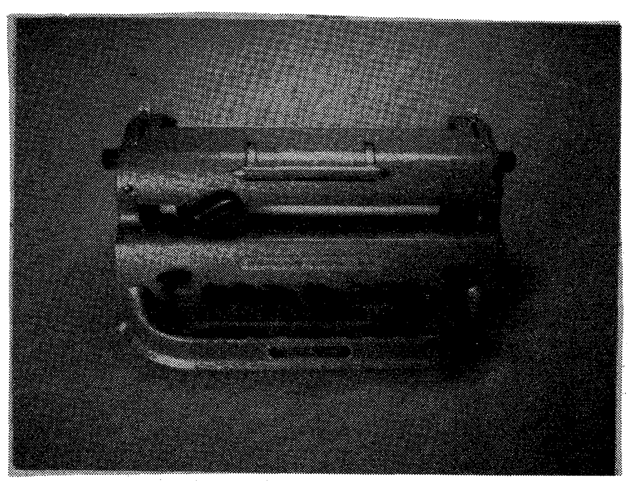

Figure 8—Perkins Braillewriter

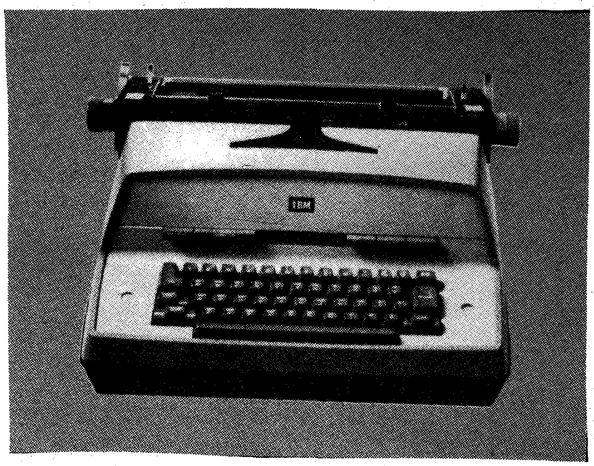

Figure 9—IBM Braille electric typewriter

simultaneously to emboss a Braille cell. The embossing usually occurs from the back of the paper so that the normal left-to-right reading is possible and the transcriber may check his work as he goes along.

Braille typewriter

Figure 9 shows an IBM Electric Braille Typewriter with a full alphabetic keyboard. The usual type faces have been replaced with dot configurations. Embossing is from the front into a rubber platen. This typewriter is easy to use because only one key is depressed at a time for any particular cell combination rather than multiple keys as on the Braillewriter.

Press braille

Where large quantities of the same material are needed, metal master plates are made on a stereotype machine such as the one shown in Figure 10, built by American Printing House for the Blind (APH). These master plates are then used on various types of presses for embossing Braille. An example of this might be the Braille edition of various magazines, periodicals, or religious books. Figure 11 shows a typical book of interpointed press Braille.

Unfortunately, due to the wide variety of textbooks used not only throughout the United States but even within one state or within a school district, it is not feasible to produce textbooks in "press" Braille. Most textbooks, school materials and the like are produced by volunteers utilizing hand or manual embossing devices. There are several Braille printing houses which attempt to fulfill the need of general-interest Braille material. The cost of producing this Braille is partially defrayed by Government agencies. Some books, magazines, and other publications are generally available from the Library of Congress.

Computer braille

Some progress has been made in the production of Braille on high-speed printers coupled to computers. Generally, a single copy is produced and has limited life, depending on the paper used and the method of embossing. (Properly embossed Braille on special paper usually lasts for 50 readings.) Embossing by impacting against a rubber platen does not produce as well a defined dot as when a metal die is used. The rubber platen tends to mushroom the dot base and limit dot height.

During the past few years, several organizations have written programs for various computers. Some of these are used regularly to produce Braille output for the blind. Printouts may be computer translated Braille from English input or conversion of computer output to simple Braille as might be used by a blind programmer.

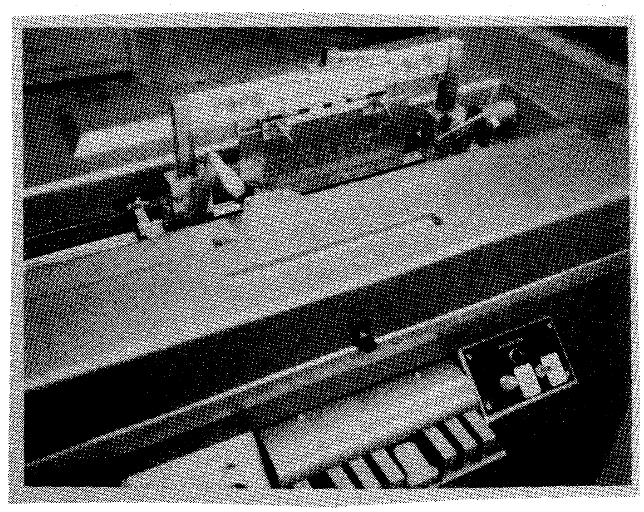

Figure 10—A Braille stereotype machine built by American Printing House for the Blind

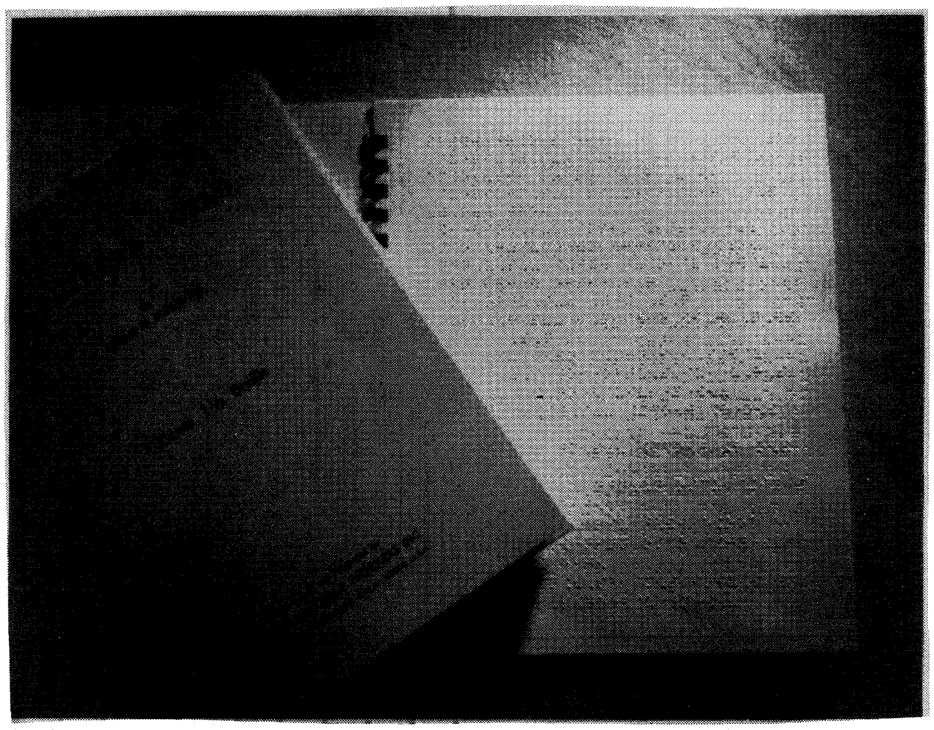

Figure 11—Braille book

PROPOSED ON-LINE BRAILLE TERMINAL SYSTEM

Description

Figure 12 shows a typical on-line terminal. Such terminals are attached by communications lines to a system to provide real-time response to various inquiries and computer assistance with mathematical problems. This capability is available now. It's a matter of using existing technologies to develop a system that will greatly improve communications and facilitate the availability of information in Braille.

The key to the proposed on-line Braille terminal system is the embossing terminal printer. This system, supported by some programming, would open "Pandora's Box" to the blind.

The terminal system should be versatile enough to operate in two modes, first as a local typewriter unit and second on-line to a computer. In the local mode the input terminal keyboard would be modified to provide the Braille function keys such as the number sign, capital sign, etc. A possible keyboard layout is shown in Figure 13. This keyboard includes all the Braille function keys, as well as the English Braille contractions. The configuration shown is used by the Lutheran Braille Workers, Inc., on their modified IBM keypunches. These automatic Braille transcribing keyboards have been used since 1956 and have proven very satisfactory.

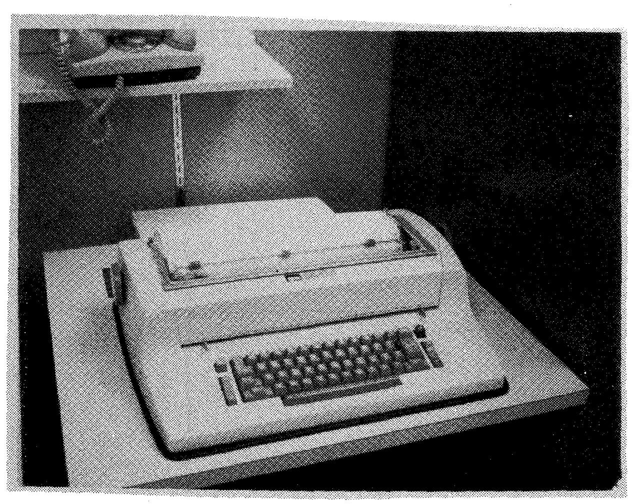

Figure 12—On-line terminal

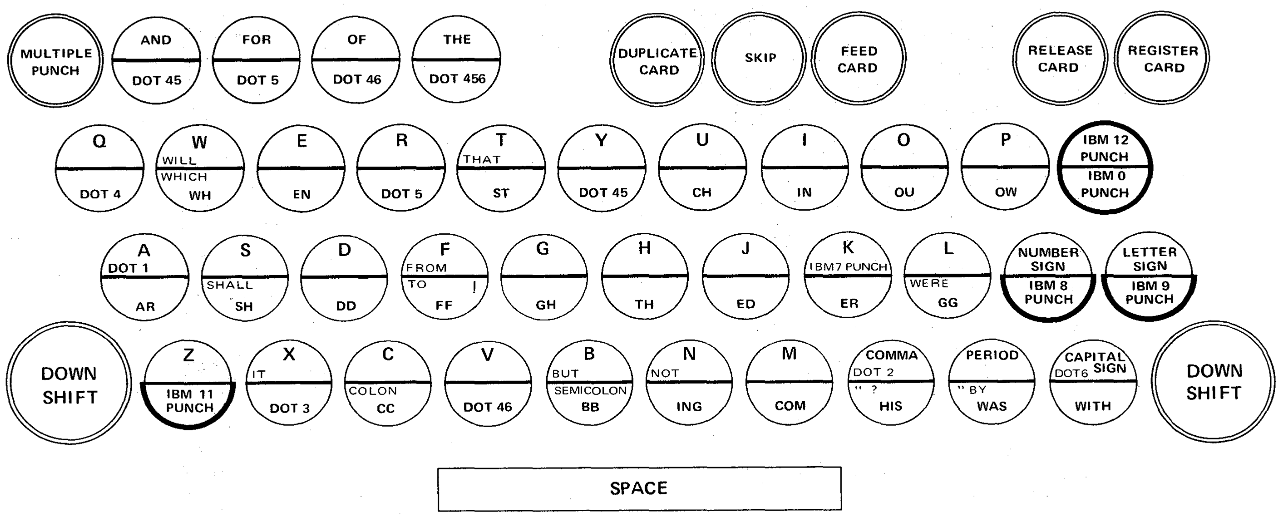

Figure 13—Automatic Braille keyboard as used on IBM keypunch

Figure 14 shows a diagram for a possible terminal system in the local mode, with the ink-print in/out terminal, encoder and a second unit for embossing Braille. Ink-print copy can be made available for the sighted and embossed copy for the blind. The embossing mechanism, having been carefully designed from a human factors standpoint, allows reading of the dots immediately after embossing without need of moving the paper. This is especially helpful to the blind person if he is interrupted while typing. It means that he can read the embossed copy to review what he has written. A metal die is used to ensure a good quality dot.

Figure 15 shows the on-line operation. When the embossing terminal is used on-line to a computer,

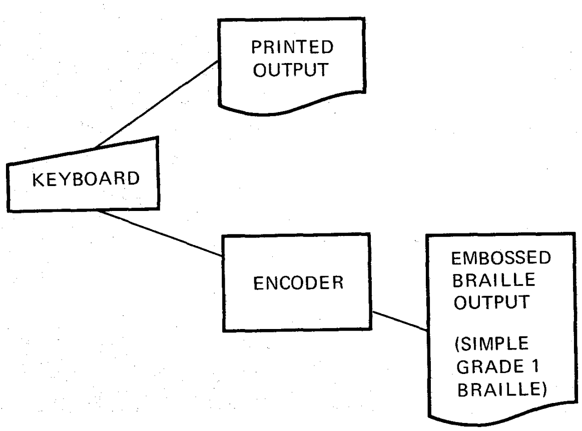

Figure 14—Proposed Braille terminal system with embosser (local mode)

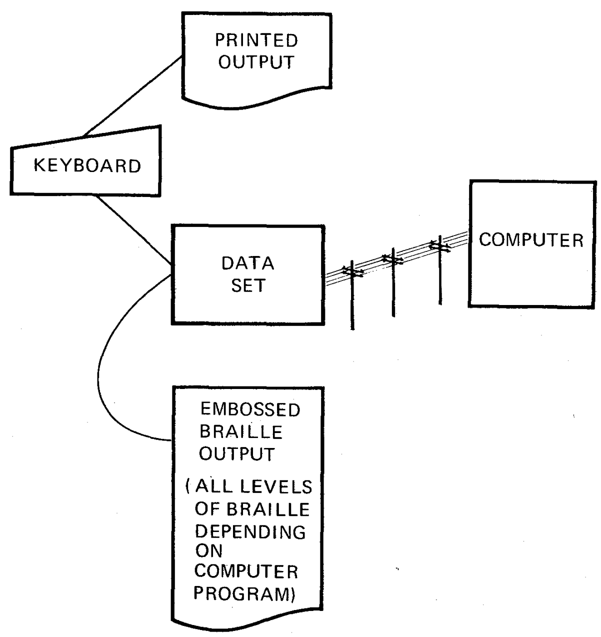

Figure 15—Proposed Braille terminal system with embosser (on-line mode)

various conversion or translating programs resident in the computer would assist the individual. These programs would convert information in various reference banks to the Braille codes.

Examples of possible system operation

Many sighted programmers use on-line terminals to write their programs and communicate directly with the computer. This speeds up the process of writing and debugging programs. The sightless programmer does not have this advantage. He does not have two-way communication with the computer. He must depend on Braille output from a high-speed printer which is usually run only once a day because certain modifications and special setups are required to print Braille. If we could provide the sightless programmer with his own embossing terminal, it would greatly increase his communication ability. To bring this about, it is necessary to take the programs that are used to provide Braille output on a high-speed printer and modify them for use on a Braille printout terminal. Providing this capability would mean many additional job opportunities for the blind.

Let us consider another example. Many school districts are now training sightless children in the classroom along with the sighted. This is an excellent arrangement in that it does not separate the handicapped child, but rather places him in society where he can participate and learn to get along with others. However, it is not an easy arrangement for the teachers, the school, or the students. Text material, handouts, and test papers must be provided in Braille for the child. The production of these various documents can at times be very awkward, inconvenient, and almost impossible.

At present it is necessary for the teacher either to know Braille and transcribe and emboss a document into Braille for that student or to enlist the aid of a volunteer to do this for him. Often there is a lack of time or availability of a trained transcriber to do this. A school district utilizing a central information bank could have much of this information available on tapes or on-line storage. When the teacher needed a copy of a particular examination, he could request it by phone and it would be provided to him, perhaps hundreds of miles away, by means of the on-line embossing terminal.

In cases where a document is not on file, the teacher could enter the text by typing it into the computer. The computer would then translate this and provide the embossed Braille on a real-time quick turnaround basis. If a terminal was used to prepare the ink-print master copy of the test, it could also be transmitted to the computer for translating. The Braille copy would then be available simultaneously with the master copy of the test for the sighted individuals. Such an arrangement would greatly aid the educational process and give the handicapped child many of the advantages and opportunities provided to the sighted.

A third example is the blind child who is limited by the number of reference books that are available for him to do his homework. He really can't afford to own a personal copy of some books. Besides being expensive, the books are voluminous, requiring much storage space. For example, a 30-volume encyclopedia used by a sighted person would equal 145 volumes of 4- to 5-inch books in Braille.

The use of a remote terminal and various data banks or information systems could solve the problem nicely. It is not hard to realize or project that a blind student could have a terminal in his home and proceed to do his homework by dialing into a data bank and inquiring about the particular subject of interest to him. Imagine the benefits to this individual if he could dial into a dictionary or an encyclopedia. What a tremendous boon to him to be able to inquire on a particular subject and have the computer respond by embossing on his remote terminal the information he is seeking.

Projecting even further we can see where a low-cost embossing terminal could be installed in the home of a sightless person for daily communication. Major newspaper items and magazine articles could all be made available from the central information bank. Individuals could receive these by means of their telephone and the Braille terminal. They could have access to many of the same articles that you and I are privileged to read.

Our last example covers handicapped individuals who have other problems in addition to blindness. They too could benefit by having a terminal in the home. Specifically, this arrangement could provide an opportunity for a new productive life. The individual, although afflicted with immobility or other difficulties, could work in his home and contribute to society. He could be employed as a programmer, communicating with the computer, developing programs, receiving his response from the computer, and enjoying two-way communication.

RESULTS OF EXPERIMENTAL MODEL

An experimental model of the proposed system was built and used for various feasibility tests. Figure 16 shows the model which consists of an ink-print terminal with an attached Braille embossing unit. Special attention was given to the human factors requirements

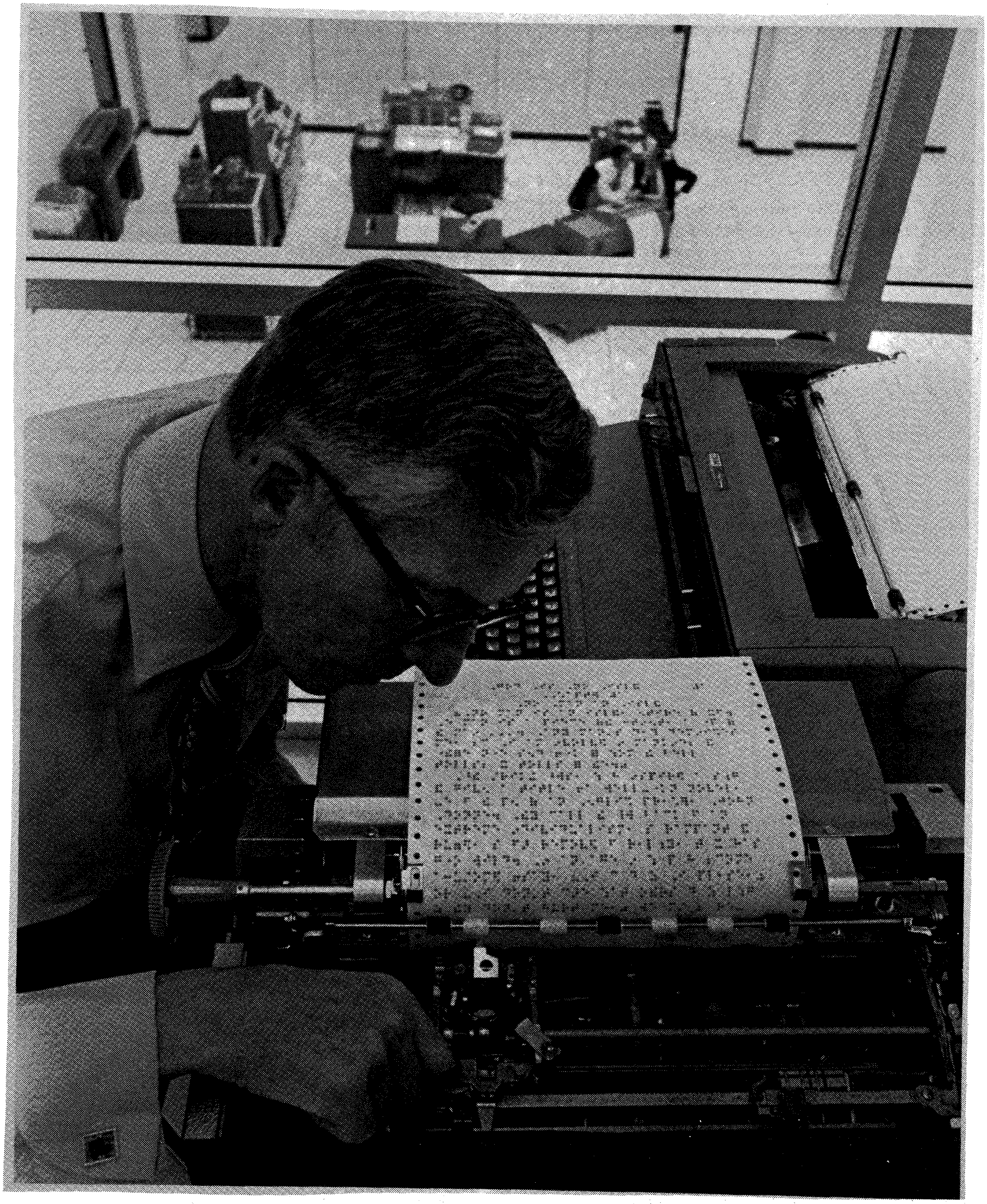

Figure 16—Feasibility model of on-line terminal with Braille embosser

during the design stage. On the basis of this study, the unit was designed and built to emboss from the rear, with the data appearing on the front side of the paper. A metal die was used to mate with the selected pins to provide positive control in forming the raised dots.

Results of the feasibility tests have been favorable. Quality of the Braille dots is good, making the symbols easy to read. Front embossing offers added convenience to the blind operator in that fingertip reading and checking are possible while the paper is in the terminal. Braille printout for the blind and conventional printout for the sighted, both from the same terminal system, allow improved speed in communicating between each other.

Our investigation and experimentation with the Braille terminal will continue. We hope to define a practical, easy-to-use, general-purpose embossing terminal. To accomplish this, we are continuing to discuss and explore the actual use of such a terminal with additional blind individuals.

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