With an impact printer,
Braille can be generated by your computer.

Braille

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This article describes a program to generate and print Braille on an impact printer that has been adjusted to make a heavy impression. To read the output, just turn the sheet over so the reversed impressions become properly oriented raised dots. This program will run on either the Level II TRS-80 or the PET with no modifications.

The Development of Braille

As most of you already know, Braille is a form of written communication for the blind. It consists of patterns of raised dots that can be felt with the fingertips. These dots represent letters, numbers and special characters.

In the early 19th century, French Army officer Charles Barbier devised a method of sending messages that could be read in the dark. The messages were coded with a series of raised dots and dashes. Barbier demonstrated his system to Louis Braille, a young Frenchman who had been blind since the age of three. Braille found Barbier's code too complicated for general use, so, at the age of 15, Braille started work on a system of his own.

Before he died at age 43 in 1852, Braille, who was a teacher of the blind, an organist and a cellist, had devised a system to represent mathematical and musical notation. He also devised a way for the blind to write in Braille by using a sliding template on the paper with a stylus to punch the dots into the paper.

The Braille Notation

Braille notation is based on a cell containing six dots. For ease of reference, the dots are numbered from 1 to 6 as follows:

1 . . 4
2 . . 5
3 . . 6

As you can see from the first row of Fig. 1, the letters a through j are formed using only the dots 1, 2, 4 and 5. The letters on the second row, k through t, are formed by adding dot three to the characters above them in the first row. The third-row letters, u, v, x, y and z, are formed by adding dot 6 to the second-row characters k, l, m, n and o. The letter w is formed independently of the rules above. (The letter w is rarely used in French, and the symbol for w was not included in Braille's original alphabet.)

The digits 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0 are formed by placing the numeral sign

● ·
● ·
· ●

in front of the pattern for the letters a, b, c, d, e, f, g, h, i or j, respectively. Similarly, capital letters are represented by placing a dot 6 before the letter symbol. Symbols for some punctuation marks are also shown in Fig. 1.

Printing Braille with a Computer

It should be obvious that Braille can be printed on a computer printer by using only the period symbol, but this would be of little use to the blind since they wouldn't be able to see the dots. A step in the right direction would be to have the printer adjusted to print a heavy impression of a dot so that it could be felt from the back of the paper. This method has a shortcoming: Turning the paper over to feel

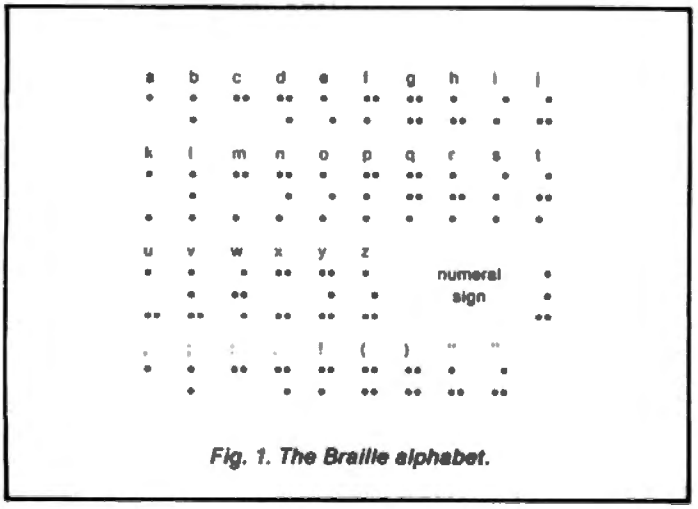

Fig. 1. The Braille alphabet.

Program listing.

```
5   DIM DA$(27,7),OT$(3)
10  DATA A,"●"," "," "," "," "," "
20  DATA B,"●","●"," "," "," "," "
30  DATA C,"●","  "," "," ","●"," "
40  DATA D,"●","  "," "," ","●","●"
50  DATA E,"●","  "," "," "," ","●"
60  DATA F,"●","●"," "," ","●"," "
70  DATA G,"●","●"," "," ","●","●"
80  DATA H,"●","●"," "," "," ","●"
90  DATA I," ","●","●"," ","●"," "
100 DATA J," ","●","●"," ","●","●"
110 DATA K,"●","  "," ","●"," "," "
120 DATA L,"●","●"," ","●"," "," "
130 DATA M,"●","  ","●","●"," "," "
140 DATA N,"●","  ","●","●","●"," "
150 DATA O,"●","  "," ","●","●"," "
160 DATA P,"●","●","●","●"," "," "
170 DATA Q,"●","●","●","●","●"," "
180 DATA R,"●","●"," ","●"," "," "
190 DATA S," ","●","●","●","●"," "
200 DATA T," ","●","●","●","●","●"
210 DATA U,"●","  "," ","●"," ","●"
220 DATA V,"●","●"," ","●"," ","●"
230 DATA W," ","●","●"," ","●","●"
240 DATA X,"●","  ","●","●"," ","●"
250 DATA Y,"●","  ","●","●","●","●"
260 DATA Z,"●","  "," ","●"," ","●"
270 DATA"  "," "," "," "," "," "
500 FORI = 1TO27:FORJ = 1TO7:READDA$(I,J):NEXTJ:NEXTI
```

```
544  OTS = (1) = " ":OTS(2) = " ":OTS(3) = " "
550  PRINT "ENTER CHARACTER STRING. NO MORE THAN 13 CHARACTERS
     "
560  INPUT TXS
570  J = LEN(TXS)
580  IF J>13 THEN TXS = LEFTS(TXS,13)
590  L = 1
600  FOR I = 1 TO 27
610  IF MIDS(TXS,L,1) = DAS(I,1) THEN 630
620  NEXT I
625  PRINT "ILLEGAL CHARACTERS ":GOTO 544
630  OTS(1) = DAS(I,2) + OTS(1)
640  OTS(2) = DAS(I,3) + OTS(2)
650  OTS(3) = DAS(I,4) + OTS(3)
660  OTS(1) = DAS(I,5) + OTS(1)
670  OTS(2) = DAS(I,6) + OTS(2)
680  OTS(3) = DAS(I,7) + OTS(3)
690  OTS(1) = " " + OTS(1)
700  OTS(2) = " " + OTS(2)
710  OTS(3) = " " + OTS(3)
720  L = L + 1
730  IFL>LEN(TXS)THEN 760
740  GOTO 600
760  PRINT OTS(1)
770  PRINT OTS(2)
780  PRINT OTS(3)
785  PRINT
790  PRINT"MORE? ENTER A Y OR N ";
800  INPUT ANS: IF ANS = "Y" THEN 544
810  STOP
```

the raised dots would make the text backwards. We can correct this by *printing* the Braille backwards, so that when the paper is turned over, it will read correctly from left to right.

That's the method that this program uses. Braille text entered with INPUT statements is converted to reversed Braille and printed. An impact printer must be used for this application so that the pressure can be set to make tangible indentations in the paper. A character printer would probably give better results than a dot matrix printer, but you can try whatever you have.

The Program

This program is offered only as an example of what can be done. As written here, it is only capable of converting to Braille the 26 letters of the alphabet and the space character and printing them in reverse on the video screen. You can add more characters by using more DATA statements and changing the number 27 in lines 5, 500 and 600 to the new number of characters.

Since it takes seven characters to represent each character in the table, you will soon run up against the PET limit of 255 for a maximum subscript value. You can break the data up into two or more arrays and modify the search routine.

The 13s in lines 550 and 580 are necessary because of the screen width restriction on the PET. The numbers can be changed to 21 on the TRS-80 and to an even larger number if the Braille text is sent to a printer. Each Braille character requires three print positions, two for the character and one for the space between characters.

An example of backward Braille, the letters a through m, is shown in Fig. 2. If you wish to demonstrate this program printing regular, nonreversed Braille, just reverse the order of the operands on the right side of the equations in lines 630 to 710. For example, change line 630 to

```
OTS(1) = OTS(1) + DAS(I,2)
```

This program is simple to run. Just type RUN and enter the character string that you want to convert when you're prompted for it. TRS-80 users will have to use the CLEAR command to reserve some string space.

Extensions

There is a lot of room for experimentation with this method, and this program is only presented as a starting place. For example, it should be relatively easy to connect a printer and a typewriter in conjunction with a keyboard and a microcomputer so that a blind person could type a document for a class or company while at the same time generating a Braille copy for his own records.

This program could also be changed to print forward as described above, and the printed output can be used as input to a scanning device, which could create embossed output.

Although I agree that it's fun to hunt the Wumpus or land your simulated rocket on the moon, there's no reason that more useful things can't be done with microcomputers. I hope this program will help someone take a step in that direction.■

Fig. 2. The letters a through m printed in reverse.