

# A System for Converting Print into Braille

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**Abstract**—This paper describes a method for converting text into braille, in the form in which it is stored as in a computer. The system has been designed to be configurable for a wide range of languages and character sets, and uses a predominantly table driven method to achieve this. The algorithm is explained in the context of the conversion of text into Standard English Braille (British), and the tables for this transformation are given. Particular importance has been attached to enabling braille specialists, who are not experts in computer algorithms, to be able to modify the system for either slight modifications to an existing braille code translator, or for producing a braille code translator for a new language.

**Index Terms**— Assistive technology, blindness, braille, code transition.

## I. INTRODUCTION

THE production of braille using computers is now well established, and there have been a number of methods employed to achieve this, particularly for American English Braille. However, it has been noted that there is a need for the “Development of computer software which is easily adapted for translating text to contracted braille for languages such as Hindi and Portuguese” [1, p. 30], and one of the major goals of the work reported here has been to address this need. A further goal has been to devise a system that can be readily updated and modified, by people who are not experts in computer algorithms, in order to reflect changes/enhancements to the braille rules of a given language. Many earlier systems, although effective translators, have proved difficult to modify for either such minor changes or for new languages.

Although this system has been designed to cope with a large number of different languages, it is discussed here in the context of the conversion of text into Standard English Braille (British). The use of Standard English Braille is for a number of reasons: the system is complex enough to fully illustrate the capabilities of this system; the structuring of the rules will provide a base for braille transcribers of other languages to copy; and, as far as the author is aware, a text to braille algorithm for Standard English Braille is not in the public domain.

This conversion utility is part of a more general system concerned with the translation of a wide range of codes used

1	○	○	4
2	●	●	5
3	○	●	6

Fig. 1. A “context specific” braille cell.

by disabled people, including the reverse translation to the one described here, i.e., braille into text [2].

## II. THE BRAILLE SYSTEM

The braille code has become the main system for the majority of those blind people who read and write using tactile means, and can be found in many countries around the world. The characteristics of braille have been described elsewhere [2], however, it is worth summarizing the main features briefly.

Braille uses raised dots in groups of six which are arranged in three rows of two. These six positions, which can be raised or flat, are used in combination to give just 64 different braille “characters.” This clearly means that there cannot be a one to one correspondence between braille characters and text. In the simplest commonly used form, called Grade 1 braille, the lower case letters A–Z and the major punctuation symbols are represented by a single braille character, with “shift” characters being used to indicate other information such as upper case, digits, and italics. A number of countries have adopted a coding method, called Grade 2 braille or contracted braille. This further complicates the Grade 1 code by introducing, in a manner which is often specific to individual countries [3], context sensitive rules for the contraction of words and frequently used letter groups. These rules determine the correspondence between one or more braille cells and the print, so, for example, in Standard English Braille the braille symbol in Fig. 1 can stand for “dis” when used at the start of a word (distance); “dd” when used in the middle of a word (ladder); or a period when used at the end of a word (stop.).

Other rules can further complicate matters by insisting that the translation is not allowed across syllable boundaries. For example, “here” will be contracted in “hereafter,” but not in “Hereford” where the “er” and “for” are contracted. In addition, a “letter sign” is used in braille to clarify when a single braille character represents a single print letter. It is worth noting that the application of the syllabification rules

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TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

1	#[,3]= 'C	-	1	#[.5]=1E	-
1	#[,4]= 'D	-	1	#[.6]=1F	-
1	#[,5]= 'E	-	1	#[.7]=1G	-
1	#[,6]= 'F	-	1	#[.8]=1H	-
1	#[,7]= 'G	-	1	#[.9]=1I	-
1	#[,8]= 'H	-	1	[.0]=#1J	-
1	#[,9]= 'I	-	1	[.1]=#1A	-
1	[,]=#'	-	1	[.2]=#1B	-
1	[,]=1	-	1	[.3]=#1C	-
5	[,]=,	-	1	[.4]=#1D	-
2	[-T]O--=T	-	1	[.5]=#1E	-
2	[-ING]--=+	-	1	[.6]=#1F	-
2	[-IN]--=-9	-	1	[.7]=#1G	-
2	[-C]OM=-C	-	1	[.8]=#1H	-
2	[-BY]--=BY	-	1	[.9]=#1I	-
2	[--INTO ]=--}96	-	1	[.]#=#1	-
2	[--IN]--=-9	-	1	[.]~=#4	-
2	[--C]OM--=-C	-	1	[.]=#4	-
1	! [----]=-----	-	5	[.]=#	-
1	[--]~=-	-	2	[/SUB ]=#*	-
1	[--]=-	-	2	[/SUP ]=#+	-
1	#[-0]=-J	-	1	[/]+/'=#	-
1	#[-1]=-A	-	1	/+[/]=	-
1	#[-2]=-B	-	1	~/[/]#=#;4	-
1	#[-3]=-C	-	1	[/]=/	-
1	#[-4]=-D	-	5	[/]=/	-
1	#[-5]=-E	-	1	#[0]=J	-
1	#[-6]=-F	-	1	[0]=#J	-
1	#[-7]=-G	-	5	[0]=0	-
1	#[-8]=-H	-	2	#[1ST]=A/	-
1	#[-9]=-I	-	2	[1ST]=#A/	-
1	[-]=-	-	1	#[1]=A	-
5	[-]=-	-	1	[1]=#A	-
1	[.] =4	-	5	[1]=1	-
1	[...] ='''4	-	1	#[2]=B	-
1	[...] ='''0'	-	1	[2]=#B	-
1	[...] ='''0	-	5	[2]=2	-
1	[...] ='''	-	1	#[3]=C	-
1	[.] +, ' =	-	1	[3]=#C	-
1	.+ [.] =	-	5	[3]=3	-
1	#[.]## A.M.=	-	1	#[4]=D	-
1	#[.]## P.M.=	-	1	[4]=#D	-
1	#[.0]=1J	-	5	[4]=4	-
1	#[.1]=1A	-	1	#[5]=E	-
1	#[.2]=1B	-	1	[5]=#E	-
1	#[.3]=1C	-	5	[5]=5	-
1	#[.4]=1D	-	1	#[6]=F	-
			1	[6]=#F	-

<sup>5</sup> Look for multiple periods to deal with dates of the form 12.2.89.

<sup>6</sup> Rule to deal with dates of the form 12/2/89.

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

5	[6]=6	-	2	[AND]=&	-
1	#[7]=G	-	2	~[ANTEA]TER=ANT1	-
1	[7]=#G	-	2	[ANTEN]NA=ANT5	-
5	[7]=7	-	2	[ANTER]IOR=ANT7	-
1	#[8]=H	-	2	~[ANTE]=ANTE	-
1	[8]=#H	-	2	[ANTIN]OM=ANT9	-
5	[8]=8	-	2	~[ANTI]=ANTI	-
1	#[9]=I	-	2	![ANCE]=.E	-
1	[9]=#I	-	2	[ANEMONE]=ANEMONE	-
5	[9]=9	-	2	![ATION]=.N	-
1	[:]#'=	-	2	~[AS]~=#Z	-
1	[:]#3	-	2	[ABOUT]=AB	-
5	[:]#:	-	2	[ABOVE]=ABV	-
1	[;]=2	-	2	[AGAIN]=AG	-
5	[;]=5	-	2	[AFTERNOON]=AFN	-
1	[<]=8	-	2	[AFTERWARD]=AFW	-
5	[<]=<	-	2	~[AFTER]E=AFT	-
2	~[T-SH]IRT=#;T-SHI	-	2	~[AFTER]I=AFTI	-
2	[#]!#;	3	2	[AFTER]=AF	-
1	[#]!#;	4	2	![ALLY]=.Y	-
1	[#]!#;8	-	2	~[ALWAYS]~=#ALW	-
5	[#]!#	-	2	~[ALSO]~=#AL	-
1	[>]=0	-	2	~[ALMOST]~=#ALM	-
1	[>]=>	-	2	~[ALREADY]~=#ALR	-
1	[?]=8	-	2	~[ALTHOUGH]~=#AL?	-
5	[?]=?	-	2	~[ALTOGETHER]=ALT	-
2	[@EN]=@EN	-	2	~[ACROSS]~=#ACR	-
2	[@ER]=@ER	-	2	~[ACCORDING]=AC	-
2	[@ED]!#@ED	-	2	[AUND]ER=AUND	-
2	[@O]NG=@O	-	2	[AINES]S=A9ES	-
2	[@AR]=@AR	-	2	![AED]~=#A\$	-
1	[@]=@	-	2	[AE]D=AE	-
5	[@]=@	-	2	[AE]A=AE	-
2	~[A];#=#;A	3	2	[AERO]=AJO	-
2	#[A]'=#;A	3	2	![AER]=AER	-
1	~[A];#=#;A	4	2	~[AENE]AS=AENE	-
1	#[A]'=#;A	4	2	[AE]N=AE	-
2	[ARIGHT]=A"R	-	1	[A]=A	-
2	[AR]=>	-	5	[A]=A	-
2	~[AND]THE~=#&	-	2	~[B];#=#;B	3
2	~[AND]A~=#&	-	2	#[B];#=#;B	3
2	~[AND]OF~=#&	-	1	~[B];#=#;B	4
2	~[AND]WITH~=#&	-	1	#[B];#=#;B	4
2	~[AND]FOR~=#&	-	2	[BRO']=#BRO'	-
			2	~[BUT]~=#B	-
			2	[BBLE]=B#	-
			2	![BB]!#=2	-
			2	[BE] =2	-
			2	~[BEATI]F=2ATI	-
			2	~[BEATI]T=2ATI	-

<sup>7</sup> Leave the digit rules to put the hash in for the number.

<sup>8</sup> First letter in the work with a number later, so use a letter sign.

<sup>9</sup> Letter directly after a number, so insert a letter sign.

IV. THIS SYSTEM

The general purpose system, of which this text to braille system is a special case, has been developed to operate with a finite number of states which can hold the current context, as well as having capabilities for both left and right context matching. The system has been designed so that a wide range of options and data can be input using a set of tables, including braille rules, which are presented in a clear manner.

In the application of this system to the conversion of braille into print [2], the approach taken was predominantly to use the state machine and right context matching capabilities of this system to achieve the translation. However, as noted above, the updates of tables for a state machine requires a good deal of care and a detailed understanding of the system's

operation. The use of context matching rules is much more straightforward and easier to understand. Consequently, the print to braille application has been constructed so that the bulk of the translation is achieved by using context specific rules. The state engine is only used for switching between grades of braille (i.e., Grade 1, Grade 2, and Computer Braille), and for handling letter signs. These state rules should easily transfer into other languages, in many cases without any modification.

The algorithm used for the conversion can be found in the Appendix. Table I shows the decision table used for the conversion of text into Standard English Braille.

Note: A nonzero value in the decision table indicates that a rule should "fire" for a given input class and current state. A value of zero indicates that the rule should not "fire."

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	~[B]EA=B	-	2	~{BERYL}=B}YL	-
2	~{BECAUSE}=2C	-	2	~{BER}BECK=B}	-
2	~{BECK}=BECK	-	2	~{BE}R=2	-
2	~{BEC}=2C	-	2	~{BESIDE}=2S	-
2	~{BED}A=2D	-	2	~{BESS}=BESS	-
2	~{BED}E=2D	-	2	~{BESTEA}D=BE/1	-
2	~{BED}I=2D	-	2	~{BESTI}A=BE/I	-
2	~{BEDRA}G=2DRA	-	2	~{BESTING}=BE/+	-
2	~{BED}B=\$	-	2	~{BESTI}=2/I	-
2	~{BEET}HOVEN=BEET	-	2	~{BEST}O=2/	-
2	~{BE}E=BE	-	2	~{BESTR}=2/R	-
2	~{BEFORE}=2F	-	2	~{BEST}=BE/	-
2	~{BE}F=2	-	2	~{BE}S=2	-
2	~{BEG}A=2G	-	2	~{BET}A=2T	-
2	~{BEG}E=2G	-	2	~{BETEL}=2TEL	-
2	~{BEG}I=2G	-	2	~{BETH}I=2?	-
2	~{BEG}O=2G	-	2	~{BETH}O=2?	-
2	~{BEG}R=2G	-	2	~{BET}I=2T	-
2	~{BEG}U=2G	-	2	~{BET}O=2T	-
2	~{BE}G=BE	-	2	~{BETR}=2TR	-
2	~{BEHIND}=2H	-	2	~{BETWEEN}=2T	-
2	~{BEH}=2H	-	2	~{BETW}=2TW	-
2	~{BEING}=2+	-	2	~{BEW}=2W	-
2	~{BEIN'}=2IN'	-	2	~{BEYOND}=2Y	-
2	~{BE}I=BE	-	2	~{BEZ}=2Z	-
2	~{BEJ}=2J	-	2	~{BE'}=2'	-
2	~{BEL}A=2L	-	2	[BLESS]=B.S	-
2	~{BEL}E=2L	-	2	[BLIND]=BL	-
2	~{BEL}LI=2	-	2	[BLEED]=BLE\$	-
2	~{BELOW}=2L	-	2	! [BLEAU]=BL1U	-
2	~{BEL}O=2L	-	2	! [BLE]=#	-
2	~{BEL}Y=2L	-	2	[BLIN]DE=BL9	-
2	~{BE}L=BE	-	2	[BLIN]DI=BL9	-
2	~{BE}M=2	-	2	[BLIND]=BL	-
2	~{BENEATH}=2N	-	2	~{BLUE}=BLUE	-
2	~{BEN}IGN=B5	-	2	~{BY AND BY}~BY & BY	-
2	~{BEN}I=2N	-	2	~{BY AND} =BY &	-
2	~{BEN}U=2N	-	2	~{BY} AT =BY	-
2	~{BEN}=B5	-	2	~{BY BUT} =BY B	-
2	~{BEQU}=2QU	-	2	~{BY IN} =BY 9	-
2	~{BERET}=B}ET	-	2	~{BY} ON =BY	-
2	~{BERG}=B}G	-	2	~{BY THE B}Y=0! B	-
2	~{BERK}=B}K	-	2	~{BY} TO =BY	-
2	~{BERL}=B}L	-	2	~{BY} WAS =BY	-
2	~{BERM}=B}M	-	2	~{BY} WITH~BY	-
2	~{BERN}=B}N	-	2	~{BY} WITHOUT=BY	-
2	~{BERR}=B}R	-	2	~{BY HIS} =OHIS	-
2	~{BERS}=B}S	-	2	~{BY ENOUGH}=05\<	-
2	~{BER}T=B}	-	2	~{BY} =]==0	-
2	~{BER}W=B}	-	2	~{BY} ]!=0	-

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	~{BY}#=0	-	1	[C].-=C	-
2	[BRAILLE]=BRL	-	1	. [C]=C	-
1	[B].~ <sup>10</sup> =B	-	1	[C]!.!=C	-
1	. [B] <sup>11</sup> =B	-	1	~[C]~-=;C	-
1	[B].! <sup>12</sup> =B	-	1	[C]=C	-
1	~[B]~ <sup>13</sup> =;B	-	5	[C]=C	-
1	[B]=B	-	2	~[D];#=#;D	3
5	[B]=B	-	2	# [D]=;D	3
2	~[C];#=#;C	3	1	~[D];#=#;D	4
2	# [C]=;C	3	1	# [D]=;D	4
1	~[C];#=#;C	4	2	[D'YOU]=D'Y\	-
1	# [C]=;C	4	2	~[DAFT]ER=DAFT	-
2	[CHILDREN]=*N	-	2	[DAY]="D	-
2	~[CHILD]~=*	-	2	~[DO'] =DO@	-
2	[CHARACTER]=**	-	2	~[DO]~=-D	-
2	[CHRISTO]=*	-	2	~[DIS]HEA=4	-
2	[CHRIST]="C	-	2	~[DIS]HA=4	-
2	[CH]=*	-	2	~[DIS]HO=4	-
2	~[COMIN'] =-IN'	-	2	~[DISH]=DI%	-
2	~[COMMON]EST=-MON	-	2	~[DISK]S=DISK	-
2	~[COM] !=-	-	2	~[DISK]~=-DISK	-
2	~[C]ONE=C	-	2	~[DISC]S~=-DISC	-
2	~[CONO]=CONO	-	2	~[DISC]~=-DISC	-
2	~[CON]NED=CON	-	2	[DISPIRIT]=DI_S	-
2	~[CO]NA=CO	-	2	~[DI]SULPH=DI	-
2	[CONY]=CONY	-	2	~[DIS] !=4	-
2	~[CONKER]=3K	-	2	~[DINGH]=D9<	-
2	[CONK]=CONK	-	2	! [DDAU]GHTER=DDAU	-
2	~[CONCEIVING]=3CVG	-	2	[DDAY]=D"D	-
2	~[CONCEIVE]=3CV	-	2	! [DD] !=4	-
2	~[CONCH]~=-CON*	-	2	[DECEIVE]=DCV	-
2	~[CONS]~=-CONS	-	2	[DECEIVING]=DCVG	-
2	~[CON] !=3	-	2	[DECLARING]=DCLG	-
2	[COULD]=CD	-	2	[DECLARE]=DCL	-
2	[COEN]ZYME=CO5	-	2	~[DE]NAT=DE	-
2	[CANNOT]=_C	-	2	~[DESH]ABILLE=DESH	-
2	~[CAN]~=-C	-	2	[DEAW]=DEAW	-
2	~[CATI]ON=CATI	-	2	~[DEAC]T=DEAC	-
2	~[CENT]=C5T	-	1	[D].-=D	-
2	[CCH]=C*C	-	1	. [D]=D	-
2	! [CC] !=3	-	1	[D]!.!=D	-
			1	~[D]~=-;D	-
			1	[D]=D	-
			5	[D]=D	-
			2	~[E];#=#;E	3
			2	# [E]=;E	3
			1	~[E];#=#;E	4
			1	# [E]=;E	4
			2	[ENOUGH] =5	-
			2	! [EDISH]=EDI%	-

<sup>10</sup> The B is probably an initial so don't insert a letter sign. This rule will introduce an error in the braille if the letter B as isolated and required a letter sign.

<sup>11</sup> Letter following a period, so probably part of an abbreviation.

<sup>12</sup> Letter before a period that is before another letter, so probably part of an abbreviation.

<sup>13</sup> Isolated letter, so probably needs a letter sign.

## V. RESULTS

The rules for the transcription of Standard English Braille are listed in Table II. Where rules have been developed to deal with special cases such as letter signs, dates, etc., an explanation is given in a footnote.

### Notes:

- The format of the rules in Table II is

Input class <TAB> rule <TAB> new\_state.

If the new\_state is “-” then no change occurs in the current state. The input class is set for each rule and is used in conjunction with the decision table to set the level of braille (i.e., Grade 2, Grade 1, or Computer Braille), and for letter sign placement in words that mix letters and

numbers. The rule is in the format as follows:

left\_context[focus]right\_context = input\_text.

Several wildcards can be used in the left\_context and the right\_context. These are as follows:

- “!” a letter;
- “#” a number;
- “~” a space or punctuation (include apostrophe);
- “ ” only a space character;
- “|” zero or more capital signs;<sup>1</sup>
- “” one or more characters that are potentially roman numerals;

<sup>1</sup>The automatic introduction of capital symbols (for some languages) is not dealt with by this system. However, this is a fairly simple task and could be carried out by a suitable preprocessing stage.

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	!	[ED]OOM=ED	-	2	~	[F];#=#;F	3				
2	!	[ED]OVE=ED	-	2	#	[F]=;F	3				
2	!	[ED]OWN=ED	-	1	~	[F];#=#;F	4				
2	!	[ED]EEP=ED	-	1	#	[F]=;F	4				
2	!	[ED]REAM=ED	-	2	~	[FOR ]THE~==	-				
2	!	[ED]ROP=ED	-	2	~	[FOR ]A~==	-				
2	!	[ED]RUM=ED	-	2	~	[FOREVER]== "E	-				
2	!	[EDD]FO=E4	-	2	~	[FOR]ENS==	-				
2	!	[EDAL]E=EDAL	-	2	~	[FORE]==E	-				
2	[E]	= \$	-	2	{	[FOR]==	-				
2	[EDREAG]H=ER1<	-	2	[FRUI]T=FRUI	-	2	[FRUI]T=FRUI				
2	[EROO]M=EROO	-	2	[FRIEN]DE=FRIS	-	2	[FRIEN]DE=FRIS				
2	[ER]=]	-	2	[FRIEN]DI=FRIS	-	2	[FRIEN]DI=FRIS				
2	[ELECTRO]=ELECTRO	-	2	[FRIEND]=FR	-	2	[FRIEND]IAN=HADR				
2	[E]NAME=E	-	2	~	[FROM]~ =F	-	2	~	[HAD]=_H		
2	[ENCED]=5C\$	-	2	[FIRST]=F/	-	2	~	[HAVE]~ =H			
2	[NCEA]=5C1	-	2	~	[FIAN]C !=FIAN	-	2	~	[HIMSELF]=HMF		
2	[NCER]=5C	-	2	[PLEAR]IDD=FL1R	-	2	~	[HIM]~ =HM			
2	!	[ENCE]=;E	-	2	!	[FULLE]=;LLE	-	2	[HEDGE]ROW=H\$GE		
2	[ENESS]=E;S	-	2	!	[FULLY]=;LLY	-	2	[HER]ESY=H			
2	!	[ENOO]K=ENOO	-	2	!	[FULL]=FULL	-	2	[HERI]SI=H]E		
2	~	[ENOUGH'S]=5'S	-	2	!	[FUL]=;L	-	2	[HERE]TI=H]E		
2	~	[EN]~ =EN	-	2	[FFOR]=F=	-	2	[HERE]R=H]]			
2	[EN]=5	-	2	!	[FF]!=6	-	2	[HER]EN=H			
2	!	[EAR]=E>	-	2	[FATHER]= "F	-	2	[HER]ED=H			
2	!	[EALLY]=E, Y	-	2	~	[FAERY]=FA]Y	-	2	[HER]EF=H		
2	!	[EALO]GY=EALO	-	1	[F].~ =F	-	2	[HERE]= "H			
2	!	[EADE]~ =EADE	-	1	. [F]=F	-	2	~	[HERSELF]=H]F		
2	!	[EADD]=LDD	-	1	[F].! =F	-	2	[HYDRO]=HYDRO	-		
2	!	[EAX]=EAX	-	1	~	[F]~ =;F	-	2	~	[HM]~ =H'M	
2	!	[EAPP]=EAPP	-	1	[F]=F	-	1	[H].~ =H	-		
2	!	[EANCE]=E.E	-	5	[F]=F	-	1	. [H]=H	-		
2	!	[EAND]=E&	-	2	~	[G];#=#;G	3	1	[H].! =H	-	
2	!	[EATION]=E,N	-	2	#	[G]=;G	3	1	~	[H]~ =;H	
2	!	[E]AWAY=E	-	1	~	[G];#=#;G	4	1	[H]=H	-	
2	!	[EA] !=1	-	1	#	[G]=;G	4	5	[H]=H	-	
2	[EVER]=EEV	-	2	!	[GHAI]=GHAI	-	2	~	[I];#=#;I	3	
2	~	[EVERY]~ =E	-	2	!	[GHEAD]=GH1D	-	2	#	[I]=;I	3
2	~	[EVERTO]N="ETO	-	2	!	[GHEAP]=GH1P	-	1	~	[I];#=#;I	4
2	~	[EVERT]=EV]T	-	2	!	[GHIL]=GHIL	-	1	#	[I]=;I	4
2	[EVERD]I~ =EV]D	-	2	!	[GHOL]E=GHOL	-	2		[IN]=9	-	
2	[EVER]="E	-	2	!	[GHOR]N=GHOR	-	2	~	[INTO] AND =9TO	-	
2	[EITHER]=EI	-	2	!	[GHOUS]E=GHVS	-	2	~	[INTO] AT =9TO	-	
2	[ETHER]E=E!R	-	2	!	[GHUN]T=GHUN	-	2	~	[INTO] BUT =9TO	-	
2	[E].~ =E	-	2	[GH]=<	-	2	~	[INTO] IF =9TO	-		
1	. [E]=E	-	2	[GOOD]=GD	-	2	~	[INTO] IN =9TO	-		
1	[E].! =E	-	2	[GOVERN]ESS=GOV]N	-	2	~	[INTO] IS =9TO	-		
1	~	[E]~ =;E	-	2	~	[GO]~ =G	-	2	~	[INTO] WAS =9TO	
1	[E]=E	-	2	!	[GG]!=7	-	2	~	[INTO] WHEN =9TO	-	
1	[E]=E	-	2	[GREAT]=GRT	-	2	~	[INTO] FOR =9TO	-		

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	~	[INTO] OF =9TO	-
2	~	[INTO] OR =9TO	-
2	~	[INTO] TO =9TO	-
2	~	[INTO HI]S =96HI	-
2	~	[INTO ENOU]GH=965\	-
2	~	[INTO ]_ =96	-
2	~	[INTO ] !=96	-
2	~	[INTO ]# =96	-
2	[INDIA]RUB=9DIA	-	
2	!	[INGRA]=9GRA	-
2	!	[ING]=+	-
2	!	[INESS]=I;S	-
2	~	[IN] !=9	-
2	~	[IN] !=IN	-
2	~	[IN] ~ =IN	-
2	!	[IN]=9	-
2	[IN] !=9	-	
2	!	[ITY]=;Y	-
2	~	[ITSELF]~ =XF	-
2	~	[ITS]~ =XS	-
2	~	[IT]~ =X	-
2	[IRRE]VERS=IRRE	-	
2	[IEVER]=IEV	-	
2	[IETN]AMESE=IETN	-	
2	~	[IMMEDIATE]=IMM	-
2	[IO]NE=IO	-	
2	~	[ISOM]ER=ISOM	-
1	[IV]~ =;IV	-	
1	[II]~ =;II	-	
1	[III]~ =;III	-	
1	[I]=I	-	
5	[I]=I	-	
2	~	[J];#=#;J	3
2	#	[J]=;J	3
1	~	[J];#=#;J	4
1	#	[J]=;J	4
2	~	[JUST]~ =J	-
1	[J].~ =J	-	
1	. [J]=J	-	
1	[J].! =J	-	
1	~	[J]~ =;J	-
1	[J]=J	-	
5	[J]=J	-	
2	#	[K];#=#;K	3
1	~	[K];#=#;K	4
1	#	[K]=;K	4
2	~	[KNOWLEDGE]~ =K	-
2	[KNOW]="K	-	
2	~	[KILO]=KILO	-

“;” zero or more letters;  
“+” one or more digits.

- Any characters which are not in the tables go through the system and result in the new\_state being set to one.
- The system used to represent the braille characters in ASCII format is American Computer Braille.

To illustrate how these rules work, the words “hear” is considered. The braille equivalent is shown in Fig. 2. In American Computer Braille the word is: HE>

The main points involved in its translation are now detailed:

It is assumed that the current state is 1, i.e., Grade 2 braille. The system will search through the tables starting with the entry: 2 ~[H]; #=#; H 3. The focus matches for [H] and so the state is checked for input\_class 2

and current\_state 1. The decision table has a 1 and so the right context is checked. The “;#” is looking over zero or more letters to see if a digit occurs later in the word. (This is to check for postcodes in England that are of the form M60 1QD.) A digit does not occur later in the word “hear,” and so the system goes to the next rule: 2 #[H]=; H 3. (This is still a postcode checking rule for a mixture of digits and letters in the same word.) In this case the focus, decision table and right-context are satisfied. The left-context is simply the wildcard for a digit. This is not satisfied and so the search continues. Each rule for “H” fails until the system reaches the rule: 1 [H]=H - where all conditions are satisfied. The rule fires, the right hand side of the rule (i.e., “H”) is output, the current\_state is

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

1	[K].-=K	-
1	. [K]=K	-
1	[K]. !=K	-
1	~[K]~-=;K	-
1	[K]=K	-
5	[K]=K	-
2	~[L]; #=#;L	3
2	# [L]=;L	3
1	~[L]; #=#;L	4
1	# [L]=;L	4
2	~[LATI]MER=LATE	-
2	[LAERT]ES=LA]T	-
2	! [LESS]=.S	-
2	[LETTER]=LR	-
2	~[LIKE]~=-L	-
2	[LITTLE]=LL	-
2	[LORD]= "L	-
2	[LAHAD]=LA_H	-
2	~[LLAN]D=LLAN	-
1	[L]. ~=-L	-
1	. [L]=L	-
1	[L]. !=L	-
1	~[L]~=-;L	-
1	[L]=L	-
5	[L]=L	-
1	~[M]C`~=-;M	-
2	~[M]; #=#;M	3
2	# [M]=;M	3
1	~[M]; #=#;M	4
1	# [M]=;M	4
2	! [MENT]=;T	-
2	~[MAHA]=MAHA	-
2	[MANY]=_M	-
2	[MONTRE]AL=MONTRE	-
2	~[MORE] 'N=MORE	-
2	~[MORE]~=-M	-
2	~[MORT]IMER=MORT	-
2	[MOTHEA]TEN=MO?1	-
2	[MOTHER]APY=MO!R	-
2	[MOTHER]= "M	-
2	~[MIS]TI=MIS	-
2	~[MIST]RIAL=MIST	-
2	~[MIST]REA=MIST	-
2	~[MIST]RU=MIST	-
2	~[MIST]RANS=MIST	-
2	~[MIS]TH=MIS	-
2	[MIST]=MI/	-
2	~[MIS]=MIS	-
2	[MICRO]=MICRO	-
2	[MUCH]=M*	-
2	[MUST]AFA=MU/	-
2	~[MUSTA]NG=MU/A	-
2	~[MUSTAR]D=MU/>	-
2	~[MUSTER]=MU/]	-
2	[MUST]=M/	-
2	~[MYSELF]~=-MYF	-
2	~[MC]=MC	-
1	[M]. ~=-M	-
1	. [M]=M	-
1	[M]. !=M	-
1	~[M]~=-;M	-
1	[M]=M	-
5	[M]=M	-
1	~` [ND]~=-4ND	-
1	# [ND]~=-ND	-
1	. [ND]~=-ND	-
2	~[N]; #=#;N	3
2	# [N]=;N	3
1	~[N]; #=#;N	4
1	# [N]=;N	4
2	~[NIGHT]=NI<T	-
2	~[NOBLES]SE=NO#S	-
2	~[NOT]~=-N	-
2	~[NONE]~=-N"O	-
2	~[NONES]~=-N"OS	-
2	~[NON]ESS=NON	-
2	~[N]ONES=N	-
2	~[NONE]THE=N"O	-
2	~[NON]=NON	-
2	[NOWI]SE=NOWI	-
2	[NOWA]Y=NOWA	-
2	[NO]WHERE=NO	-
2	[NA]MENT=NA	-
2	[NAME]= "N	-
2	! [NESS]=;S	-
2	[NECESSARY]=NEC	-
2	[NCRE]A=NCRE	-
1	{N}. ~=-N	-
1	. [N]=N	-
1	[N]. !=N	-
1	~[N]~=-;N	-
1	[N]. =N	-
2	~[O]; #=#;O	3
2	# [O]=;O	3
1	~[O]; #=#;O	4
1	# [O]=;O	4
2	~[OF ]THE~=- (	-
2	~[OF ]A~=- (	-
2	[OFOR]=O=	-
2	[OF]= (	-
2	~[OUT]HELD= \T	-
2	~[OUT]~=- \	-
2	! [OUND]=.D	-
2	! [OUNT]=.T	-
2	[OUGHT]= " \	-
2	~[OURSELVES]~=- \RVS	-
2	[OU]= \	-
2	{OWORK}=O"W	-
2	[OW]=[	-
2	! [ONG]=;G	-
2	[ONEA]=ON1	-
2	[ONEC]K=ONEC	-
2	[ONENESS]= "O;S	-
2	[ON]EN=ON	-
2	[ONER]=ON	-
2	[ONED]=ON\$	-
2	[ONES]IA=ONES	-
2	[ONES]IM=ONES	-
2	[ONES]S~=-ONES	-
2	~[ONSELFS]~=- "OF	-
2	[ONES]E~=-ONES	-
2	[ONEST]= "O/	-
2	[ONE]E=ONE	-
2	[ONEOU]S=ONE \	-
2	[ONEO]=ONEO	-
2	[ONEY]~=-"OY	-
2	[ONEU]M=ONEU	-
2	[ONE]UR=ONE	-
2	[ONET]ED=ONET	-
2	[ONET]S=ONET	-
2	[ONET]CY=ONET	-
2	[ONET]~=-ONET	-
2	[ONET]TE=ONET	-
2	[ONEL]S=ONEL	-
2	! [O]NEL~=-O	-
2	[ONE]="O	-
1	[O]IN=O	-
2	[OI]=OI	-
2	[OEN]=OEN	-
2	[OED]! =OED	-
2	~[OVEREA]T=OV]1	-
2	~[OVER]=OV	-
2	~[O' CLOCK]~=-O'C	-
2	[ORSE]RADISH=ORSE	-
2	[OON]E=OON	-
2	~[OLE]A=OLE	-
1	~[O]~=-MY=O	-
1	~[O]~=-DEAR=O	-
1	[O]. ~=-O	-
1	. [O]=O	-
1	~[O]~=-;O	-
1	[O]=O	-
2	~[P]; #=#;P	3
2	# [P]=;P	3
1	~[P]; #=#;P	4
1	# [P]=;P	4
2	~[PH]ONEY=PH	-
2	[PHONE]S=PH"O	-
2	[PHONETI]=PHONETI	-
2	[PHONE]~=-PH"O	-
2	~[PAR]TH=P>	-
2	[PART]= "P	-
2	[PAID]=PD	-
2	[PAINS]TAK=PA9S	-
2	[PAGODA]=PAGODA	-
2	~[PEOPLE]~=-P	-
2	~[PERHAPS]~=-P]H	-
2	~[PERCEIVE]=P]CV	-
2	[PERCEIVIN]G=P]CV	-
2	[PERSE]VER=P]SE	-
2	[PREACH]=PR1*	-
2	[PRED]AC=PR\$A	-
2	[PRED]TOR=PR\$A	-
2	[PRED]ECES=PR\$	-
2	[PREDI]L=PR\$I	-
2	[PREDI]C=PR\$I	-
2	[PRENT]ICE=PR5T	-
2	[PRERO]G=PR]O	-
2	~[PRE]=PRE	-
2	[POST]H=PO/	-
1	[P]. ~=-P	-
1	. [P]=P	-
1	[P]. !=P	-
1	~[P]~=-;P	-
1	[P]=P	-
5	[P]=P	-
2	~[Q]; #=#;Q	3
2	# [Q]=;Q	3
1	~[Q]; #=#;Q	4
1	# [Q]=;Q	4
2	[QUICK]=QK	-
2	~[QUITE]~=-Q	-
2	[QUESTION]= "Q	-
1	[Q]. ~=-Q	-
1	. [Q]=Q	-
1	[Q]. !=Q	-
1	~[Q]~=-;Q	-

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	[MUST]AFA=MU/	-
2	~[MUSTA]NG=MU/A	-
2	~[MUSTAR]D=MU/>	-
2	~[MUSTER]=MU/]	-
2	[MUST]=M/	-
2	~[MYSELF]~=-MYF	-
2	~[MC]=MC	-
1	[M]. ~=-M	-
1	. [M]=M	-
1	[M]. !=M	-
1	~[M]~=-;M	-
1	[M]=M	-
5	[M]=M	-
1	~` [ND]~=-4ND	-
1	# [ND]~=-ND	-
1	. [ND]~=-ND	-
2	~[N]; #=#;N	3
2	# [N]=;N	3
1	~[N]; #=#;N	4
1	# [N]=;N	4
2	~[NIGHT]=NI<T	-
2	~[NOBLES]SE=NO#S	-
2	~[NOT]~=-N	-
2	~[NONE]~=-N"O	-
2	~[NONES]~=-N"OS	-
2	~[NON]ESS=NON	-
2	~[N]ONES=N	-
2	~[NONE]THE=N"O	-
2	~[NON]=NON	-
2	[NOWI]SE=NOWI	-
2	[NOWA]Y=NOWA	-
2	[NO]WHERE=NO	-
2	[NA]MENT=NA	-
2	[NAME]= "N	-
2	! [NESS]=;S	-
2	[NECESSARY]=NEC	-
2	[NCRE]A=NCRE	-
1	{N}. ~=-N	-
1	. [N]=N	-
1	[N]. !=N	-
1	~[N]~=-;N	-
1	[N]. =N	-
2	~[O]; #=#;O	3
2	# [O]=;O	3
1	~[O]; #=#;O	4
1	# [O]=;O	4
2	~[OF ]THE~=- (	-
2	~[OF ]A~=- (	-
2	[OFOR]=O=	-
2	[OF]= (	-
2	~[OUT]HELD= \T	-
2	~[OUT]~=- \	-
2	! [OUND]=.D	-
2	! [OUNT]=.T	-
2	[OUGHT]= " \	-
2	~[OURSELVES]~=- \RVS	-
2	[OU]= \	-
2	{OWORK}=O"W	-
2	[OW]=[	-
2	! [ONG]=;G	-
2	[ONEA]=ON1	-
2	[ONEC]K=ONEC	-
2	[ONENESS]= "O;S	-
2	[ON]EN=ON	-
2	[ONER]=ON	-
2	[ONED]=ON\$	-
2	[ONES]IA=ONES	-
2	[ONES]IM=ONES	-
2	[ONES]S~=-ONES	-
2	~[ONSELFS]~=- "OF	-
2	[ONES]E~=-ONES	-
2	[ONEST]= "O/	-
2	[ONE]E=ONE	-
2	[ONEOU]S=ONE \	-
2	[ONEO]=ONEO	-
2	[ONEY]~=-"OY	-
2	[ONEU]M=ONEU	-
2	[ONE]UR=ONE	-
2	[ONET]ED=ONET	-
2	[ONET]S=ONET	-
2	[ONET]CY=ONET	-
2	[ONET]~=-ONET	-
2	[ONET]TE=ONET	-
2	[ONEL]S=ONEL	-
2	! [O]NEL~=-O	-
2	[ONE]="O	-
1	[O]IN=O	-
2	[OI]=OI	-
2	[OEN]=OEN	-
2	[OED]! =OED	-
2	~[OVEREA]T=OV]1	-
2	~[OVER]=OV	-
2	~[O' CLOCK]~=-O'C	-
2	[ORSE]RADISH=ORSE	-
2	[OON]E=OON	-
2	~[OLE]A=OLE	-
1	~[O]~=-MY=O	-
1	~[O]~=-DEAR=O	-
1	[O]. ~=-O	-
1	. [O]=O	-
1	~[O]~=-;O	-
1	[O]=O	-
2	~[P]; #=#;P	3
2	# [P]=;P	3
1	~[P]; #=#;P	4
1	# [P]=;P	4
2	~[PH]ONEY=PH	-
2	[PHONE]S=PH"O	-
2	[PHONETI]=PHONETI	-
2	[PHONE]~=-PH"O	-
2	~[PAR]TH=P>	-
2	[PART]= "P	-
2	[PAID]=PD	-
2	[PAINS]TAK=PA9S	-
2	[PAGODA]=PAGODA	-
2	~[PEOPLE]~=-P	-
2	~[PERHAPS]~=-P]H	-
2	~[PERCEIVE]=P]CV	-
2	[PERCEIVIN]G=P]CV	-
2	[PERSE]VER=P]SE	-
2	[PREACH]=PR1*	-
2	[PRED]AC=PR\$A	-
2	[PRED]TOR=PR\$A	-
2	[PRED]ECES=PR\$	-
2	[PREDI]L=PR\$I	-
2	[PREDI]C=PR\$I	-
2	[PRENT]ICE=PR5T	-
2	[PRERO]G=PR]O	-
2	~[PRE]=PRE	-
2	[POST]H=PO/	-
1	[P]. ~=-P	-
1	. [P]=P	-
1	[P]. !=P	-
1	~[P]~=-;P	-
1	[P]=P	-
5	[P]=P	-
2	~[Q]; #=#;Q	3
2	# [Q]=;Q	3
1	~[Q]; #=#;Q	4
1	# [Q]=;Q	4
2	[QUICK]=QK	-
2	~[QUITE]~=-Q	-
2	[QUESTION]= "Q	-
1	[Q]. ~=-Q	-
1	. [Q]=Q	-
1	[Q]. !=Q	-
1	~[Q]~=-;Q	-

not changed (i.e., after the start of the word) and the system moves 1 character along the braille word, leaving "EAR" to be translated. The system now searches from the entry: 2 ~[E]; #=#; E 3. The focus does not match. The search continues in this manner until the rule: 2 ! [EAR]=E> - is satisfied giving the total output "HE>", as required. Note that the rule: 2 ! [EAR]=E> - occurs before the rule: 2 ! [EA] !=1 - ensuring that an "AR" contraction has a higher priority than an "EA" contraction.

The system detailed here has been tested on a set of Standard English Braille words which were designed to test all of the rules found in the Braille Primer [16]. In addition, extensive tests have been carried out by Torch Trust for the Blind.

Overall the system performs well on for Standard English Braille. However, there are a number of problems which have been identified.

- In proper names, e.g., "Mr. B. Smith" where there is no period after the initial, this system will insert a letter sign taking the "B" to be an isolated letter rather than an initial. (See Footnotes 10 and 13.)
- It is anticipated that there will be words for which the syllabification produced by this program is incorrect. These words can be added to the tables as required.
- Specialist biblical references containing chapters of the bible and verse numbers are not converted correctly. (However, this is simple a matter of adding the biblical names to the main tables for the system.)

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

1	[Q]=Q	-	2	~[RENO]M=RENO	-
5	[Q]=Q	-	2	~[RENU]M=RENU	-
1	~`[RD]~`=4RD	-	2	~[REREDO]S=R]S\$O	-
1	#[RD]~`=RD	-	2	~[RE]R=RE	-
1	[RD]~`=RD	-	2	{REVER]EN=R"E	-
2	~[R];#=:R	3	2	{REVER]IE=R"E	-
2	#[R]=;R	3	2	~[REVER]=REV]	-
1	~[R];#=:R	4	2	{REJOICE]=RJC	-
1	#[R]=;R	4	2	{REJOICING]=RJCG	-
2	[RIGHT]="R	-	2	[RECEIVE]=RCV	-
2	~[RATHER]~`=R	-	2	[RECEIVING]=RCVG	-
2	{RAFT]ER=RAFT	-	1	[R].~`=R	-
2	{RARED]~`=RAR\$	-	1	[R]=R	-
2	~[RANS]OME=RANS	-	1	[R].!`=R	-
2	[RAR]ENAL=RAR	-	1	~[R]~`=;R	-
2	~[REA]B=REA	-	1	[R]=R	-
2	[REACHING]=R1*+	-	5	[R]=R	-
2	~[REACH]I=REA*	-	1	#[S"]~`='S	-
2	~[REACH]=R1*	-	2	~[S];#=:S	3
2	~[RE]AC=RE	-	2	#[S]=;S	3
2	~[READ]AP=READ	-	1	~[S];#=:S	4
2	~[REA]DD=REA	-	1	#[S]=;S	4
2	~[READ]J=READ	-	2	~[STILL]~`=/	-
2	~[READ]M=READ	-	2	! [STID]E=STID	-
2	~[READ]O=READ	-	2	! [STION]=S;N	-
2	~[READ]V=READ	-	2	! [STIME]=S"T	-
2	~[REA]F=REA	-	2	! [STHEAD]=/HLD	-
2	~[REA]G=REA	-	2	! [ST]HOOD=/	-
2	~[REAL]IG=REAL	-	2	! [S]TH=S	-
2	~[REAL]IN=REAL	-	2	! [ST]OWN=ST	-
2	~[RE]ALL=RE	-	1	~`[ST]~`=4/	-
2	~[REAN]=REAN	-	2	~[ST].~`=ST	-
2	~[REAP]P=REAP	-	2	{ST]=/	-
2	~[REAS]C=REAS	-	2	~[SHALL]~`=%	-
2	~[REAS]S=REAS	-	2	! [SHART]=SH>T	-
2	~[REAT]T=REAT	-	2	! [SHAW]K=SHAW	-
2	[REAW]AKE=REAW	-	2	{SHOULD]ER=%\LD	-
2	~[REDEE]M=R\$EE	-	2	{SHOULD]=%D	-
2	~[RED]EMPT=R\$	-	2	! [SHOUS]E=SH\S	-
2	~[RED]E=RED	-	2	! [SHOO]D=SHOO	-
2	~[RED]I=RED	-	2	! [SHOR]N=SHOR	-
2	~[REDOUB]T=R\$\B	-	2	! [SHOR]SE=SHOR	-
2	~[REDOUND]=R\$.D	-	2	! [SHOUND]=SH.D	-
2	~[RE]DO=RE	-	2	! [SHIL]L=SHIL	-
2	~[REDR]AW=REDR	-	2	! [SHEAR]T=SHE>	-
2	~[REDU]C=R\$U	-	2	! [SHEAD]=SHLD	-
2	~[REDU]ND=R\$U	-	2	! [SHUN]D~`=SHUN	-
2	~[REDU]=REDU	-			
2	~[RE]NAM=RE	-			
2	~[RENA]V=RENA	-			

\* Insert an apostrophe before an 's' when it is after a number, i.e. date.

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

2	~[SH]'=%	-	2	[THERE]="!	-
2	~[SH]~`=SH	-	2	! [THERD]=TH]D	-
2	[SH]=%	-	2	~[THEIR]=_!	-
2	! [STON]=.N	-	2	[THESE]~`=^!	-
2	~[SINGH]=S9<	-	2	~[THEMSELVES]=!MVS	-
2	[SAID]=SD	-	2	[THENCE]=?;E	-
2	! [SOFAR]=SOF>	-	2	[THEND]=?5D	-
2	! [SOMED]~`=SOM\$	-	2	! [THEAST]=?1/	-
2	! [SOME]TRY=SOME	-	2	! [THEAD]=THLD	-
2	! [SOME]TRIC=SOME	-	2	! [THEAR]T=THE>	-
2	! [SOME]TER=SOME	-	2	[THE]=!	-
2	[SOMER]!`=SOM	-	2	~[THIS]~`=?	-
2	[SOME]="S	-	2	! [THIL]L=THIL	-
2	~[SO]~`=S	-	2	[THRO']=?RO'	-
2	[SEVERED]=S"E\$	-	2	[THROUGH]="?	-
2	[SEVER]E=SEV]	-	2	~[THOSE]=^?	-
2	[SEVER]ITY=SEV]	-	2	! [THOO]K=THOO	-
2	[SED]ATIV=S\$	-	2	! [THOO]D=THOO	-
2	[SPHER]=SPH]	-	2	! [THOR]SE=THOR	-
2	[SPIRIT]=_S	-	2	! [THOUS]E=TH\S	-
2	~[SUB]=SUB	-	2	! [THOL]E=THOL	-
2	[SUCH]=S*	-	2	! [THOL]D=THOL	-
2	~[SSH]~`=S%	-	2	~[THYSELF]=?YF	-
2	[SS]H=SS	-	2	[TH]=?	-
2	[SWED]ISH=SW\$	-	2	~[TO] AND~`=TO	-
2	~[SWOR]D=SWOR	-	2	~[TO] AT =TO	-
2	[SQUA]LLY=SQUA	-	2	~[TO] BE]~`=6BE	-
1	[S']~`=S0'	-	2	~[TO] BUT =TO	-
1	[S']~`=S'	-	2	~[TO] BY ]!=TO 0	-
1	[S].~`=S	-	2	~[TO] IF =TO	-
1	[S]=S	-	2	~[TO] IN =TO	-
1	[S].!`=S	-	2	~[TO] IS =TO	-
1	~[S]~`=;S	-	2	~[TO] WAS =TO	-
1	[S]=S	-	2	~[TO] WERE =TO	-
5	[S]=S	-	2	~[TO] WHERE =TO	-
1	~`[TH]~`=4?	-	2	~[TO] WITH =TO	-
1	#[TH]~`=?	-	2	~[TO] FOR =TO	-
1	[TH]~`=?	-	2	~[TO] OF =TO	-
2	~[T];#=:T	3	2	~[TO] OR =TO	-
2	#[T]=;T	3	2	~[TO] TO =TO	-
1	~[T];#=:T	4	2	~[TO HIS ]=6HIS	-
1	#[T]=;T	4	2	~[TO ENOUGH]=65\<	-
2	! [THAND]=TH&	-	2	~[TO _BE]=6.BE	-
2	! [THART]=TH>T	-	2	~[TO _]=6.	-
2	~[THAT]~`=T	-	2	~[TO ]=6	-
2	[THERER]=!R]	-	2	~[TO ]!=6	-
2	[THERED]=!R\$	-	2	~[TO ]#=6	-
2	[THERE]SA=!RE	-	2	~[TOGETHER]=TGR	-
2	[THERE]TT=!RE	-	2	~[TODAY]=TD	-
2	[THEREEN]=!RE5	-	2	~[TOMORROW]=TM	-

VI. CONCLUDING REMARKS

Although this system performs well in the translation of text into braille it should be understood that further work is required to produce a full text to braille system, specifically in the formatting and layout of the braille.

APPENDIX  
THE CONVERSION ALGORITHM

The algorithm is described below using Structured English.

```

program convert
begin
do
  read_word
  convert word into normal form // use table to convert lower to upper case.
  // tidy up graphics characters etc.
  convert_print_into_braille

```

```

while not end_of_input
end // of main program

```

```

procedure convert_print_into_braille
begin // turn print word into braille
set current_state to 1
set current_character to first character in word
while still converting do // do the whole word
begin
set match to FALSE // initialize for the loop
start search in rule table at rule defined by current_character
repeat
  if focus_matches and state_ok and right_context_ok
  and left_context_ok then
  begin
  output right hand side of rule // i.e. the text after the equals sign
  set current_state to new_state // get new state from end of the rule
  move along word by size of current rule focus
  set match to TRUE
  end
end

```

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

A System for Converting Print into Braille		
2	~[TONIGHT]=TN	-
2	~[TO-DAY]=TD	-
2	~[TO-MORROW]=TM	-
2	~[TO-NIGHT]=TN	-
2	~[TORE]ADORE=TORE	-
2	! [TION]=;N	-
2	! [TI]MEN=TI	-
2	! [TIME]TER=TIME	-
2	[TIME]=T	-
2	[TEAROOM]=T1ROOM	-
2	[TWOULD]=TWD	-
2	~[TWO]=;U	3
2	[TLDE]DG=TLED	-
2	! [TLE]D!=TLE	-
2	! [TTLE]N=TTLE	-
1	[T] . ~=T	-
1	[T]=T	-
1	[T] . !=T	-
1	~[T] ~=;T	-
1	[T]=T	-
5	[T]=T	-
2	~[U]; # =; U	3
2	# [U]=; U	3
1	~[U]; # =; U	4
1	# [U]=; U	4
2	~[UNDER]I=UND	-
2	~[UNDER]O=UND	-
2	~[UNFUL]F=UNFUL	-
2	[UNDER]=U	-
2	~[UNEAS]=UNIS	-
2	~[UNEAR]=UNE>	-
2	~[UNLESS] ~=UN . S	-
2	~[UNITY]=UN; Y	-
2	~[UN]=UN	-
2	[USEA]GE=USEA	-
2	~[US] ~=U	-
2	[UPON]=^U	-
1	[U] . ~=U	-
1	[U]=U	-
1	[U] . !=U	-
1	~[U] ~=;U	-
1	[U]=U	-
5	[U]=U	-
2	~[V]; # =; V	3
2	# [V]=; V	3
1	~[V]; # =; V	4
1	# [V]=; V	4
2	~[VERY] ~=V	-
2	~[VICEN]=VIC5	-
2	~[VICE]=VICE	-
1	[V] . ~=V	-
1	[V] . TH <sup>15</sup> =; V	-
1	[V]=V	-
1	[V] . !=V	-
1	~[V] ~=; V	-
1	~[VI] ~=; VI	-
1	~[VII] ~=; VI	-
1	~[VIII] ~=; VI	-
1	[V]=V	-
5	[V]=V	-
2	~[W]; # =; W	3
2	# [W]=; W	3
1	~[W]; # =; W	4
1	# [W]=; W	4
2	[WAS] =-WAS	-
2	[WAS] = 0	-
2	[WERE] =-WERE	-
2	[WERE] = 7	-
2	[WAF]=WA	-
2	~[WITH] THE=-)	-
2	~[WITH] A=-)	-
2	[WITH]=)	-
2	~[WILL] ~=W	-
2	~[WHICH] =: I * '	-
2	~[WHICH] ~=:	-
2	! [WHID] E=WHID	-
2	! [WHERE] D=WH] D	-
2	[WHEREVER] =: ] E	-
2	[WHERE] ER=: ] E'	-
2	[WHERE] =: "	-
2	~[WHOSE] ~=^:	-
2	! [WHOUS] E=WH\ S	-
2	[WH] =:	-
2	[WOULD]=WD	-
2	[WORK]=W	-
2	[WORD]=^W	-
2	[WORLD]=_W	-
1	[W] . ~=W	-
1	[W]=W	-
1	[W] . !=W	-
1	~[W] ~=; W	-
1	[W]=W	-
5	[W]=W	-
2	~[X]; # =; X	3
2	# [X]=; X	3
1	~[X]; # =; X	4
1	# [X]=; X	4
1	[X] : ~=; X	-

<sup>15</sup> Check for 5\*.

```

else go to next rule
if not match
and new rule does not start with same letter as current_character then
begin // no more rules for that character
output current_character // so use default option
set current_state to 1
set match to TRUE // and output braille character
end
until match // keep going round until done current character
set current_character to first character in word
end // while still converting - keep going until done whole word
end // of convert print into braille
function focus_matches
begin
set match to TRUE
set input_index to index into input_buffer position for current_character
set rule_index to index start of focus for rule

```

TABLE II (Continued.)  
RULE TABLE FOR TEXT TO STANDARD ENGLISH BRAILLE

1	[X] . ~=X	-
1	[X]=X	-
1	[X] . !=X	-
1	~[X] ~=; X	-
1	[X]=X	-
5	[X]=X	-
2	~[Y]; # =; Y	3
2	# [Y]=; Y	3
1	~[Y]; # =; Y	4
1	# [Y]=; Y	4
2	[YOUNG]=Y	-
2	~[YOURSELF]=YRF	-
2	~[YOURSELVES]=YRV S	-
2	[YOUR]=YR	-
2	~[YOU'] M=Y\ '	-
2	~[YOU] ~=Y	-
1	[Y] . ~=Y	-
1	[Y]=Y	-
1	[Y] . !=Y	-
1	~[Y] ~=; Y	-
1	[Y]=Y	-
5	[Y]=Y	-
2	~[Z]; # =; Z	3
2	# [Z]=; Z	3
1	~[Z]; # =; Z	4
1	# [Z]=; Z	4
1	[Z] . ~=Z	-
1	[Z] =Z	-
1	[Z] . !=Z	-
1	~[Z] ~=; Z	-
1	[Z]=Z	-
5	[Z]=Z	-
1	[{]=, 7	-
5	[{]=[	-
1	[\]=/	-
5	[\]=\	-
1	[ ]]=7'	-
5	[ ]]=	-
1	[^]=,	-
5	[^]=^	-
1	[_]=#=-#	-
1	[_]=. .	-
2	~[_EN] ~= . EN	-
2	[_ENOUGH]=. 5	-
2	[_TO]=. 6	-
2	[_IN]=. 9	-
2	[_INTO]=. 96	-
2	[_WAS]=. 0	-
2	[_WERE]=. 7	-
2	[_HIS]=. 8	-
2	[_BE]=. 2	-
2	[_BY]=. 0	-
1	[_]=	-
5	[_]=	-
1	[^]=^	-
5	[^]=`	-
1	[{]=, 7	-
5	[{]={	-
1	[ ]]=^	-
5	[ ]]=	-
1	[ ]]=7'	-
5	[ ]]=	-
1	[~]=^	-
5	[~]=~	-

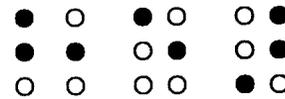


Fig. 2. The braille word "hear."

```

do
if input_buffer[input_index] != rule[rule_index] then // not got a match
set match to FALSE
increment rule_index // move along rule
increment input_index // move along input
while match and (rule[rule_index] != ')') // Note: ')' terminates focus
return match
end // of focus_matches

```

```

function state_ok
begin // nonzero entry fires state
if decision_table[input_class of current rule, current_state] > 0 then
return FALSE
else
return TRUE
end; // of state_ok

```

function left\_context\_ok // similar to right\_context\_ok below

```

function right_context_ok
begin
set match to TRUE
increment input_index // step over ')'
do
if rule[rule_index] is a wildcard then // '!', '#', '~', '^', '|', '*', '+', or '+'
begin
if not valid_wildcard_match then //see wildcard definitions-Appendix 3
// Note: this will move along input buffer

```

```

    set match to FALSE // and increment input_index appropriately
else do wildcard match // see wildcard definitions-Appendix 3
end
else
begin
if input_buffer[input_index] != rule[rule_index] then // not got a match
set match to FALSE
increment input_index // move along rule
end
increment rule_index // move along input
while match and (rule[rule_index] != TAB) // Note: TAB terminates
// right hand context of rule
return match
end // of right_context_ok

```

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