

BRAILLE RESEARCH NEWSLETTER

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edited by

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Editorial

Milton D. Graham 1916-1977

We report with much sadness the death in August 1977 of Milton D. Graham, formerly director of the Department of Research of the American Foundation for the Blind, after a brief illness. A firm believer in international collaboration and cooperation, Dr. Graham did much on a personal and professional level to insure that unnecessary duplication of effort and needless human and monetary expense in that duplication did not become the norm in research related to blindness and its sequelae. He was also involved in the organisation of many conferences and seminars focussed on braille and technological advances designed to enhance its use, indeed from the earliest days of his 18 year tenure at the Foundation. In ill health in his last years, Dr. Graham retired from the Foundation in 1975.

Questionnaire results

There were 48 replies to the questionnaire sent out with the last issue.

	YES	NO
1. I have/have not found Braille Automation Newsletter useful in my work.	46	1
2. I do/do not want to continue receiving the Newsletter.	47	1
3. I agree/disagree with your plan to publish in collaboration with another organisation	30	3
4. I would/would not be willing to pay a reasonable price to cover the cost of the Newsletter.	41	2

	YES	NO
5. I do/do not want the Newsletter in contracted English braille	16	28

In the near future there will be a meeting of the editorial board to make a decision on the future of this publication. The results of our deliberations will be reported in the next issue.

The Introduction of Braille Produced by Computer at
The Canadian National Institute for the Blind

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The Institute has had a small business computer (Honeywell) since 1971. It handled mailing, registration, service delivery and causes of blindness statistics, accounting, inventory control and payroll applications. During the years 1971 to 1976 we followed, with considerable interest, the efforts of such organisations as the R.N.I.B., Volunteer Services for the Blind in Philadelphia, the American Printing House, The Atlanta School Board and the University of Manitoba in utilising the computer to produce Grade II braille. We also familiarised ourselves with DOTSYS III and examined the program itself through the kind assistance of George Dalrymple at the Massachusetts Institute of Technology. Unfortunately, it was possible to miss certain sources of valuable information because of lack of communication between organisations either developing or using computer produced braille. However, those we did contact in depth during this investigation and learning period (M.I.T., V.S.B. and A.P.H.) gave us valuable assistance.

At the beginning of 1976, C.N.I.B. management gave the green light to go ahead with the installation of the computer braille facility. We were coming to the end of the five year rental period of our existing Honeywell computer and therefore we had a fairly free hand to identify our future computing requirements and type of equipment.

The first decision was that our computer should handle not only computer braille but also our other various applications. At this point, January 1976, we were still quite ignorant of how a computer braille system, using

state of the art computer technology could operate. We contacted Mr. R. Gildea, located in Colorado, who whilst working for the Mitre Corporation had been the project director for the development of the DOTSYS translation system in 1969. He gave us valuable advice concerning translation systems and the use of "Mini" computers plus a walk-through of the Duxbury Braille Translation System produced by Mr. J. Sullivan, Dr. S. Simpson and himself.

Following this meeting, we decided that our new computer would need to be capable of supporting a minimum of 16 terminals, have both disc and tape storage of data, be able to handle easily devices manufactured by various companies, use advanced methods of information handling and enable the use of COBOL and FORTRAN programming languages. Part of these requirements were dictated by a new Library Cataloguing System we were also planning at this time. We also decided on the method of computer braille production we wanted.

The braille system can be divided into three parts

1. the entry of text on to the computer
2. the translation of text into Grade II
3. the embossing of the translated text.

The first section, text entry, is now a fairly common computer application. We followed the general practice of having a terminal (in our case a visual display screen, a device with a television-like screen and a typewriter-like keyboard) linked through a cable to the computer. The operator types the text in upper and lower case just like a typist, on to the terminal. The text appears on the screen and is also recorded by the computer on to a storage device. Typing mistakes can be corrected at the time or by recalling the stored text back to the terminal, changing it and restoring it. We placed high emphasis on this input function because it is the slowest and most expensive part of the computer braille process.

The second section, translation, required further thought. DOTSYS III, whilst a remarkable piece of systems design, has some drawbacks in practical use. It requires various special codes to be placed in the text to control such items as paragraphing, capital letters etc. It does not allow upper and lower case text input. Automatic tabulating, facilitating the production of columns of information such as a table, an index or agenda is not available, running page titles, semi-automatic ink print page numbering and a number of other facilities are not present. DOTSYS III also requires a fairly large computer to run it, and it is unsupported. In other words, the user has to shop around for help if the contraction process does not work properly. On the other hand, acquisition is virtually free of charge. However given the drawbacks and recognising that the CNIB will be producing braille for many years to come, we decided not to use it on the grounds that the saving in initial costs would be rapidly overtaken by costs of implementation, unsophisticated input methods and difficulty of maintenance.

So far as we knew at this time we had two alternatives. The Duxbury Braille Translation System put forward by Mr. Gildea and colleagues and the American Systems Inc. translator by Dr. K. Ingham. We spoke to Dr. Ingham but he advised that ASI would supply only a complete package including the computer. However we wanted a free hand in choice of equipment and there would have been problems in an over the border arrangement so we did not proceed further with ASI. We paid a visit to Mr. Sullivan and Dr. Simpson for a detailed examination of their system. The translator was demonstrated on their own computer with test texts and a list of words which were, because of the letter groups and the often tortuous rules of Grade II braille, particularly difficult to translate properly. They indicated willingness to install the computer system on the computer of our choice and discussed with us our general computing needs.

The third part of the whole system is the embossing device and during our various travels we had solicited comments on the Triformation LED-120. Triformation is a small company in Stuart, Florida run by a group of capable people interested in the technological challenge of braille output. We decided we should at least start with one LED-120 and if satisfied, continue the relationship with Triformation.

Finally therefore, we could outline all of the systems and needs for the replacement computer and we began a rapid review with the manufacturer's representatives in Toronto. For those who may ask, we also looked at time sharing via a bureau, but finally decided on a new offering by Data General Ltd. called the Eclipse C300 - one of the new breed of so called "Mini" computers. By March 1976, our own management approved the plan and budget and we sent out a frightening group of purchase orders. One new computer for installation in July 1976, one braille translator and text editor with various supporting programs, manuals and user guide from Duxbury Systems Inc., for installation in August, one LED-120 from Triformation and a handful of video display screens purchased in Toronto.

Happily all of our suppliers met their deadlines according to specification and without any price changes. So in September 1976, we launched our new baby under the wondering view of many of our own colleagues at the C.N.I.B. We had two surprises for them, firstly the quality of braille produced by the LED-120 was excellent and secondly, so was the translation. As those of you in other agencies will realise these two points are the most often criticised in automated methods of braille translation. As so clearly pointed out to us by Bob Haynes of APH, quality is a requirement without compromise and we worked very hard to achieve it. At the time of writing, mid-June 1977, we have not received any criticism on this point.

When Dr. Gill, University of Warwick, asked me to write this article for his newsletter, I was pleased to do so but thought that at least some time should elapse to allow experience to be reported. The present position is that we have two online terminals inputting text to the computer. The operators of the terminals had no previous knowledge of braille but were excellent typists and are achieving a very high rate of throughput due to the text editor program. We plan to add a third screen and operator by the end of this year. The translator is running on the Eclipse at about 1300 words per minute with excellent accuracy thanks to the continued support from Duxbury Systems by way of table maintenance and a further advanced training program by Mr. Sullivan.

We have Phase 1 of our library cataloguing system installed on the Eclipse plus mailing and inventory control. The remaining systems registration, payroll and accounting will be converted by mid-July 1977. We are also preparing to review a new automatic stereograph produced by Triformation Inc., which will run at 30 characters per second. This will enable us to produce plates as easily as paper on the LED-120. One area we have not yet touched is magnetic tape material produced by publishing houses as input to our translation system. It is high on our priority list and we are looking forward to it.

I would like to discuss some of the more important points concerning braille production by the computer. Because any system is a dynamic changing thing, it is capable of being defined more than one way. This means that we are presented with as many different methods as there are advisors. Very confusing. So firstly is to avoid being locked into a piece of equipment or a method.

For example, the program should run on a variety of computers. Now COBOL is supposed to be universal, but this is not really true because of the way different computers handle files of data. Also a large computer can handle files of data. Also a large computer can

handle a higher level of complication permitted by COBOL than can a small machine. The use of terminals often marks considerable differences in methods of implementation between computers, even when both use the same language. Without wishing to necessarily advertise, Duxbury got around this problem by programming in FORTRAN using simple sequential files. Generally speaking, FORTRAN is not a widely used language commercially but is usually available on most computers because of scientific and statistical requirements. Its structure usually follows IBM 1130 implementation and it is controlled under the ANSI standards. The main point is that the differences of implementation between large and small computers is not as pronounced as COBOL.

The computer chosen should handle terminals efficiently and be capable of other administrative functions as well as computer braille. Terminals place a considerable overhead on a computer and you should carefully forecast your total requirements as far as possible and insure that the computer can be upgraded in place without programming changes. Alternatively, if you decide to use a bureau to start, obtain a mini computer which allows growth but is small enough initially to be cost justified and use it for text editing. Take tapes to the bureau for translation and bring the translated tapes back to your mini for it to drive the braille embosser.

Lastly, the heart of the system, the translator. Do not commit yourself to DOTSYS III without actually reviewing the other translators available. At the beginning, there is so much to learn that a decision to go with DOTSYS III may be a decision based on ignorance which may later be regretted. If funds are limited, DOTSYS III is a great temptation but in my view it is not a system for the inexperienced. If expert programmers are on hand to utilise it properly, as in the case of the University of Manitoba or at Atlanta, then that is a

different story. In the years ahead, we will see a translator built right into a micro computer. But for now, with a limited market and funds for development the one or two experienced suppliers will give predetermined acceptable results. The ultimate answer to the software problem lies with simpler and more straightforward rules for Grade II contraction. Efforts are being made in this direction which we support and will ultimately be of benefit to the braille user generally and to the newly blind.

The Efficiency of Braille as a
Medium of Communication

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Although recent advances in technology have greatly expanded the communication repertoire of the blind, a knowledge of braille is probably still the single most important communication skill for many blind people. Braille is valuable insofar as it is able to communicate ideas quickly and accurately. Like any symbol system, its ability to transmit information efficiently is the ultimate test of its effectiveness. Objective procedures exist not only to determine how effective braille is as a means of communication but also to gauge the relative efficiency of each braille whole-word sign.

What is involved, to oversimplify, is a comparison between the whole-word signs in grade II braille and written standard American English. More specifically, with what frequency are each of the 149 whole-word signs used in standard English? One of the principle underpinnings of the braille system is the belief that whole-word signs should represent those words which are used most frequently in written English and are most in need of abbreviation. The extent to which this assumption is true may be verified by content analysis. Although capable of more sophisticated applications, content analysis is important to the study of braille because of two major works in linguistics which make it possible to determine, with reasonable accuracy, the relative efficiency of whole-word signs for written standard American English.

The first of these is W. Nelson Francis' *A Computational Analysis of Present-day American English*, (ref. 1), the results of a six year study by Francis and his colleagues

in the Brown University Linguistics Department on adult English. Drawing reading matter from eighteen different genres (e.g. news, reportage, sports, hobbies, religion, and science), Francis assembled a corpus of slightly more than 1 million words which was designed to be representative of a cross-section of reading matter. The Brown corpus, as it is known, generated 50,406 distinct words.

The American Heritage Word Frequency Book (ref 2), by J.B. Carroll was commissioned to supply background data for the *American Heritage School Dictionary*. Its slightly more than five million word corpus was drawn to represent standard written children's English in the United States. Therefore, works of fiction and non-fiction, children's magazines, textbooks, etc., for children in grades 3-9 compose the corpus and the 86,741 distinct words which it contains.

Both of these studies have several advantages which recommend them in assessing the efficiency of braille:

1. With one million and five million words respectively, the Brown and American Heritage Corpora are of sufficiently large size to provide a meaningful sample. The size of the text analysed is important since a significant number of words in English occur only once in every one million words of text. For example, a smaller corpus of 250,000 words, the equivalent of two standard-size paperback books, would fail to include a large number of such words.

2. The original data from both studies are stored on computer tape and, consequently, may be analysed in greater detail than are presented here. Frequency of certain words "Spirit" and "lord", for example, appear with much greater frequency in the religious genre. Examination of the original data would aid in studying such relationships.

3. That both studies are confined to standard written English is so obvious that its merit might be overlooked. Written English is different from spoken English. Braille is concerned either with written English or with spoken English as it is written. These are precisely the criteria that governed the collection of these corpora by Francis and Carroll.

4. Just as written and spoken language are essentially different, so too are children's language and adult's language. This is not to say that the fundamental vocabulary is distinct. It is, however, a singular advantage to have both an extensive study of child and adult language for purposes of comparison.

It is the purpose of this paper to sketch (i) the whole-word signs that are significant aids to effective communication, (ii) whole-word signs which are of marginal value in efficient communication, and (iii) some suggestions for improving the general efficiency of braille. These views are presented in the hope of generating a more extensive discussion of the braille system, its effectiveness, and possible improvement.

Before turning to the areas in which whole-word signs serve to advantage, it may be well to clarify what is meant by "efficiency in communication". For purposes of measuring braille effectiveness, three simple tests might be applied.

1. How frequently is the whole-word sign used? Some signs, quite literally, are used thousands of times more often than are others. The extent to which a whole-word is used is easily determined from both the Brown corpus and the American Heritage study.

2. How many cells are saved by the use of the whole-word sign? The saving of space and paper is especially important in commercially printed braille materials. Whole-word signs which occur most frequently usually, but not always, save more space. The amount of space saved is arrived at by calculating the number of cells that would be needed to form the word if there were no whole-word sign. For example:

people	6 cells	(wh)i(ch)	3 cells
p	1 cell	(wh)	1 cell
saved	5 cells	saved	2 cells

3. Is a clearly more efficient alternative to the present whole-word sign possible? Braille is not being employed to its maximum capability if a word not presently represented by a whole-word sign occurs with much greater frequency and resultant saving of space than "people" or "which". If a word could be logically represented by "p" or "wh", the communicative efficiency of the system would be significantly improved.

In general, whole-word signs are a most efficient method of communication. Figure 1 indicates the large number of the most frequently occurring words in standard written English which are represented by a whole-word sign. Fifty-eight of the 100 most frequently occurring words in the Brown corpus have whole-word equivalents, while most of the remainder have too few letters to benefit from contraction. Whereas the median average frequency of occurrence for all written English words in the Brown corpus is only 2 and the modal average is 1, the median average for words having whole-word signs is 665 and the modal average is 145. On the average, whole-word signs are used to represent those words which appear most regularly in written standard American English.

Figure 1. Most Commonly Used Whole-Word Signs

Rank in Brown Corpus	Frequency in Brown Corpus	Rank in American Heritage	Frequency in American Heritage	Frequency/million American Heritage
1 the	69,971	1	373,123	73,122
2 of	36,411	2	146,001	28,461
3 and	28,852	3	133,899	26,172
4 to	26,149	4	121,347	23,653
6 in	21,341	6	99,108	19,366
7 that	10,595	9	47,443	9,266
9 was	9,816	13	40,934	7,457
11 for	9,489	12	39,322	7,487
12 it	8,756	10	47,284	9,179
13 with	7,289	17	30,455	5,933
14 as	7,250	16	32,208	6,296
15 has	6,997	62	10,369	2,003
17 be	6,377	21	23,756	4,554
19 by	5,305	27	20,189	3,924
21 this	5,146	22	23,301	4,517
22 had	5,133	29	20,511	3,634
23 not	6,609	30	18,645	3,631
25 but	4,381	31	19,196	3,620
26 from	4,349	23	22,799	4,456
28 have	3,941	25	22,337	4,345
31 which	3,462	41	14,016	2,678
32 one	3,292	28	19,976	3,908
33 you	3,286	8	50,957	9,573

The ability of the braille whole-word system to transmit efficiently most ideas is an accomplishment which should not be minimised. With few exceptions, whole-word signs represent those words which appear most frequently in standard English. While averages convey a general impression, they may, however, obscure as much as they reveal.

Many words represented by whole word signs, for example, are used with such little frequency that they are of marginal value. Eleven words with whole-word equivalents occur less than 24 times in the 1,014,000 word Brown corpus, 20 occur less than 75 times, and 36 appear less than 200 times. Figure 2 lists the least frequently used whole-word signs and their frequencies in adult English. These figures are somewhat inflated since two words sharing the same stem are added together and treated as a single word on the assumption that learning of such signs is more analogous to learning a single new sign than two separate and distinct signs. Therefore, words like "receive" and "receiving", "declare" and "declaring" are added together and treated as a single sign.

Allocating whole-word signs to words which appear so rarely in written English is a serious limitation on the effectiveness of braille. The Brown corpus would occupy 2,393 pages of standard paperback book print (ref. 3), but about one in four braille whole-word signs, 24 per cent, would be used fewer than 200 times in a collection of this scope. Expressed another way, the average whole-word sign is used between 3 and 300 times more often than are these seldom used symbols.

Not only do these signs occur infrequently but they also result in a very minimal saving of space. If the 149 whole-word signs are rank-ordered and divided into percentiles (the first fifteen in percentiles 1-10, the second fifteen in percentiles 11-20, etc.), it is possible to obtain a rough approximation of the cells, or space,

Figure 2. Least Frequently Used Whole-Word Signs
(Note: The frequencies presented here are per one million words of standard prose.)

<u>Word</u>	<u>Frequency</u>
father	183
spirit	182
beyond	149
letter	145
knowledge	145
below	145
paid	145
necessary	141
according	139
friend	133
myself	129
herself	125
character	118
receive/receiving	110
afternoon	106
lord	93
immediate	81
besides	78
quick	68
ought	68
yourself	67
ourselves	66
tomorrow	63
beneath	57
blind	47
tonight	38
altogether	30
declare/declaring	18
afterwards	16
conceive	16
perceive	14
yourselves	8
oneself	5

Figure 2 (continued)

<u>Word</u>	<u>Frequency</u>
rejoice	5
deceive	2
braille	1
thysself	0
o'clock	-

that is being saved by signs of differing frequencies (see Figure 3). Probably more than half of the whole-word

Figure 3. Whole-words: Economy of Expression

Percentile	Average Saving of cells	Total Saving of cells	Rank in Brown Corpus
1-10	22,528	337,928	69,971-5,146
45-55	1,272	19,085	702-495
80-90	336	5,040	139-38
90-100	53	797	30-0

signs save more cells themselves, individually, than do all of the signs comprising the last ten percentile. Comparison with paperback publication may be helpful. While it is difficult to receive more than a qualified estimate, printers of paperback books generally estimate about 2,000 printed characters to the page. In other words, in the eight regular-sized paperbacks represented by the million-word Brown corpus, the fifteen least used whole words, as a group would not have reduced a single page of print. The thirty least used whole-words would have saved three pages.

It should be noted, however, that some groups of words are so familiar that they might be more fairly represented as a single category than as several distinct whole-words. Put another way, it is possible that, when learning braille, one remembers only the way that "f" is configured to form the "-self" suffix rather than the individual signs for "oneself", "myself", "himself", "herself", "itself", and "yourself". If learning occurs in this way, it might be more realistic to treat such groups of signs as though they were a single sign for purposes of assessing their efficiency (see Figure 4).

Figure 4. Special Whole-word Groups

<u>Frequency</u>	<u>Words in Group</u>
1481	behind, below, beneath, besides, between, beyond
1233	thysself, oneself, yourself, herself, myself, himself, itself
385	today, tomorrow, tonight
344	ourselves, yourselves

A group of words, regardless of its total frequency, would be of questionable efficiency if each individual word were little used. If, however, only one word in a frequently occurring group is little used (e.g. "beneath" appears 57 times in the Brown corpus), its continued inclusion as a whole-word might be reasonably justified on the grounds that it is learned as a part of the more commonly used group (e.g. whole-words beginning with the low "be").

Not only are whole-word signs allocated for words which occur infrequently in standard English but, ironically, a number of commonly used English words have no braille equivalents. To understand how this problem might be minimised, it is first necessary to review some rudimentary semantics as it applies to braille.

In semantics, one thing, a symbol, may be used to stand for something else, a referent (ref. 4). Therefore, young American children learn the word "father" to stand for the person. When the child goes to school, he/she will learn first to print, and then to write, the written equivalents of the oral symbol for "father". If the child should take a foreign language, he/she will learn that the same referent may be depicted by the symbol padre in Spanish, "Vater" in German, etc. The single referent, in sum, can evoke several different types of appropriate symbolic responses in English and several more in other languages, and the same individual is capable of distinguishing among and using all of these appropriately.

It is axiomatic in semantics that people can, and do, learn new symbols for old referents. It is outside the scope of this paper to argue the case for this type of learning, but it is worth noting that psycholinguistics, communication theory, applied linguistics, and language acquisition have all arrived at similar conclusions. Moreover, everyone, whether conscious of it or not, engages in learning new symbols for old referents several times in their lives. Learning to read print, learning to write, print-users learning to read braille, traditional math users learning abacus calculation, learning of foreign languages, learning stenography and court reporting, and learning to type are only a few of the more obvious.

Understanding that it is possible to learn new symbols for old referents is critical to an introduction of whole-word signs for commonly used words not provided with braille equivalents at present since any new signs would have to replace signs currently in use.

Only seven whole-word signs would appear to be better used representing other words than the ones they currently signify. The words that would be substituted occur between 2 and $7\frac{1}{2}$ times more often than the ones they would replace (figure 5). A number of other words with low frequencies are not included here since the most likely word with which they would be substituted appears only slightly more often. Both the relative and absolute saving of space would be minimal.

To this list might be added a handful of words which occur so frequently that, while their representation by a sign would not result in a significant saving of space, it might aid reading and writing. For example, "is" occurs 10,099 times in the Brown corpus, "are" 4,393, "been" 2,472, and "what" 1,908. Providing signs for these or similar words would do almost nothing for the printer's problems of space, but it would facilitate the reading and writing of grade II braille.

Figure 5. Whole-word Substitutions

Word	Frequency	Cells Saved if Represented by the Whole-word Sign	Net Cells Saved
state/states	1,413	2,826	2,098
spirit	182	728	
she	2,859	2,859	2,058
shall	267	801	
made	1,125	2,250	1,818
mother	216	432	
even	1,171	2,342	1,380
every	491	962	
life	715	1,530	1,244
lord	93	186	
new	1,635	1,635	1,048
name	294	588	
year/years	1,609	1,609	839
young	385	770	

Five of these seven words are among the 100 most frequently occurring in adult English and all are used more regularly than the present median average for whole-word signs.

Neither the Brown corpus nor the American Heritage project is designed to study part-word signs. With the exception of a recent Swedish paper (ref. 5) which, although suggestive, is not directly relevant, no research applicable to the efficiency of part-words could be discovered. This is unfortunate since it seems quite likely that part-word signs hold the greater promise for improving the efficiency of braille.

The Brown and American Heritage studies are, however, helpful in suggesting the prominence of part-words in effective communication. For example, of the 50,400 distinct words included in the Brown corpus, over half of them, 27,864 occur only once, with another 20,631 occurring only twice. Not only are there a large number of words which would be impossible to represent with whole-word signs but these words compose a significant portion of standard American prose. In the Brown study, words which were used fewer than 5 times in a million accounted for 38 per cent of the total corpus.

Part-words may be needed because of the length of a word as well as because of its infrequency. Approximately 80 per cent of written adult English is composed of words having three or more letters and therefore is, theoretically, amenable to part-word signs. For various reasons, the actual use of part-word signs will be nowhere near this large, but the concern here is merely to outline the potential for further investigation. Many standard prefixes have no braille equivalents. Words beginning with "pre-", "post-", and "sub-" occur in the thousands in the Brown and American Heritage works. A more detailed study of the most frequent vowel and consonant combinations in English, prefixes and suffixes, etc., would prove instructive and beneficial. It would, at minimum, provide a solid factual base from which to evaluate the efficiency of part-word signs.

Language, whether written or spoken, is constantly changing. One needs only to read a book or newspaper or letter of a hundred years ago to realise how much standard American English has changed. Style, vocabularly, imagery, etc., have altered dramatically. Braille is fixed and dependable, whereas language is fluid and changing.

Nonetheless, it remains inescapable that braille is, generally, a most efficient means of communication. Four areas of possible improvement have been suggested. First, a significant number of whole-word signs are used with so little frequency as to be of minimal value and might-well be eliminated altogether. Second, seven words which are not currently represented by whole-word signs might be substituted for little used words with whole-word signs. Three, a few words appear with sufficient regularity in standard English that they might deserve a whole-word sign to facilitate reading and writing. Fourth, initial evidence suggests that a detailed investigation of part-word signs, similar to that in the Brown and American Heritage studies, would be most valuable in aiding the assessment of braille efficiency. It is hoped that these data will present a new perspective from which to examine the efficiency of braille as well as stimulate additional discussion on the effectiveness of the braille system.

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The Braille Press and Its Future

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At the beginning of 1976, which in terms of recent technological development seems a long time ago, some of us were concerned that advances in minicomputer-assisted translation systems, and the forthcoming microprocessor-based systems, would by-pass applications to the presses that make long runs of braille copies possible. What appeared to be necessary was the development of a new specification for a braille press. Such a specification ought, we thought, to be suited to replacement of present aging presses in the underdeveloped countries. That is, it ought to cover all of the functions of the present braille presses, and it ought not to require electrical supply, contain motor drive, nor require sophisticated embossing means beyond placing a normally prepared stereotype plate on the flat bed. Yet the specification ought to allow for the retrofitting of a motor drive to up-grade an installation; and it ought to allow for fitting with sophisticated computer-assisted embossing and translation means for applications in the advanced and underdeveloped countries. Finally, we thought, it would be desirable for such a specification to be submitted for bidding to large machinery makers around the world in the expectation that a single source at the best price could be found for braille presses for a world community of users.

What we discovered in the course of our exploration of this idea can be summed up simply: there is no need for such a specification; and there is not likely to be such a need in the future. The reasons and information that support this conclusion (a conclusion that is rather pleasant in a world committed to ceaseless change, it would seem) appear potentially to have interest for a fairly wide spectrum of readers, however; hence this report.

Some readers may have heard of a research proposal that the AFB had submitted to the U.S. Library of Congress. In it, my colleagues and I suggested a computer-assisted embossing system that included as its central novelty a resettable embossing plate on each side of blank braille paper; the pins that would emboss a blank page with braille on both sides (i.e., interpoint) would be under the control of the computer. The result would be a considerable simplification in the printing process, since a continuous supply of paper would be fed to the press, four pages would be embossed at the same time (say, pages 1 and 100 on the first page, and page 2 and 99 on the second page to the right of the centrefold) seriatim. All that would be required at the output would be to staple a book and send it off to a reader. (See Appendix I for an "Executive Summary" of that proposal.)

If one assumes that this scheme would operate as described (of course we believe it would!), a crucial question then becomes whether the bulk of the braille presses around the world are flat bed or whether they are rotary. If the majority of presses were rotary, say, then we could not anticipate up-grading such presses by retrofitting of resettable plates as a very important advantage of our suggested scheme.

We were fortunate enough to engage the help of Mr. Vergil Zickel, formerly the supervisor of braille printing at the American Printing House for the Blind in Louisville, Kentucky, one of the world's largest producers of braille product. Mr. Zickel is now retired, and graciously consented to assist us in our enquiry. What he has discovered may well have interest for a wide variety of readers:

About 90 years ago the "thin plate" method for printing braille was developed. This replaced hand-set metal type and shallac-reinforced paper masters. The thin plate method employs a sheet of zinc, brass, iron,

and sometimes aluminium, roughly .010-inch (0.25 mm) thick and 11 inches wide by 22 inches long (c. 30 by 56 cm), which is folded to make a double plate 11 inches (30 cm) square. When embossed with braille dots, this thin plate becomes in effect a male and female die. To produce paper copies the paper is placed between the two parts of the metal plate, and pressure is applied to the outside surfaces of the plate.

The first printing presses resembled the wringer found on old-fashioned washing machines: the plate-paper sandwich was inserted into a wringer type of press having rubber rollers. In later models, the rubber rollers were replaced with metal rollers, a rubber pad being used to prevent the crushing of the braille dots.

Although the invention of the thin plate was a major advance, using it with a wringer type of press still entailed a slow and labour-intensive means of producing braille product. Soon after 1900, however, the flat bed press was adapted to accept the thin plate, making possible a true production procedure for making braille copies. With this method, plates could be changed in a few minutes, and press runs of 800 and 1500 copies per hour could be achieved. This combination of technologies has many advantages. Braille of the highest quality desired can be produced without difficulty; press speeds for all but the longest runs of copies are respectable; and the presses used are both rugged and simple to repair, since parts are widely available and the niceties of repair can be mastered by a wide variety of craftsmen. This last is so because in point of fact the braille press is essentially an adaptation of machines used in the folding box industry, and even when original tolerances for folding boxes are exceeded with the onset of wear of parts, the precision of braille is retained in the plates used for embossing. An additional advantage is that used presses of this type are readily available as folding machinery is replaced in general industry.

By using paper with a high moisture content that makes very durable braille pages, copies for school or other hard use can also be obtained easily with the flat bed press, in which the high pressures necessary to emboss such strong paper can be achieved.

The most recent refinement in braille presses was the fitting of automatic sheet feed mechanisms. These permit printing speeds two or three times greater than the hand-fed press.

A compilation of sources of standard and high speed presses is given in Appendix II, along with some representative current prices in the USA.

The final question we tried to answer in this investigation was the extent to which flat-bed vs. rotary presses can be found around the world. Although a definitive answer is not yet available, we anticipate that one will soon be. Dr. Jeanne Kenmore of the Helen Keller International, Inc., New York, initiated a survey of braille presses around the world during 1976, by requesting the completion of a remarkably extensive questionnaire by press operators concerning their equipments, organisation, and procedures. The data has been received from the field, but its analysis has been slowed by lack of time and available personnel. Dr. Kenmore indicated to us that the analysis of the data will proceed rapidly toward the end of this calendar year. But she was able to give us a preliminary opinion in answer to our query. It does seem evident that the flat bed press is the majority choice of equipment, if indeed not the overwhelming choice, around the world; that although the presses do wear and lose their initial precision, the precision of the braille printed is maintained by the precision of the plates used to print it; and that local craftsmen can and do learn to cope with the repairs to the relatively simple presses regardless of the state of technical development in a country, no matter where this may be in the world.

In sum, it may be said that the majority of the world's braille presses do offer interesting opportunities for upgrading by retrofitting of motor drive, and by computer assisted embossing plates when the conditions exist for these to be installed, i.e., when electric power is available, when motors and drive mechanisms are secured, and when advanced schemes such as resettable stereotype plates become deployed.

Appendix I

Research and Technological Research Department
Proposal to Enhance Production and Stabilise Costs of
Press Braille in Response to RFP 76-17 of the Library of
Congress - 17 May 1976

Executive Summary

In this proposal we suggest an innovation at the output or printing end of the press braille production process. In the present system, zinc plates are prepared on a stereotyper, inserted into a braille press, paper is fed to the press, and multiple copies of a page are made, stacked, and set aside. Pages are then collated for a book, and then stapled and bound. This process is followed even though the input to the stereotyper is machine-readable, and is the product of a computer transcription process that is highly automated.

In the proposed system, the output of the computer transcription from ink print to braille code is stored on a "floppy disc", part of a minicomputer system associated with the braille press. This text data is then fed to two electromechanical embossers, one at the top and one at the bottom of the braille flatbed press. The pins corresponding to the dots of the braille cell are raised into position and locked, paper is fed automatically into position, the press closes, the pins mate with holes in the opposite plate, and a fully interpointed page of braille is produced. Since the pins can be reset in the time it takes to bring a fresh piece of paper into position, and since the order in which pages are embossed can be programmed easily, an entire book can be embossed, the pages piled one on the other and, when the entire book is printed, it needs only stapling and/or binding to be shipped out. This method eliminates much labour-intensive costs of actual embossing, eliminates the stereotyper,

eliminates the use of zinc or other printing plates. In serial production, the programmable embossing plates and associated control system ought to earn their cost in a very few years. The system is simple and it is reliable.

Appendix II

Suppliers of Braille Presses in the USA

Hand-Fed Braille Presses

1. Thomason National Press Company
Franklin, Massachusetts
Model: Thomason Style 5, 14 x 22 Cutter and
Creaser (Hand Fed)
2. Chandler and Price, Inc.
6000 Carnegie Avenue
Cleveland, Ohio 44103
Model: C & P 14-1/2 x 22 Die Cutter and
Embossing (Hand Fed)
3. Used and Rebuilt Thomason and Chandler & Price
presses are available from:
 - (a) Everyready Machinist
137 West 19th Street
New York, New York 10011
 - (b) Nessler and Wagner Co., Inc.
818 Reedy Street
Cincinnati, Ohio 45202
4. Additional sources of supply will be found among
suppliers of printing and binding machinery in
many larger cities, who can set up such presses
to print braille.

Automatic Sheet-Fed Presses

1. Thomason National Press Company
Franklin, Massachusetts
Model: Thomason 17 x 25 Die Cutter
Price: US \$27,000 + US \$2500 for refitting to
produce braille
2. Chandler & Price, Inc.
6000 Carnegie Avenue
Cleveland, Ohio 44103
Model: C & P 14-1/2 x 22 Automatic Die Cutter
Price: US \$27,000 + US \$2500 for refitting to
produce braille
3. Heidelberg Eastern, Inc.
73-45 Woodhave Boulevard
Glendale, New York 11227
Model: Heidelberg 18 x 23 Cylinder Press
Price: US \$38,000 + US \$2500 for refitting to
produce braille

4. S. & W. Machine Company
532 East 12th Street
Cincinnati, Ohio 45210

Special Note: This firm, in cooperation with Mr. Martin Droege of the Clovernook Printing House for the Blind (7000 Hamilton Avenue, Cincinnati, Ohio), built the web-fed automatic press.

5. American Printing House for the Blind (APH)
Louisville, Kentucky

Special Note: The APH has several web fed cylinder presses that were designed and built by its own personnel.

History and Status of the
Computer Generated Braille Project

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In 1975 Region IV Education Service Center undertook a review of the textbook system in use in various districts with the objective of offering suggestions for increasing their effectiveness. Throughout the review recurrent problems with braille texts were indicated. Among these were:

1. Delays in receiving braille material.
2. Receiving the back sections of a braille text three months before receiving the front sections.
3. Unavailability of certain texts in braille.
4. Lack of current braille material.
5. Bulk of braille volumes and storage space required to house them.

These problems led to a study of the reading requirements of the blind or visually handicapped student. The study revealed the following conditions:

1. The blind student has available only a limited variety of reading material.
2. Extensive research or outside reading requires the employment of a human "reader", due to the limited availability of brailled material.

3. The elapsed time between the discovery of the requirement for a brailled publication and its availability can be 12 months or longer.
4. The blind student is further handicapped in that reading material of a current nature is not generally available to him in braille form.
5. Under present methods, the variety and timeliness of braille material is likely to be further reduced as fewer brailleists are being trained each year.

The study then shifted to methods employed in the preparation of braille material. The following determinations were made:

1. The manual process of transcribing braille texts is slow and expensive. Elapsed time for transcription of a text can be as much as a year. Cost is estimated at fifteen cents per page by the Atlanta School District.
2. Computer assisted braille texts are prepared by:
 - (a) Atlanta School District, Atlanta, Georgia
 - (b) Printing House for the Blind, Louisville, Kentucky
3. Braille samples prepared by the Atlanta School District appear inferior to manually transcribed braille.
4. Computer programs and technology exist to:
 - (a) Key punch a printed text, introduce the data to computer tape and convert the data to braille language, thus:
 - (i) Print a text by computer, or
 - (ii) Print a text by an automatic braille printer.

- (b) Type a text and create a cassette tape, introduce the tape to a computer and convert to braille and:
 - (i) Create a translated cassette tape for later embossing in braille, or
 - (ii) Drive an embosser to braille a text.
- (c) Obtain a publisher compositor's tape, introduce the tape to a computer, convert it to braille language and:
 - (i) Drive a page embosser creating a text, or
 - (ii) Create a translated braille tape to drive a braille press.

The need for more current and a wider variety of reading material for the blind and visually handicapped was certainly evident. Moreover it appeared that the blind student could benefit from participating in computer assisted instruction programs. It further appeared that a wider variety of vocational opportunities were needed by the visually handicapped. In addition, computer generated braille appeared not only feasible but cost effective.

Therefore, in the fall of 1976 the management of Region IV decided to make a substantial investment in hardware and talent to pioneer in the development of computer assisted techniques to aid the handicapped. Initial efforts were to be focused on the visually handicapped with some cursory investigations into the problems of the hearing handicapped. The Region proceeded to acquire a braille translation computer program, an interactive stationary high speed page braille embosser, a portable interactive tape embosser and a number of other related hardware items.

The Region's plans and objectives (Figs. 1 and 2 and Appendix) can be summarised as follows:

1. Develop computer assisted braille II translation capabilities to:
 - (a) Accept and translate typewritten input
 - (b) Accept and translate foreign languages
 - (c) Accept and translate publishers compositors tapes
 - (d) Accept and translate computer assisted instruction programs
 - (e) Accept and translate news wire service releases.
2. Test and evaluate various interactive embossing devices.
3. Establish a cassette library of translated braille reading material.
4. Provide braille text books and other student reading material from typewritten input and publishers compositors tapes.
5. Develop additional vocational opportunities for the visually handicapped.
6. Establish a daily news release capability on accessible computer disc.
7. Install a computer assisted instruction capability for the Texas School for the Blind and others schools for the visually handicapped.

Early in 1977 the Region received some assistance for the program in the form of a \$12,000 grant from the Governor's Coordinating Office for the Visually Handicapped. With these funds and some additional support from Region reserves the project was able to demonstrate a satisfactory braille II computer translated braille capability. From January through May the following projects were initiated:

- (i) School Textbooks - The elementary textbook "It Happened This Way" has been placed on cassette tape and translated. It is ready for publication once certain hardware modifications have been made to the braille embosser. The embosser generates what the manufacturer calls standard braille which deviates slightly from Library of Congress braille.
- (ii) Outside Reading Material - The minutes of the "AD HOC Advisory Committee of the Visually Handicapped" have been placed on cassette tape.
- (iii) Computer Assisted Instruction - CAI programs are currently operable in grade I braille. They are expected to be operable in grade II braille by September if funding is available.
- (iv) News Wire Service - Arrangements are being made with the Houston Post for a direct wire tie in to the Region IV computer. The computer file will be updated daily representing a mini-newspaper and processed through the translation program. Among other things the mini paper will contain World, National, State and City news summaries; Sport Scores; Weather; Reviews: Music/Theatre and Book Reviews; People; Commentary; Lynn Ashby; Names in the News; Today's Prayer; and Astrocast. The file will be accessible from any remote location by a braille embossing terminal.
- (v) Compositor Tapes - Arrangements were made through the Houston Post to obtain compositor's tapes so that work can commence on this facet of the program.
- (v) Vocational Applications - The Texas Bankers Association series entitled "Your Bank and

Personal Money Management" is being reviewed for conversion to a computer assisted instruction (CAI) program.

During the later part of May 1977 a small supplemental grant of \$2,160 was received from TEA to support the braille project through the month of June. During this period a more detailed review of problems associated with the translation of compositor's tapes was conducted.

It was determined that compositor's tapes are generally magnetic tapes or punched paper tape using a variety of bit structures and varied languages. This lack of standardisation represents the principle problem to be resolved in translation. A secondary problem will be the "culling" of extraneous press instructions from the text material. Arrangements are being made with Control Data Corporation to assist in resolving these problems.

A cursory review was made of the computer assisted instruction requirements of the Texas School for the Blind. As a result a proposal was prepared proposing the installation of interactive braille embossing terminals at the School. The terminals are to be "on line" with the Region IV computer in Houston making computer assisted instruction available to the students at the School. The Suppes CAI packages will be offered to the school along with the braille translation program, the mini newspaper, the computer games, the Region IV braille "library" and the occupation data bank.

In anticipation of acceptance of the proposal to the School for the Blind, discussions with CDC were initiated on modifying the translation program to accommodate CAI in grade II braille.

To support the School for the Blind installation the Region is seeking two additional grants of \$25,000 each. One grant is being sought from the Governor's

Coordinating Office for the Visually Handicapped and one
from the Texas Education Agency.

Fig. 1. Braille transcription system

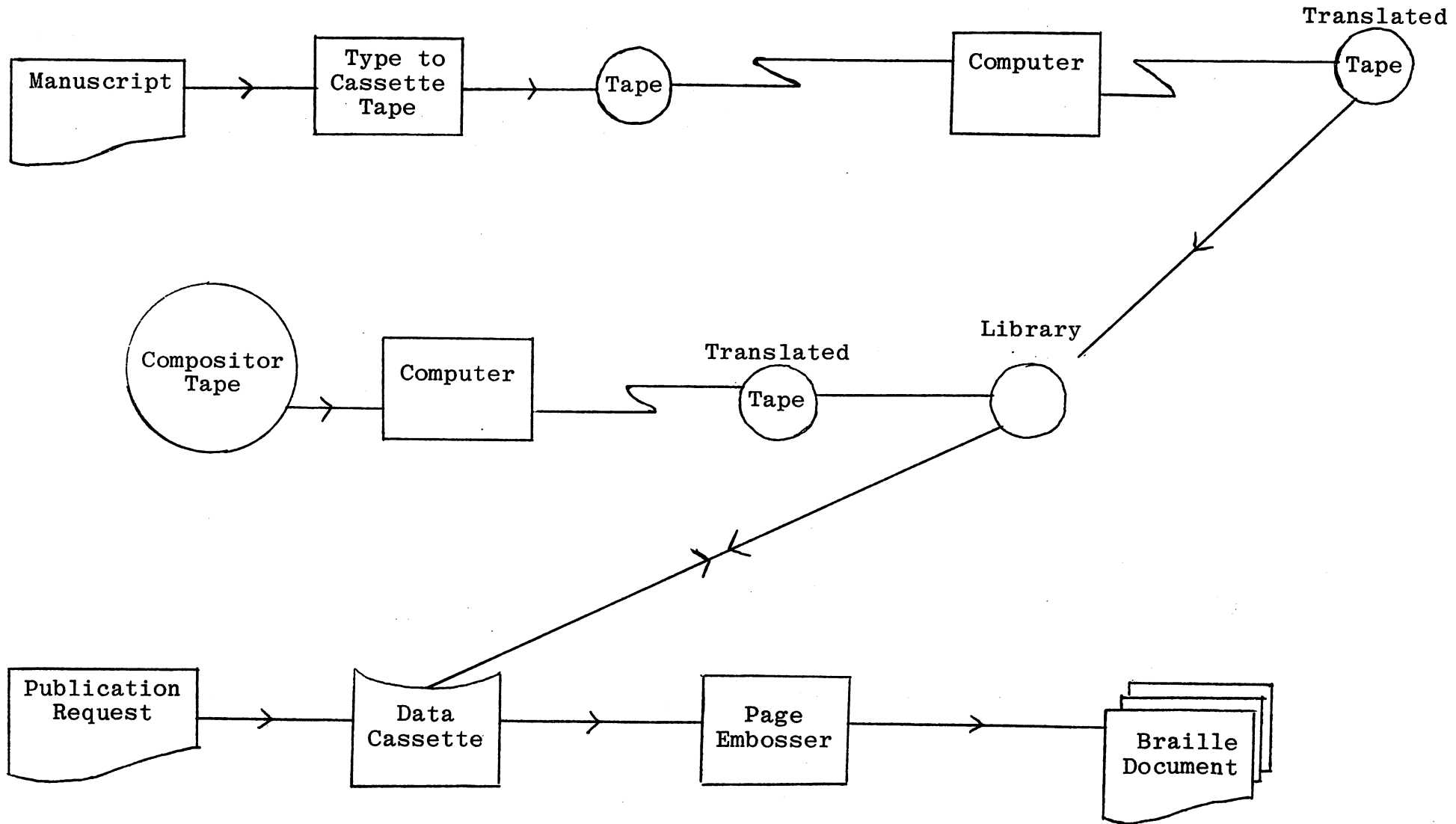
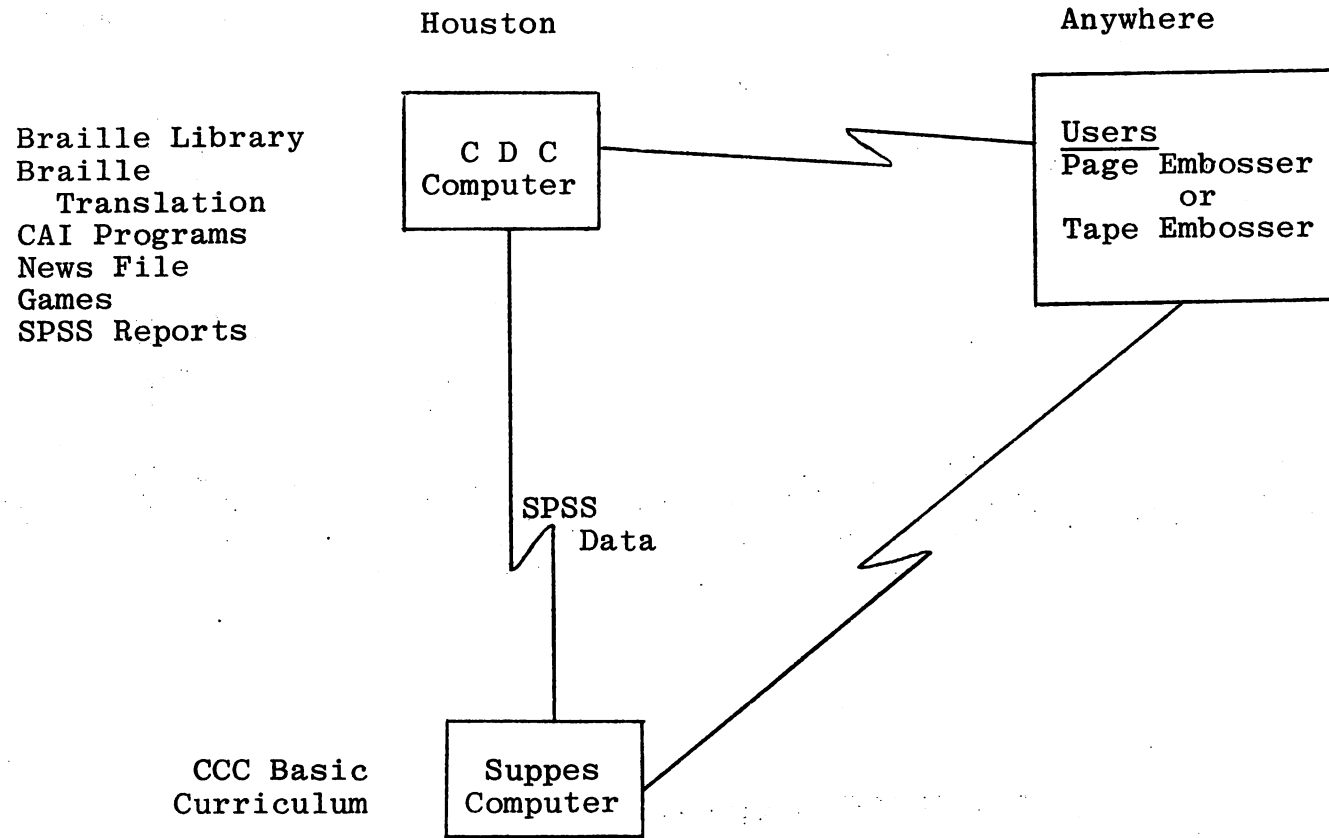


Fig. 2. Computer assisted instruction



Appendix - Objectives

Vocational Applications

Computer Programming
Banking
Brokerage
News Casting
Publishing
Employment Agencies
Weather Bureau
Government Agencies
Ministry

Future Projects

Foreign Language Translation
National Network of Braille Cassette Libraries
Music Translation
Computer Generated Embossed Graphics

Large Print

Exploratory

Computerised Variable Type Size Program
Laser Beam Recorder to Microfiche to Large Print

Deaf and Hard of Hearing

Exploratory

Computer Assisted Instruction

Total Communication Employing CRT's and
Computer Driven Microfiche
CAI Programs Oriented to the Deaf

An Alternative Approach to
Semi-Automatic Brailleing

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Overview of Process and Project

The approach here has been to develop an inexpensive way of producing braille using a program* for a small computer and existing hardware technology.

The principle constraint on any brailleing system is the cost; there must be little or none. Human services must be on a volunteer basis and hardware must be donated since there are rarely any funds that can be allocated for these purposes. With a view to the high cost of computer translations, the attempt here has been to use the Digital Equipment Corporation's PDP-8. It is a common and relatively inexpensive machine, which increases the likelihood that some owners of such computers would donate time on it to the production of braille. However, because it is a small computer (the smallest has a memory size of 4096, 12 bit words), generally without a large store of secondary memory, one could not always incorporate all the rules involving special symbols and word contraction in a program. Therefore, some of the responsibility for translation must be placed in the hands of a brailist. In order to avoid slow hand brailleing and the use of expensive, mechanical brailleing devices a specially modified ASR-33 teletype, a common PDP-8 peripheral device was used for embossing.

* The program is available from the University of Arizona.

The project consisted of an experiment to test the practicality and usefulness of this semi-automated approach and a survey to determine the feasibility of using donated PDP-8 computer time for braille production.

The Semi-automated Process

The semi-automated process is depicted in figure 1 and involves the following steps:

1. A trained brailist marks the text in pencil, indicating where Grade II contractions and some special braille symbols occur. This involves making a slash mark following one of 189 abbreviations or contractions in the text or placing one of 2 special symbols over a letter. For example:

Millions of/ dollar/s have/ been/
spent/ in/ developing/ devices for/
people/ who have/ visual and/ hear/ing/
loss. The/ over/wh/elming/ majority/
of/ these/ devices ar/e not curren/tly
in/ use.

This can be done rapidly since the actual contractions need not be indicated nor their braille equivalent known.

2. A typist creates a paper tape from the marked text using a program similar to EDITOR (a program used to write and modify programs for the PDP-8) to make corrections. The typist makes corrections in English and need have no special knowledge of braille. However, because the teletype lacks a lower case font, capitalisation is indicated by preceding a capitalised letter by an up-arrow (↑). The typist produces the following output for the paragraph above:

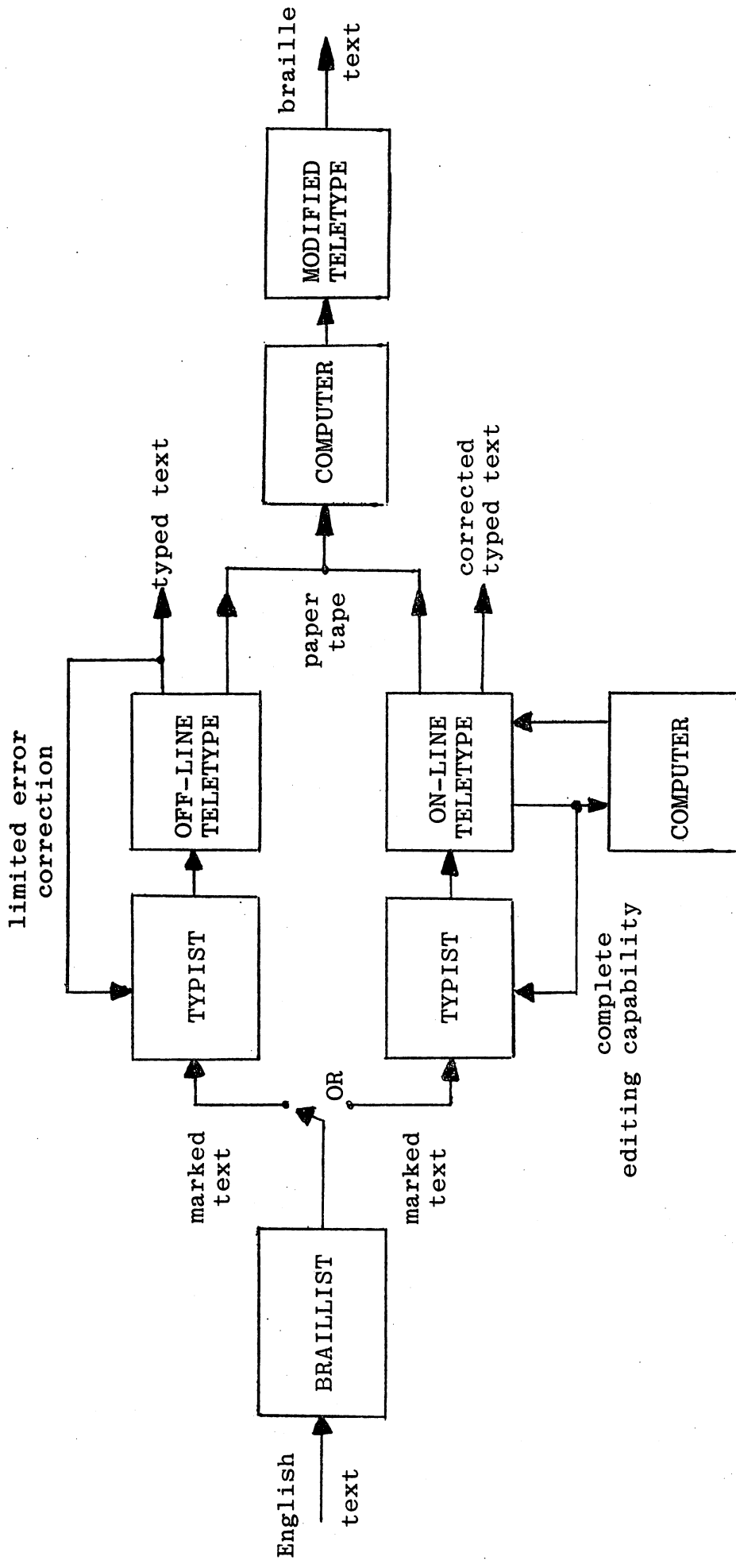


Figure 1. Diagram of the semi-automated English to braille translation process.

↑ MILLIONS OF/ DOLLAR/S HAVE/ BEEN/
SPENT/ IN/ DEVELOPING/ DEVICES FOR/
PEOPLE/ WHO HAVE/ VISUAL AND/ HEAR/ING/
LOSS. ↑ THE/ OVER/WH/ELMING/ MAJORITY/
OF/ THESE/ DEVICES AR/E NOT CURREN/TLY
IN/ USE.

If a computer is unavailable for this step, then the paper tape can be created, using the teletype alone. This, however, severely restricts the kinds of corrections that can easily be made. The paper tape must be backspaced to the error and "rubouts" punched over all the positions passed while backspacing. Then the text must be retyped, beginning at the point where the error occurred.

3. The regular type head on the ASR-33 teletype is replaced by one with steel pins which embosses $\frac{1}{2}$ a braille cell at a time, and a platen covered with surgical rubber is substituted for the hard rubber one (see Woodward and Anderson for other modifications). Then heavy bond paper is loaded.
4. The braille program is loaded, and the paper tape containing the text to be brailled is placed in the teletype paper tape reader.
5. The reader is turned on and the program started.
6. The program fills the input buffer with characters from the paper tape. When the buffer is filled, the program begins searching it for the occurrence of a string of characters for which there is a braille contraction. Where no such string is found, each letter is "spelled out". This means three letters are placed in an output buffer, which when printed will emboss the two halves of the braille cell and leave a space to separate cells. When a string of characters, which can

be contracted, is followed by a slash (/), the code for the appropriate braille contraction is placed in the output buffer. When a slash does not follow, the letters are "spelled out". If a slash is accidentally placed where no contraction occurs, it is ignored. The interrupt system is used to keep the input buffer full, concurrent with other processes. When enough characters have been placed in the output buffer, the line is embossed backwards, starting with the end of the last whole word in the buffer. This avoids the problem of dividing words at the end of the line and allows the page to be read from left-to-right when turned over.

7. The teletype is restored to the normal configuration.

The Experiment to Test the Semi-automated Approach

The plan of the experiment was to provide small amounts of braille, produced semi-automatically, on request, to meet the personal needs of the visually handicapped in the local environs. As it turned out, however, the service was used exclusively by four blind university students. Although the Tucson Chapter of Books for the Blind and Special Services in the University of Arizona Rehabilitation Center used the service, they did so to process "rush" orders given them by the students mentioned above.

The braillist recommended by the Tucson Chapter of Books for the Blind for the experiment was a trainee who had not completed her studies because arthritis had made the physical act of embossing too painful. Three student volunteer typists were provided by Special Services. For their work they received volunteer service credit as part of the requirements for a course in rehabilitation. They had only average typing skill.

The author had the responsibility for computer and teletype conversion operations, instructing the brailist how to prepare the text for semi-automatic braille, and teaching the typists how to type the text using the EDITOR program. Special Services provided the "in" box for material to be brailled, a central location for keeping track of the movement of the material through the various phases of its conversion to braille and the "out" box. Their personnel were of great assistance in planning and organisation, as well.

The Results of the Experiment

Training

The brailist experienced no problems adjusting to the use of the special symbols used to represent braille symbols or to marking the text rather than embossing. Indeed, she was relieved that her review of the rules of braille was considerably shortened, since she did not have to study the braille equivalents of English letters and contractions. The choice of marking the end of a contraction, rather than the beginning, made the movement across a line proceed smoothly and naturally, requiring no backtracking, except to double check a decision to contract a group of letters.

The typists quickly learned the location and typing of the few unusual symbols that were introduced into the text. They had no difficulty adjusting to the unusual means of capitalisation. However, they did experience problems adjusting to the use of the EDITOR program. Since they depended on the author for assistance, they received little practice on their own in correction procedures. As a result, they forgot the principle correction commands from one week to the next. It was apparent that the typists were somewhat in awe of the computer; so even when they knew the commands, they were hesitant to implement them without first consulting the author. One

typist, more accustomed to the typewriter, complained of the loud noise generated by the teletype. The other two managed to adapt to it, though a quieter device such as a DEC-WRITER can be used for editing purposes. The teletype is required only for the embossing step.

The author was responsible for converting the teletype to emboss the braille and for starting execution of the computer program. In general, the person responsible for teletype modifications requires some mechanical dexterity to perform the adjustments necessary to obtain maximum embossing height, without punching holes in the paper, and because fine adjustments are needed to return the teletype to normal operation. The computer program, once started, only rarely requires operator intervention. When dealing with very long paper tapes (over 2,000 words), the operator must be prepared to handle jams which necessitate restarting the process, since characters may have been misread. Attentiveness to the feeding of the tape can usually prevent this. The experience here has been that the heavy bond paper must be realigned at approximately $\frac{1}{2}$ hour intervals. This sometimes must be done with regular paper during particularly long print jobs. Toward the end of the experiment, it was discovered that the rubber cover for the print hammer needed replacement because it had been damaged by the pins on the braille punch head. The damage was the result of roughly 28,000 words embossed in this project (including tests of the program before the project was begun) and another related project which used the modified teletype (see Woodward, 1972).

The Time Required to Mark the Text

It was noted earlier that the brailist participating in this experiment had not brailled for some time and was out of practice. In the beginning she could only mark the text at approximately 20 words/minute. Nevertheless,

during the course of the experiment she achieved a rate of 33 words/minute. The rate, of course, will vary with the difficulty of the material because sometimes the rules must be consulted during the process. In a separate experiment, it was found that an experienced brailist with only a few minutes practice could mark the text at 70 words/minute. This means a 7 fold increase in brailist productivity, since a good brailist, while translating and embossing at the same time, can usually achieve, assuming one braille page contains 125 words, only 8-10 words/minute (see Goldish, p. 39).

The Time to Type and Edit

If no editing is done, a paper tape can be created as fast as one can type. If editing is done, three separate times must be considered:

1. The time the typist takes to type the text - which will vary with the skill of the typist;
2. The time the typist takes to make corrections - which depends on the typist's skill at typing and using the EDITOR program;
3. The time the editing program takes to make the paper tape - which is a constant rate limited by the output device used. The tele-type punches paper tape as fast as it can type - 10 characters/sec or 100 words/minute, if one assumes an average of 6 characters/word.

Assuming a typing speed of 40 words/minute, with negligible errors, and a tape punching speed of 100 words/minute, a paper tape can, theoretically, be created at the rate of

$$\frac{1}{\frac{1}{40 \text{ words/minute}} + \frac{1}{100 \text{ words/minute}}} = 29 \text{ words/minute}$$

The actual rates (computed from sample material used in the experiment) varied between 6-16 words/minute. The average of the rates was 10 words/minute. This can be attributed to a slower typing rate (some "hunting-and-pecking" was observed) and mistakes which required a correction procedure. Additional time was lost because the typist usually requested confirmation or assistance for a correction.

The Times for Changeover

The time to modify the teletype for braille embossing at first took as long as 20 minutes, but with practice, could be done in 7 minutes, including final adjustments. Restoring the teletype to normal operation took a little longer, generally 10 minutes. More time was required because the normal print head requires finer adjustments than the braille head.

The Time to Emboss

If one assumes the number of braille symbols (e.g. capital and number signs) introduced into the text to be negligible, then because each English letter requires three punches to make the braille equivalent, Grade I braille can proceed at 1/3 the normal teletype speed, or 33 1/3 words/minute. The time required by the program to search a table for the braille equivalent of a letter, symbol, or contraction produces no delay in embossing, because before the carriage return and line feed from the previous line are completed by the teletype, the next line has been processed and buffered.

The program is never delayed by a lack of text to translate because reading, input buffering, the substitution of braille characters for English characters, and output buffering is three times faster than embossing. The result is that the paper tape reader is often idle

and the program is quiescent, waiting for the teletype to finish printing a character so it can be given another one. A negligible amount of time is spent actually translating text to braille. Therefore, because Grade II braille requires fewer symbols to be printed than Grade I, the embossing rate for Grade II should be faster than 33 words/minute. In practice, embossing rates for samples of text varied between 26 and 75 words/minute. The average of the rates was 36 words/minute.

Turnaround

The time required to process and return to the braille user material submitted for brailleing varied from same-day service to as long as three weeks when the brailist was unavailable. Some material was delayed to process requests considered more urgent.

The average turnaround (excluding delays caused by the absence of the brailist or author) was about eight days. The delay was about a week because two or three typing sessions (two per week) were required to complete a batch of text to be submitted to the brailleing program. Turnaround could have been much faster if paper tapes were converted to braille as soon as they were completed rather than batching the tapes for one embossing session.

The Types of Material Brailled

The first material to be brailled was ten copies of the announcement of the Semi-automated Braille Project which was to be distributed, by Books for the Blind and Special Services, to potential users. Special Services requested six braille copies of their newsletter and three copies of a brochure describing services and aids for the handicapped at the University of Arizona. The students used the service to obtain braille copies of mimeographed handouts they received in their courses. The handouts included syllabuses, record lists, student teaching guides and assignment lists, biographical sketches and others.

The Translation Quality

As long as the program is functioning properly, the translation will be as good as hand braille, perhaps even better since corrections are not as tedious and marking is not as tiring as embossing. However, feedback from one user indicated the contraction for "sh" was not being used, rather the letters "s" and "h" were being spelled out. An examination of the paper tape record revealed that the "sh" had not been typed with a slash, indicating that it should be contracted. This was an omission by either the typist or brailist.

The Page Quality

Users of the service found cell size and alignment to be acceptable. However, while regular braille will "rub down", the embossing done by the teletype rubbed down too easily. The paper used, while a heavy bond, was not as heavy as that used in standard braille, which was found to be too hard for the pins on the teletype head to penetrate. Experiments with softer rubber platens and layers of different rubbers and sponge rubber did not seem to increase the penetrating ability of the punch in an acceptable manner. If the platen was too soft then the dots were not defined clearly enough. Experiments with different pin lengths did not make an appreciable improvement either. Surgical rubber tubing seemed to be the best choice after all.

The addition of a spring across the empty ribbon guides to give the print head more striking force, while not improving embossing height, reduced the number of adjustments needed to provide maximum height.

The least expensive approach to prevent flattening of the embossed page through use was to spray paint or lacquer it. This is normally done with books for the blind. A more expensive approach that provides permanent copies is to thermoform the page. This is the braille equivalent to photocopying.

Per Unit Output Analysis

The semi-automated approach has three rates that must be considered:

1. The rate at which the brailist marks the text.
2. The rate at which typing and corrections are made to the text, and a paper tape created.
3. The rate at which embossing is done.

Figure 2 illustrates the upper bounds for the rates mentioned above, and the rates obtained by averaging the individual rates computed for material used in the experiment.

	Brailist	Typing and Corrections	Embossing
Upper bound using the EDITOR program	70 (best)	29 ²	33.3 ⁴
Upper bound punching the paper tape directly	70 (best)	40 ^{2,3}	33.3 ⁴
Average rates ¹	33 (best for brailist in the Experiment)	10	36

¹These were obtained by averaging the individual rates for the material used in the experiment.

²These figures assume a negligible number of corrections are needed.

³If a mistake is discovered when the tape is finally completed, it may have to be retyped from the point the error occurred.

⁴Embossing is done at 1/3 the normal teletype speed.

Figure 2. Upper bounds and average rates for the steps in the semi-automated brailleing process.

The upper bound for the overall semi-automated rate using the EDITOR program is:

$$\frac{1}{1/70 \text{ words/minute} + 1/29 \text{ words/minute} + 1/33.3 \text{ words/minute}} = 13 \text{ words/minute.}$$

The upperbound for the overall rate, punching the paper tape directly, is:

$$\frac{1}{1/70 \text{ words/minute} + 1/40 \text{ words/minute} + 1/33.3 \text{ words/minute}} = 14 \text{ words/minute.}$$

The actual overall rate resulting from actual measurements was:

$$\frac{1}{1/33 \text{ words/minute} + 1/10 \text{ words/minute} + 1/36 \text{ words/minute}} = 6 \text{ words/minute.}$$

The lower actual rate can be attributed to generally lower individual rates. The average marking rate for the brailist helping in the experiment was lower than that of an experienced brailist because she was less practiced. The typist used in the experiment typed less than 40 words/minute. The typists, naturally, did make mistakes; and time was required, not only to make the corrections, but to instruct them how they should be made.

Evaluation

Tucson Books for the Blind remarked that our services eased the pressure on them because the Human Factors Laboratory could handle small "rush orders" they found inconvenient. Through the service, Special Services in the University of Arizona Rehabilitation Center could provide their newsletter to their blind clients. Normally,

the newsletter would get a very low priority since its contents are not directly related to essential school work. The fact that the semi-automated approach allowed the newsletter to be brailled by people who, individually, could not translate braille serves to illustrate how this approach can be used to more fully integrate the blind into sighted society. Beyond that, the key individual in the process, the brailist, found her task greatly simplified and her productivity increased because she didn't have to emboss nor did she have to know the braille equivalent for contractions. These are factors which would also simplify the training program for prospective braillists, which, as mentioned earlier, has a 70% certification rate.

The typists found it difficult to remember text correction procedures. Their slow learning of the EDITOR procedures could be improved with more careful instruction or the use of volunteer typists familiar with the program. It should be noted that the use of text correction programs in the publishing industry, by people who would otherwise be unfamiliar with computers, is increasing.

Paper tape used to store a copy of the text to be brailled was found to be bulky and inconvenient. However, a generation of PDP-8 users have managed. The program can be easily modified, using standard routines, to accept input from DEC-TAPES, tape cassettes, or disks. Paper tapes were chosen as the standard because every ASR-33 can handle them, and an ASR-33 is needed for embossing.

The degradation of normal printing, caused by the braille punch head damaging the rubber cover for the print hammer, can be prevented by keeping two covers. One can be used for normal printing and the other for braille embossing. Switching them is a trivial operation. In this case, the damage occurred over a period of many months.

The single instance of inaccurate translation found during the course of the experiment was due to omissions by the brailist or typist.

The durability of the embossed page, over that used during most of the experiment, can be improved by a coat of spray paint or lacquer. The use of an additional spring on the teletype reduced the number of adjustments needed to obtain optimum embossing height.

Conclusions for the Semi-automatic Braille Portion of The Project

During the two months that the service was offered, the over 25,000 words of braille produced demonstrated:

1. The semi-automated approach eased the burden on the local braille producing agency by using people who individually could not produce braille, but working in concert could.
2. Using the process has been shown to increase the productivity of a brailist as much as seven times.
3. The translation quality is as good as the brailist's knowledge of braille and the typist's accuracy in transcribing it. The process is failsafe when a point is marked for which no contraction exists because the slash is ignored.
4. Page quality is adequate when lacquered or thermoformed.
5. If a typist can type 40 words/minute, the semi-automated rate can exceed that of hand braille and corrections are considerably easier to make in the semi-automated approach.

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Argonne System for Braille Publication

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In 1966 this author published a paper* in which he suggested that it may be advisable to base dissemination of braille reading material on a new technology; namely, storing braille information on magnetic tape and to present the corresponding text to the user in a continuous stream of braille characters (in non-permanent form) whenever the user wishes to read it. A specification was proposed in this paper in the hope of stimulating experimentation, and as a basis for our own efforts at realising the idea. This specification reads as follows:

1. The machine should be conveniently portable. This implies at least an optional battery operation, and a weight of approximately 4.54 kg.
2. The machine should be inexpensive. An estimated production cost of less than £500 should put it within the financial means of professionals. There are approximately 380,000 blind or severely visually handicapped people in the United States. Let us assume that one out of eight in this population reads braille intensively when braille reading material is more widely available. Free distribution of reading machines to those who need them would then entail expenditure of approximately \$25 million - not an excessive amount by government or foundation standards.
3. The machine should be durable, with simple and convenient controls, and should require

* Science, Oct. 7, 1966 (Vol. 154, No. 3745)

standard supplies such as batteries.

4. Presentation of material should be made in the B.1 mode, and the characters should be erased after they have been read.
5. The machine should allow the magnetic tape to move quickly forward and backward, permitting the reader to locate any desired page or passage of text easily.
6. The code used on the magnetic tape should be producible as direct computer output. It should include pagination, indexing, and cueing features for the reader.
7. The tape (including box and reel) should contain at least 1000 words per cubic centimeter of space it occupies to make the system competitive with ink-print volumes.
8. The maximum rate at which the machine presents characters should exceed 22 characters per second. (Three of our subjects routinely achieved this remarkable speed.)

In addition to these requirements, certain accessory features would be highly desirable with regard to the use of the machine for writing and annotating. With the addition of a device incorporating a braille typewriter keyboard, it should be possible to type directly onto magnetic tape. A blind author could then have his text translated into standard print by means of a computer. More commonly, it would simplify his letter writing and note taking, and would also be useful for making annotations in space providing on book tapes.

Since then a continuous effort has been undertaken* at Argonne National Laboratory with corresponding equipment; if compliance with the specification is a measure of success, this effort has succeeded; several more or less systematic tests have been performed with more than 50 subjects,** which seem to confirm that the original criteria in the specification for a useful device were intelligently chosen; most users expressed subjective satisfaction, ranging from qualified or reluctant acceptance to enthusiasm. The U.S. Government, which provided substantive funds for the whole enterprise, obtained a patent on the product in November, 1971 - ancillary devices and methods, especially for the efficient production of tapes, were also developed as part of the whole program and tried out. Extensive market and population studies in this context by a consultant were performed.

Before we felt ready to set specific goals for our work, we felt it necessary to develop a better understanding of the problems than we had. Especially, we wanted to know more about braille reading single word speed potential, and about the most acceptable modes of presentation. The results of a separate study and series of experiments were published in the paper mentioned; they can be summarised as follows:

With dots of normal braille configuration (inter and intra cell spacing of 3.75 and 2.5 mm respectively), the ability to resolve dot patterns by touch is lost at a relative velocity of dots and finger tips of ≥ 13.75 cm sec^{-1} or 22 char. sec^{-1} . These findings were remarkably consistent for each subject as well as for the group as a whole.*** The reading speed recorded in actual reading coincided with this resolution limit for the most

* under this author's direction.

** both sexes, age 6 to 55, pre-existing reading speeds 5 to 218 words per minute.

***this suggests to us a neurological constant.

accomplished readers we have observed* (~ one in ten of the many we did observe over the years). The other finding of the preliminary research was that a continuous stream of characters, passing under fingers which are essentially stationary, is not only an acceptable, but in most cases the preferred mode of presentation.

We then proceeded to design, build and test a prototype, a preproduction model and 30 machines, as well as supporting equipment, etc. The basic components of all our models are the tape deck module with provisions for readout, the fast forward and rewind operations; the braille readout module with an endless plastic belt, on which bi-stable "bubbles" are molded in braille cell configuration, solenoid-driven styli and erase means, which set appropriate dots and depress them after they have been read, provided with a variable speed drive; the data processing and electronic module, which controls the deck and output operations, stylus synchronisation and position sensing, and allows the user to advance the tape to pre-selected (index) positions, tape writing functions and mode selection**; the 8 watt, 12 V power supply (on or off net, with ~2.5 hr. battery operation capacity).

The machine weights presently ~4 kg and measures 23 x 33 x 7 cm; when tooling for use of stampings, castings, etc., are provided for serial production, the weight would be reduced by at least one-third, and other economies are predictable.

* the reading speed reported (up to 320 wpm, the equivalent of 22 char. per second in Grade II English Braille) have been questioned by some professionals, but to my knowledge, neither our method nor these results have ever been invalidated by analyses or experiment.

** The machine reads tapes and writes on tape; if blank spaces are provided on a "book tape" one may make annotations on this tape without deleting the text, and the machine can be directed to read either "book" or "notes" (and to ignore the other); it will move forward, and if an index is selected by the operator, stop automatically at the position indicated. With a writer/editor attachment, a paper copy is produced, and if checked and found satisfactory, the text is automatically transferred from memory to tape.

The controls for the operator's directions are:

- On/Off switch
- Tape channel selector switch
- Index position selector
- Speed control
- Belt start control, operated by touching the belt or by means of a foot switch
- Push buttons for:
 - Read book
 - Read notes
 - Write
 - Fast forward
 - Rewind

Reading speeds are currently:

<u>Speed</u>	<u>Speed Equivalents</u>	
	<u>Characters Per Second</u>	<u>Approximate Words Per Minute*</u>
1	5.3	71
2	6.9	92
3	8.5	113
4	10.6	141
5	13.3	177
6	16.4	219

* Computed with 4.5 characters per word, including spaces and punctuation. Character counts, on several samples we have used, ranged from ~ 4.2 - 5.0 and may easily exceed this range.

Other speeds can be implemented easily.

Few people encountered any difficulties with operating the controls. Loading tapes, and to a lesser degree, removing them, however, requires some skill and practice. We have designed the tape deck around a cartridge containing ~ 300 feet of ¼" tape. Because the cartridge requires a complex molding for a housing, we have on the

prototypes used plain (open) 3¼" dia. reels;** the loading difficulty will be eliminated by the switch to cartridges. The reason why we have not used the popular Philips cassettes is connected to the small amount of tape they contain in a given package size. This affects the signal to noise ratio, the storage density and tape stability adversely, singly or in combination; furthermore, the cost of high quality cassettes is relatively high. For experimental or proof of principle design, these factors are irrelevant; i.e., they can - at tolerable cost - be circumvented simply by yielding on storage density. But, as soon as one looks at a consumer product with a main market for individual users, libraries, agencies and so on, even moderate savings in initial price, storage space, mailing cost, and wear and tear accumulate to very sizable factors. Furthermore, the frustration associated with even occasional interruption of access when a cassette fouls the tape, and the convenience of maximal compactness in real life situations should be emphasised. All these factors are directly related to track length available and thickness of carrier used, thus to volume of tape contained in a given package size and weight, and the cassette with its large void spaces and components other than tape is heavily compromised in this regard.

The main question is, of course, how well users are doing with the machine in reading. We have striven to make the experience nearly identical to "normal" braille reading and thereby make learning or re-learning unnecessary. Actually, we found a somewhat more complex situation; firstly, the feel of the plastic reading belt is, of course, different from that of paper; it resembles in this respect thermoformed braille on plastic sheets, which most people like somewhat less than paper, but accept because of its availability. Furthermore, the expectation that users would be able to read with the machine spontaneously up to their usual highest speed turned out to be true only with a small percentage of our

** The machine will, however, accept the cartridge without change.

sample; interestingly, the learning time required is apparently inversely correlated to the pre-existing speed maximum and to reading habitually with a very light touch. Initial difficulties are, furthermore, not surprisingly, often due to a lack of self-confidence or exceedingly competitive attitudes. We were impressed by the finding that the people who read braille much slower than the maximum described earlier seem to exceed their pre-existing top speed considerably after practicing with the machine. It is probably significant - perhaps not only for the special experience at issue here - that learning as a function of experience seems to follow a regular way: We defined "experience" as the product of time spent in practice, modified by an empirical constant multiplier, to be assigned to the individual who is learning, based on progress observed over a period of time. The parameters are h = (hours) learning time and C_n = efficiency multiplier of subject, $E = C_n \cdot h$ and S = reading speed. We found that with growing experience the speed tends to approach the maximum of 22 char. sec⁻¹ as $S \sim E^{\frac{1}{4}} c$. where c is a proportionality constant.

Conclusions

In conclusion, we submit the following observations:

1. Almost ten percent of the sample found the machine immediately acceptable from the start and used it skillfully even at the higher speeds.
2. Another group, four-fifths of the sample, experienced at least some difficulties in reading with the machine but could read more or less well from the start, at the very least some words at the slowest speed. Those people who continued reading for several hours improved considerably; their reading speed increased along what appears to be a regular

curve towards a maximum in the range of speed typical of the group mentioned in 1. It is especially noteworthy that the reading speed of some of the participants surpassed their individual scores measured with regular braille before exposure to the new system.

3. The remainder of the sample (roughly 10 percent) who did not demonstrate a clear ability to read at Speed 1 after a short exposure, were not followed up, because our resources and the pressure to collect necessary data for development of the equipment did not allow us to develop their skills over longer periods. Some of this group would probably have responded to such efforts.
4. The learning curve suggests a causal relationship between reading steadily moving braille characters and resulting reading speed improvements.
5. The learning curve suggests that the new system could be used to develop braille reading skills.

All students ranging in age from six to eighteen could read spaced words metered on the machine,⁽⁶⁾ and approximately half could read some continuous text.

Even very young children demonstrated that they can decipher some braille passing under their fingers at a rate of approximately five characters per second.

One student progressed from reading spaced to continuous material, and another student read spaced phrases as well as singly-spaced words after some practice. We believe several more who were improving in their ability to handle spaced material would have made this shift with further practice. Spaced material,

then, seems promising as a training format; it has been with beginners and with others who have difficulty reading on the machine.

6. At least four factors seem to account for ability to read on the machine: prior braille reading speed, finger sensitivity, motivation, and practice.

Notes and References

1. Most reading speed of participants were measured using a selection from The American Adventure, by K. Bailey et al., Field Ed. Publications, Inc., San Francisco, 1970 (7th grade level on Fry Readability Index.) The younger children were tested using an unfamiliar passage in their basic reader.
2. Designs for a self-threading tape mechanism exist but are not yet incorporated into the system.
3. A separate report will cover an investigation of the influential variables leading to acceptance of dots and methods to optimise this acceptance by modification of the dots.
4. Spaced material was not tried with the six early subjects listed in Table 3 as non-readers.
 - (a) Final Report Summary (A. Grunwald - Internal Report)
 - (b) How to Use the Braille Machine (P. Bieseimer)
A user's guide explains how to read, write, index, and load the Braille Machine; suggestions for care of tapes and machine are made.

- (c) Development of the Argonne Braille Machine -
Summary Status Report, December 1972 (A. Grunwald
et al.)

The development of the Braille Machine is outlined,
and work remaining to be done, fabrication of 30
machines, and generation of reading tapes are
described.

- (d) Case History of a Bio-Engineering Project, The
Argonne Braille Machine (A. Grunwald, RESA Lecture,
March 9, 1972)

The braille reading process is examined and
maximum reading speeds are determined, as
preliminaries to designing a braille machine
with moving braille characters.

- (e) A Magnetic Tape Braille Machine (J. Haasl and
W. Lidinsky, ANL T.M. 176, April 1969)

The system approach, electronic memory and
control package, and read-write electronics
for the new Braille System are described.

- (f) On Reading and Reading Braille (A. Grunwald,
Proceedings Braille Research and Development
Conference, sponsored by Sensory Aids Evaluation
and Development Centre, M.I.T., 1966)

Results of braille reading tests, with and without
vocalisation and with continuous as well as
random patterns, indicate that pattern
recognition in reading is not correlated to
comprehension and is a dynamic rather than a
static process.

- (g) A Braille Reading Machine (A. Grunwald, SCIENCE
154 (1966) 144-146)

The Braille Machine concept is presented, together
with experiments to determine specifications for
the device, and reader preference with regard to
different modes of braille presentation.

- (h) The Reading Belt of the Braille Machine (A. Grunwald - Internal Report)

Belt performance is analysed both objectively and subjectively. Remaining problems include dot height, belt deterioration and weld distortion.

- (i) The Beltmaker (A. Grunwald and T. Pienias - Internal Report)

The Beltmaker is described and directions for its proper use and maintenance are given.

- (j) Argonne Tape Production Facility Systems Description (R. Foster and W. Lidinsky - ANL T.M. 308, June 1977)

The operation of the Tape Production facility is described, including both the system hardware and the system software.

- (k) Argonne Braille Machine Tape Production Facility User Guide (R. Foster ANL T.M. 307, June 1977)

- (l) Argonne Portable Braille Input Editor (B. Kroupa, W. Lidinsky, and A. Grunwald - ANL T.M. 309, June 1977)

A device, based on the Perkins Brailler, is described which (in conjunction with the Braille Machine) allows an operator (who may be blind) to write on magnetic tape; the tape may be read back on the Braille Machine. For editing and correcting the input before recording, a paper braille copy is presented to the operator.

- (m) An On-Line System for Immediate Braille Presentation of Computer-Stored Information to the Blind (A. Grunwald and R. Vonderohe, 1972 Carnahan Conference on Electronic Prosthetics, Lexington, Kentucky, Sept. 1972)

Procedures are described which permit using the braille display mechanism of the Argonne Braille

Machine in a computer terminal for blind clerical workers in lieu of the C.R.T. devices commonly used in such applications.

- (n) The Development of a Computerised Grade II Braille Translation Algorithm (L. Leffler, A. Grunwald and W. Lidinsky, 1971 Wescon Conference, San Francisco)
The development of a computerised modular translation system is described. Acceptable Grade II Braille tapes can be produced for use on the Argonne Braille Machine.

- (o) The Argonne Braille Translator (L. Leffler and S.M. Prastein - Internal Report)
The Argonne Braille Translator transforms type-setter oriented input (such as monotype paper tape) into a master magnetic tape suitable for replication of tape for the Argonne Braille Machine.

- (p) Prospects for Utilisation of Composer's Tape in the Production of Braille (G. Grunwald, Study for ANL)
Information obtained from a literature search, a questionnaire, and interviews with publishing houses suggests that composer's tape will have little effect on Braille production: very few titles get on tape completely; tapes are kept only briefly after printing; and different formats are used.

The BRS 76 Braillocord System

Main Features of the Braillocord BRS 76

This braille reading and writing system receives and sends out information in a format of 32 lines of 32 characters each. This is approximately the information content of a typical page of braille. The information is stored in an ordinary C-60 or C-90 magnetic tape cassette, the same as used in audio applications in the common cassette recorder. Using one C-90 compact cassette, up to 400 pages of text can be stored and retrieved. Playback of braille text occurs without unwanted pauses on an electromechanical braille line, a line at a time, from the electronic buffer store, with the operation of a single key. Reading can be done at a rate selected by the individual user, in the manner he is accustomed to in reading ordinary braille pages. Text can be in contracted or uncontracted braille code.

Reading Functions and Use

As mentioned, the 'large page' format of 32 lines of 32 characters on each line is the format used. Each line is returned for reading on the tactile braille line display. Each line is brought up by pressing a key when one reaches the end of a line of text on the display. A single line can be recalled for re-reading or for text study. There is unrestricted selection for recall of lines in a given page stored in the memory, whether forward or backward from a given point in the text, via a comfortably spring-loaded key.

"Page turning", or in this System the passing from one block of stored text to the next, is accomplished automatically.

One can order a search run for a selected page of text (selected, for example, from a table of contents of a book) through a special entry key. The criteria for search can be selected with considerable freedom.

Writing/Editing Function and Use

The format used for entry of text is the same as for reading, i.e., 32 lines of braille text of 32 characters per line. The keyboard allows the selection of functions: reading, writing, editing. The keyboard contains the usual six keys plus space key for entering braille information. In editing, one has a braille character recall key which searches out the place in the text where a correction is to be made. Editing can also be accomplished in the reading mode if one wishes.

A change line key has multiple functions. It will allow passing over a next line of text of a page just entered, and cancellation of just-entered text under constant control via the braille line. Finally, one can change lines to read-and-correct in one pass.

There is a "record" or "enter" key allowing one to insert a correction at a predetermined location of page and line.

There is also a "start position" key which selects the first character to appear on the first line of a page, that is, a "begin to write" key.

Audible Signals

Several kinds of signals aid the editing of text. There is a signal for the end of a line, for example, which becomes an intermittent tone at the point where one enters the 25th character. There is also an end-of-page signal which begins at the beginning of the 32nd line of text and this continues to the end of the line. There is a special signal for the end of the page. Another signal indicates that the device is in record mode, and

also signals when recording is stopped. There is a signal indicating an automatic run-through of the possible remainder of an unfilled written page after one has pushed in the record key.

Corrections in Editing

Line-by-line control of the text material of the last written page is available, with easy correction of mistakes, whether these exist in memory or only on the braille line. Correction is effected with an overwriting of the incorrect character on the line, after which a correction is made automatically in memory. Thus, error-free text can be guaranteed with a quite modest investment of effort. As in the reading mode, one can hold a line of text at the end of the line of text entry. And, as in reading, there is unrestricted selection of lines in a text, whether in a forward or backward direction, that is always available.

Additional Data and Features

Connections are available on the basic unit to create a community of users, locally or remotely.

Cassette duplication is possible from the mother-cassette.

The entire system has been developed around modular construction so there are several possibilities for further expansion of its capabilities.

Accessory modules are now in preparation. In due course, they will be added on to the keyboard for entering text.

Finally, there is a connection which allows the easy transfer of text to or from larger open reel tape recorders.

Specification

Storage capacity: 400 pages of 32 lines of braille
on each C-90 cassette

Dimensions of basic unit: 35 cm wide x 14 cm high x 33 cm
deep (14 x 5.5 x 13 inches)

Weight: About 7 kg (15.4 pounds)

Developers

Laboratory prototype development was done by Heinrich Hertz Institute for Information Processing Technology Berlin, Inc. This work was supported by the Senator for Commerce, Berlin (as ERP special project).

Production prototype engineering, and serial production was done by:

AID Electronic GmbH Berlin
Wilhelm von Siemens Strasse 16-18
D 1000 Berlin 48

The AID Electronic GmbH/Berlin telephone number is:
030 741 7083.

This work was supported by the German Ministry for Research and Technology (BMFT).

The current price of the basic unit is DM 8,450 (approximately US \$3521, or Sterling £2071). The price will decline as serial production increases.

(Translated from German by L.L. Clark).

TSPS Braille Display

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The MIT Sensory Aids Evaluation and Development Center, in conjunction with the Arkansas division of Southwestern Bell Telephone and the Arkansas Enterprises for the Blind, Inc., have equipped a modern central office operator's console for use by a blind operator. A single braille line, electronically controlled, has been connected to a Traffic Service Position System (TSPS) console. Most of the interaction between telephone users and telephone operators - except directory assistance - occurs through these consoles. With this braille display, a blind operator can be competitive with sighted operators.

The TSPS braille display consists of 12 cells and is controlled by a Motorola MC 6800 microprocessor. Each cell is connected to a separate I/O port (1/2 of a PIA, Peripheral Interface Adapter). The braille display is hardwired to the TSPS console.

The TSPS console has a 12-digit numeric display and approximately 80 lamps. The microprocessor scans the lamps in an appropriate sequence to determine the status of the TSPS console. Any change in the TSPS numeric display causes an interrupt-controlled transfer of data to the microprocessor.

The blind operator uses all the console controls that are used by the sighted operator, except all information from the console is read from the 12-cell braille display. When a new call is received, the initial braille message provides sufficient information for the operator to make the correct response to the customer. Actions by the operator in servicing the call changes the status of the various lamps of the console. The braille message changes with each change of console status, permitting verification of the action taken.

Six control push buttons on the braille display enable the operator to select different braille messages as required. For example, the operator knows when numbers are displayed on the TSPS console. Pressing one of the push buttons causes this data to become the braille message; e.g., time and charges for a pay telephone. Depressing another push button returns the braille display to the previous message.

Another push button causes the messages to be sequenced through in the reverse of the order in which they were initially presented, while yet another cycles them through in the original order. With the provision of these six extra push buttons, essentially all the information presented by the lights or numeric display on the TSPS console is rapidly and concisely available to the operator.

The single-line braille display was assembled from modules containing two cells. All dimensions of the individual cells and of the braille line are essentially the same as a braille line produced by a Perkins braille writer. A two-cell module was dictated by the smallest reliable commercial solenoid available at the time the braille display was initially designed. These solenoids are 7/16 inch in diameter, permitting stacking on 1/2 inch centres, twice the pitch of the braille cell. Each module consists of two identical cells nested together. The completed module extends 4 1/2 inches below the reading surface and about 8 1/2 inches perpendicular to the braille line.

The solenoids are stacked vertically, pointing toward the centre, with plungers moving horizontally. Cams or levers are used to transfer the horizontal plunger motion to the required vertical motion of the pins. Two types of cams are needed, one type for the inside pins and another for the outside pins. The cams are made of brass, while the braille pins are made of steel. Delrin is used for

both the top and lower guides. Snap rings are used to limit the travel of the solenoid plungers and to provide surfaces on the braille pins which the return spring can act against. The module body is made of aluminium.

The cells do not have latching capability; hence power must be expended to hold a pin in the Up position. A latch similar to that developed by Sutherland (ref. 1) could be incorporated at the expense of making the cells 1/2 to 3/4 inch deeper. While latching capability would slightly complicate the control of the cell, it would significantly reduce power consumption.

Initial results have been very encouraging. The present operator can handle essentially all calls without assistance, with the exception of those which require manual timing. The manual timing information is placed on special computer cards and read by an Optical Character Reader (OCR). A template has been made to assist in marking the cards, the rubber stamps have been provided to mark them. Some changes in the microprocessor program are required to make the braille display reflect immediately the change in the supervisory lamps when a customer hangs up. With these changes, the blind operator should be able to handle essentially all calls.

1. Sutherland, N.B. *Development of a Braille Display*
The MITRE Corporation, Report MTR-1951.

The Sensory Aids Evaluation and Development Center is a component of the Joint Harvard-MIT Rehabilitation Engineering Center, and is supported, in part, by the Rehabilitation Services Administration. The braille cells were developed under a grant from the E. Matilda Ziegler Foundation.

Editorial Note: The excellent description Mr. Dalrymple has given of an application of advanced technology in the service of blind telephone operators assumes particular importance in view of a recent meeting on this topic: a special session of "Blind Switchboard Operators" at the April 1977 conference of the Technical Aids Committee of the European Regional Committee of the World Council for the Welfare of the Blind. The report from that meeting said, in part "...technical development within telecommunication gives rise to grave concern owing to the fact that the development may cause the employment in this very important occupation...(may be) no longer open to the blind;...a preliminary survey shows that the occupation is one of the most important ones as far as the number of operators employed in Europe is concerned;...low-energy boards...may make it impossible to connect...necessary special aids." Mr. Dalrymple and his colleagues at MIT have shown one viable and working solution to the dilemma. The temptation may be very strong for readers to take pen in hand and enquire of Mr. Dalrymple when they might order a TSPS for installation. It is important to keep in mind, however, that MIT's Sensory Aids Center is a research and development centre not a production facility; and the ability to satisfy a demand which may develop as a result of this work proves problematic for the Institute. There is one possible remedy, however: MIT is, like other research and development centres, amenable to persuasion by those on the outside and there is demand to be met for a development they have encouraged. I express but a personal opinion in saying this, but experience would indicate that it is nearly right: if readers will write to Mr. Dalrymple and tell him of their interest in this development, there is the possibility that pressure from persons outside MIT along with financial support will encourage consideration of serial production of all or part of the braille TSPS system. Again, speaking from a personal perspective, I have heard directors of organisations say that were demand to come from outside any service organisation, then that consumer demand cannot be ignored. There is a moral in all this, but I leave it to the discretion of the reader to infer it.

L.L. Clark

Electronic Aids for the Blind at
The Polytechnical University of Madrid

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The direct experience with a physics blind student of one of the members of this laboratory motivated the development of some electronic aids for the blind, back in 1972. Tuning and zero adjustment circuits for laboratory measurements, made through auditive outputs, were the first projects carried out by some enthusiastic students. Later, a digital calculator with eight braille digits output was built.

Little effort has been devoted to the development of electronic technology for the blind in Spain. The Spanish Organisation for the Blind (ONCE) is becoming more concerned with this research activity and, with its partial support a digital calculator with eight bimorph braille characters was developed.

Later microprocessors arrived, and we think they can be successfully applied in electronic aids with new possibilities in price and performances. On the other hand, information displays for the blind are still in an unsatisfactory status. Electromechanical tactile braille outputs are always a limit in maintenance, display size, weight and price. Large area tactile displays are not easily achievable today, and this situation really limits drawing and graph transmission to the blind. Along these ideas, microprocessors and new information outputs for the blind, our present projects have been selected.

A cassette system for digitised braille is in a quite advanced status. Their characteristics are similar to those of some commercial systems already announced. A standard cassette assembly plus an IC RAM buffer memory

offer a convenient way to record/reproduce digitalised braille. An output display line of 32 braille characters has been provided. Although the system could easily accept a teletype keyboard, a data transmission line, or calculator outputs, etc., in this model has been aimed at a low-price cassette book-reader.

Speech output offers new possibilities for the blind. Present IC memories and microprocessors have made feasible synthetic voice generation and acoustic man-machine communication. Our present main project concerns the development of synthetic voice in Spanish. In this line, speech calculators offer, probably, the best solution concerning consumption, maintenance and portability. We have developed a speech calculator in Spanish. Digits and basic functions have been stored in a 4K ROM, and speech compression for storage was obtained by performing cuts in the amplitude-versus-time representation of the acoustic display. Further memory minimisation was achieved through storing basic morphemes and presenting speech words by composing these morphemes. Reasonable comprehension was obtained at sampling rates as low as 3KHz. Compression and morpheme composition was obtained with the aid of an INTEL MDS-80 microprocessor system. This research is being continued for spelled speech and morpheme determination, being a programmed self-learning machine our next goal.

Finally, in the same line of output display improvements, large area tactile electrophysiological displays are being considered. Through a low cost printed-board technology, electrode arrays can be produced that could allow drawings and special forms to be dynamically reproduced for the blind. A study on the characteristics of the adequate electrical pulses, and their possible medical secondary-effects on tactile sensitivity, has been initiated. Display dots are formed by two semi-circular electrodes, as close as several hundred microns, being the finger skin the conducting path when the character is excited.

Economic support is very meager for these activities. We think each society has to develop a minimum of technology for the handicapped, to be able not only to adapt and to maintain systems from outside, but to fulfill specific needs. We hope our democratic institutions will pay more attention to the technology for the blind, and the present modest programs could receive more substantial support.

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World Council for the Welfare of the Blind
Committee on Computerised Braille Production

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Early in 1977 the Committee on Cultural Affairs of the WCWB decided to form a sub-committee on computerised braille production and I was invited to be chairman. The sub-committee is still being formed and to date Mr. R.A.J. Gildea, U.S.A., is the only other sub-committee member to have been appointed.

The accent of the sub-committee's work is on production systems. With this in mind four objectives have been adopted.

(i) to create and maintain a directory of people involved in computerised braille production systems;

(ii) to create the means for collecting and disseminating information about current production activities and future plans;

(iii) to collect statistical information on a regular annual basis about braille production systems;

(iv) to promote cost-effective computerised braille production systems.

Mr. Gildea is taking care of objectives (i) and (ii). Readers of this notice concerned with computerised braille production systems - as systems or operations managers - and who have had no previous contact with Mr.

Gildea can help the work of WCWB by letting Mr. Gildea have their names, addresses and brief details of their association with computerised braille production. The same applies to those who are planning to implement such systems.

When a directory of computerised braille production systems has been compiled it will be published to all concerned. It will also be used for the purposes of objective (iii), which I am looking after, which aims to establish a bank of up-to-date information about operational systems. Common information collected on a regular annual basis may help to identify the appropriate technology and methodologies for particular environments.

Objective (iv) is a distillation of the other objectives. Under this heading it is hoped to mount a symposium in London in the Spring of 1979. The symposium would cover the state-of-the-art of using computers for everyday braille production, and the state of research projects and their likely impact. I would be very grateful to hear from anyone who would like to make a presentation or to attend such a gathering as a delegate. It is extremely doubtful whether any funds could be provided to cover travel and hotel costs so participants had better budget on their employers meeting the bills.

Improvements to the SAGEM Embosser

B. Rottier

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Since December 1976 (see Braille Automation Newsletter, Dec. 1976, pp. 26-29) a number of modifications have been made to the SAGEM braille embosser. Firstly there is now available a six-key board (plus the space bar, line feed and carriage return) to permit a skilled brailist to input contracted braille.

This keyboard is very similar to the Perkins braille-writer and has proved to be very comfortable and satisfactory to the operator. The operator can easily switch between this keyboard and the conventional typewriter keyboard.

The SAGEM agent in The Netherlands is now E.S.I. bv, Postbus 69, Nieuwerkerk a/d Ijssel, The Netherlands (Tel. 1803 32 17).

The send-receive double-sided braille embosser is now 25,355 Francs and the receive only version 20,870 Francs.

Braille Burster

B.P.C. Business Forms Ltd. (Whitehall Road, Leeds LS12 1BD, England) sell a burster which will trim and separate continuous form braille stationery into separate sheets, and stack them in sequence on the output tray without damaging the dots. The machine will operate at 150 feet a minute but it is noisy. The approximate price, including side trimmers for removing sprocket holes, is £800.

Braille Microprocessor Translation Program

R. Fox (Tonedale House, Wellington, Somerset, England) has written a microprocessor-based braille translation program. The program takes 2500 bytes, data 2000 bytes and associated lists 500 bytes; translation speed is about 100 characters per second.

It is proposed to use this program as a component of a system for the deaf-blind which will be based at Oxford University.

Correction

The editors apologise for an error in the last issue (July 1977). The following paragraph was accidentally omitted from page 30 (5th paragraph).

For material required in single, or a small number of, copies a sequential braille printer will be used. This printer will be either a LED-120 or a SAGEM REM-8. At the time of writing no definite decision has been taken on which of these will be used. This printer will also be used for the production of proofreading copy in braille.