

BRAILLE AUTOMATION NEWSLETTER

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edited by

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Editorial

Since the present issue of the BAN is issued shortly after an important meeting which discussed changes in the rules of braille, it seems appropriate to mention it in the present context of an editorial statement. It is appropriate not only because the readership of this modest publication has escalated significantly since its first issue (from 94 to about 150); and among this population of readers there are undoubtedly some who, like some of the authors in this issue, look for changes in the rules of braille that will simplify the task of automatic translation of ink print into braille. It is also appropriate because the process of accommodating the needs of the ultimate reader and the needs of the researcher and developer who seeks to serve him are being aired in a fresh and invigorating climate of change.

The meeting of which I speak was sponsored by two organisations: the AFB, and the Special Interest Group on Communications for the Physically Handicapped of the Association for Computing Machinery (SIGCAPH/ACM). SIGCAPH has been in existence for almost a decade, and its Chairman, Robert Gildea, has been an important leader in the effort to apply computer techniques to braille translation - a fact which we neglected to mention in our last, and for which we offer our apologies. Mr. Gildea was also the chairman of the meeting, whose working title was The Workshop on Compliance of Computer Programs with English Braille, American Edition (Literary Braille). Readers of the Newsletter will each receive individual copies of the proceedings of this meeting when these are ready, at the end of Summer or the beginning of the Fall.

I wish to make two observations about the meeting, with no intention of discussing the content of the many discussions.

The first is that the meeting represented a signal event in the encountering of skilled braillists and proof-readers and the researchers and developers involved in adaptation of computer hard- and software for the trans-

cription of ink print into braille. It was striking to observe the relatively rapid evolution of new postures of these two groups, one toward the other. On the one hand, one could see the growing admiration of the researchers for the logic and even the elegance of the braille rules, along with a new appreciation of the painful process through which the present system of (American) braille emerged out of the "war of the dots" in the early decades of this century in the USA.* By the middle of the meeting, in walking around to visit each of the seven separate workshop groups, the observer was struck by the new sense of confidence with which researchers were proposing simplifications and rationalizations of the rules of braille.

The second observation was the display of excited discovery on the part of the skilled braille transcribers and proofreaders at the meeting when they found that the braille versions of the prepared position papers were transcribed entirely without human intervention (from a machine-readable version of the ink print text, which was then processed through a standard braille transcription program in a medium-sized computer). More than one reader of the braille versions of the papers remarked that it was hard to believe there were so few errors in the text; one even said that it was hard to believe these were done by computer (!). One comment may be cited as typical: "I never believed that computer prepared braille could be so good." This sense of how near we are to the goal of completely automatic transcription of ink print into braille was heightened in quite new ways during the meeting; and made more believable the reports that it was quite common for users of computer-produced braille materials not to realise that some systematic errors in the text existed at all.

The atmosphere was never more ripe, therefore, for the proposal that we consider the ideal goal to be the creation of a single standard for braille rules of contraction and of format, one that would obtain both for computer trans-

*Irwin, Robert B. The War of the Dots New York: AFB, 1962, (MSC141, 56pp \$2.00).

cription and for braille produced by other means, and one establishing continuity with the evolution of braille rules during the last fifty years. An exciting prospect, indeed; and plans for the research that would help bring about this state of affairs were discussed in brief (cf. Douce and Tobin, BAN, Issue No. 1).

To imitate the famous paper by Crick and Watson on the double helix: the implications of the above for simpler programs and smaller computers may be easily inferred. The editors are not unmindful that de facto or de jure versions of single-standard braille rules have already been implemented in other countries in the world - most notably in Denmark by Jensen and Vinding, and in Germany by Helmut Werner, among others. Whilst they are stifling a yawn and comfortably sipping their Schnapps, we can compliment some of our colleagues on their foresight and energy, and we thank them for providing us with the models that helped one part of the English-speaking community of braille publishers and readers in the same general direction...

The Use of Digitally-Stored Text for Braille Production

J.M. Gill

Warwick Research Unit for the Blind

Summary

This paper describes some of the possibilities for utilising text stored digitally for automatically producing contracted braille. It is suggested that this type of data input could greatly increase the availability of straight-forward braille text.

Introduction

In most countries the standard braille code uses contractions and abbreviations which are governed by a complex set of rules. The use of contractions typically results in 26% reduction in the number of cells required, but it necessitates the use of skilled transcribers, or a computer, to produce contracted braille. The prime motivation for automation, up to the present time, has been the shortage of skilled transcribers rather than cost saving, either projected or actual.

The automation of the translation process is not simple since contracted braille is a language and not a code; for instance, the use of a contraction is sometimes governed by pronunciation, meaning or the presence of particular adjacent words. This presents formidable difficulties if perfection is required but existing computer programs often have error rates of about one incorrect choice of contraction per five pages which most users find acceptable.

A current automated translation system with manual input of data includes the following processes:

- (i) A typist keys in the text adding a few control characters, for new paragraph etc.

- (ii) A line-printer listing of the text is produced in order to proof-read for typing errors.
- (iii) The text is interactively edited on a visual display unit.
- (iv) The text is translated to contracted braille; a translation speed of 5000 words per minute can be achieved on a medium-sized machine.
- (v) The braille is output on an embosser (a line embosser can output 120 braille cells per second).

Typically, a good typist would take about 44 hours to type, proof-read and edit one hundred thousand words, translation would take 20 minutes and output 1 hour.

Automated Systems

With manual input of material, a large proportion of the total cost of producing the braille-coded data is that allocated to data input and checking. To reduce this component, experiments have been undertaken to investigate the transcription of material available in machine readable form. The current status of some of these projects is as follows:

Telephone Directories

Many organisations use computers or word-processing typewriters to produce their internal telephone directories. Since many blind employees rely heavily on use of the telephone, a braille directory can be invaluable. The conversion of the digital data to braille is relatively trivial since the data is usually in a fixed format. At

the University of Warwick, the internal directory is now computer-based, and the data base is used for both the ink-print and braille editions. A valuable incidental advantage is that this directory can now be produced with both alphabetical and departmental listings.

Bank Statements

Lack of privacy is one of the most serious deprivations caused by blindness, therefore the availability of bank statements in braille can be very important to some blind individuals. The braille statements can be automatically produced from a digital magnetic tape supplied by the bank. The data is in print-image format but without the customers' names and addresses in order to maintain confidentiality. The main advantages of an automated system are speed, accuracy and cost saving when compared with manual transcription.

Current Alerting Services

A blind professional has special problems in keeping up to date in his own field. He needs a means of identifying what is relevant to him from the current literature. This problem is particularly acute for blind scientists and computer programmers.

The sighted can use information services such as INSPEC and Psychological Abstracts to identify articles likely to be of interest. Since these services are computer-based, it has been possible to run a pilot scheme for automatically producing selective listings, in braille, of abstracts for individual blind programmers and psychologists. This would have been uneconomic by manual transcription which would also have introduced a considerable time delay.

Printers' Tapes

The traditional composing systems involves an operator inputting the text on a special keyboard and the data is punched on wide Monotype tapes. The typing errors are corrected using a pair of tweezers to make alterations to the metal type. However there are some newer computer-based systems which incorporate interactive editing and produce a virtually error-free computer-compatible digital tape.

These tapes contain the control commands for the type-setting machine as well as the text; typically the control commands account for 20% of the data on the tape. The problem is to convert these control commands to the ones needed by the braille translation program or to modify the braille translation program to directly accept these tapes.

For straight-forward text a simple table-driven pre-processor can be written to accept tapes from a variety of printers. However there are some minor problems such as footnotes which are normally incorporated in the main text in the braille edition. Page numbers and running headings can also be handled automatically in most cases.

It is harder to recognise foreign words and phrases which, by convention, are translated into uncontracted braille. The major problems start when position on a printed page is used to convey part of the information e.g. in mathematics, music and tables. It would be technically feasible to automatically transcribe simple tables but complex ones will always require some formatting instructions from a human operator.

Conclusions

For simple text it has proven possible to automatically produce braille from the digital tapes used for preparing

the inkprint version. However it is only now that serious attempts are being made to assemble information on sources of 'clean' text in digital form. In the next few years, as the printing industry gradually changes to computer-based composing systems, the availability of braille could be significantly increased. It is also technically feasible to eliminate multiple typing of material when inkprint, large print and braille editions are required.

Acknowledgements

The financial assistance of the Department of Health and Social Security is gratefully acknowledged.

Project Braille 2000

R.P. Vickery, L. Helmer and J. McCubbin

Our project was funded by a grant from the Canadian Federal Government under their Local Initiatives Program. The aim of the project was to investigate braille production from the point of view of the printing industry, the theory being that as braille and printing are both reprographic sciences, many printing techniques could be beneficial for the production of braille matter.

Lithography

It would appear that the only areas Lithography can be utilized lie in the combination of Lithography and Thermography to give a solid dot formation and the use of used Aluminium Lithographic plates to replace Zinc stereomasters.

Thermography

The principle of solid dot formation in braille production appears to be going through a change in its popularity at the moment, and this formation is the only way that Thermography can be used for braille matter. A form of solid dot could be produced with the inclusion of a red pigment in the medium to create a heat reflectant, the loss of image height inherent in this process could possibly be counteracted with this application.

Silkscreen

Silkscreen plays a prominent role in the printing industry due to its ability to apply a thicker ink image. The possibility of applying a large enough image to give a solid dot formation could be looked into and possibly better thermographic results would be obtained with the application of a resinous substance to give a plastic dot using the larger ink deposit available. With respect to image clarity,

photomechanic techniques should be investigated for their use as a master. We have begun to look into reports of screen dot sizes of up to 150 lines per inch (60 lines per cm) by German firms, which would exceed sharpness requirements and the use of rotary silkscreen equipment, which would certainly be advantageous to the silkscreen solid dot theory in terms of added speed.

To obtain optimum image quality, the direct-indirect method of making screens would seem to be the most suitable. This is the most recent innovation in the manufacture of Stencils, combining the best properties of the two older methods; the direct method and the indirect method. According to the direct-indirect method, unsensitized photographic emulsion, normally of polyvinyl alcohol and polyvinyl acetate, is applied precoated, on a plastic film carrier, which is put emulsion-side-up on a pre-stretched screen mesh. The top side of the screen mesh is coated with sensitized emulsion which wets and as a consequence, sensitizes the pre-coated layer. The two layers fuse together and are dried. The support film is then removed and the screen is ready for exposure.

One drawback in doing image deposits with silkscreen would be the drying factors of the ink. Solvent based inks would be of little use without expensive modifications to silkscreen equipment to retrieve the solvent. What would be required would be a water based ink or an ink requiring UV curing. These inks are potentially available in the printing industry.

Letterpress

Letterpress would be the most advantageous system since it could utilize the basic form of letterpress which is a raised image. Two ways of producing an embossed effect through letterpress would consist of (1). A form of Honeycomb with the recessed image corresponding to the 6 dot formation of a braille cell which would cover the entire surface of the platen. It would then become a matter of supplying the

type matter with the braille configuration. (2). A system consisting of rubber sheeting which would cover the platen allowing the indent produced by the raised braille characters to be accepted. To produce braille images using type economically, hot-metal machines could be incorporated (linotype, intertype, monotype). Matrices are already available for the linotype system (Specification 18-348 Universal Braille, Characters 166-173).

We ourselves have successfully produced braille by utilizing the latest techniques in the newspaper industry through the use of a plastic stereo. By this method, we produced an ink original of a braille page. Negatives were made, and plastic stereos were produced by the Mirror-Graph Plastic Stereo Production System, which the newspaper industry are converting to on the North American market. These plates were used to produce braille on a hand operated press.

Photocomposition

With the possibility of braille being produced using printing techniques, the setting of braille matter could be undertaken through the use of photocomposing systems. With only few modifications required, a braille translation program could be included with the justification hyphenation text program and a grid with the appropriate braille characters in the phototypesetting device. There would be two ways of approaching this production method. One would be the re-keyboarding of printed matter and subsequent conversion to braille in a computer environment. The second would be a further addition to the computer system, enabling original printers tapes to be regenerated into a braille production form. An example would be the case of deletion of a typeface change command or the addition of a numerical braille sign.

It should be remembered at this point that large quantities of printed matter are produced by using information at one stage or another that is in machine readable form.

With the cooperation of printers and publishers, large amounts of printed material could be produced in braille with the use of a braille translation program i.e. Dotsys III and the LED-120 braille embossing device.

Paper

The paper used in braille production at the present is of the soft fibrous type. Possibly better image retention would be obtained if a machine finished paper is used with the drying taking place at the stage of having the finish applied. Also the application of heat on braille presses to aid in the bending of the fibres, would produce better image retention and prevent subsequent breakage of the fibres.

Storage of braille books and braille paper should be in humidity controlled areas to obviate swelling and distortion of the paper. Due to the radical rise in paper cost, the use of plastic papers need to be investigated for their possible use in braille publications and for their resistance to the atmospheric problems which are encountered by the ordinary paper. Although plastic papers are also increasing in cost, the comparative ease of recycling might render their future use attractive.

The final result of the program shows that there are many areas in which the printing industry could collaborate in the production of braille. The most obvious is the case of Error Free Compositors tapes, this approach especially in conjunction with the Printing and Publishing industry would create a great saving, not only in equipment but also in time.

One thing we had to keep in mind was that the printing industry is geared for mass production whilst braille requirements are of a small order, so that cost factors cannot be assessed on a one to one basis, but if braille matter could be understood to be a single entity incorporating stages of the printing process the expense requirements would be kept to a minimum.

Computer-Assisted Braille Production Capability

P.R. Bagley

Information Engineering operates a computer-assisted braille production system jointly with another organization. Our combined staffs can handle every aspect of production - from initial preparation of text and indexes, through translation into braille, proofreading, correction, embossing, binding, labelling, packing, and shipping.

Material to be brailled is first put into machine-readable form, expressed in conventions acceptable to a braille translation program. Magnetic tapes used to typeset printed text are already in the machine-readable form, but must be reformatted by computer program before translation into braille.

The Master Tape Reformatting Program performs the following functions:

- (1) It substitutes words and phrases where an ink print character lacks a corresponding braille character (e.g., the mathematical symbol "+" becomes "plus").
- (2) It converts the typesetting commands into corresponding braille formatting commands (e.g., for headings, italics, etc.)
- (3) It converts upper-lower case ink print representation to a braille representation which is all one case, with all capitals preceded by a character denoting "capital sign."

The output of the reformatting program is in the form of punch cards, which are then listed and proofread.

It is often the case that the document is not available on magnetic tape, or that parts of it are not on the tape.

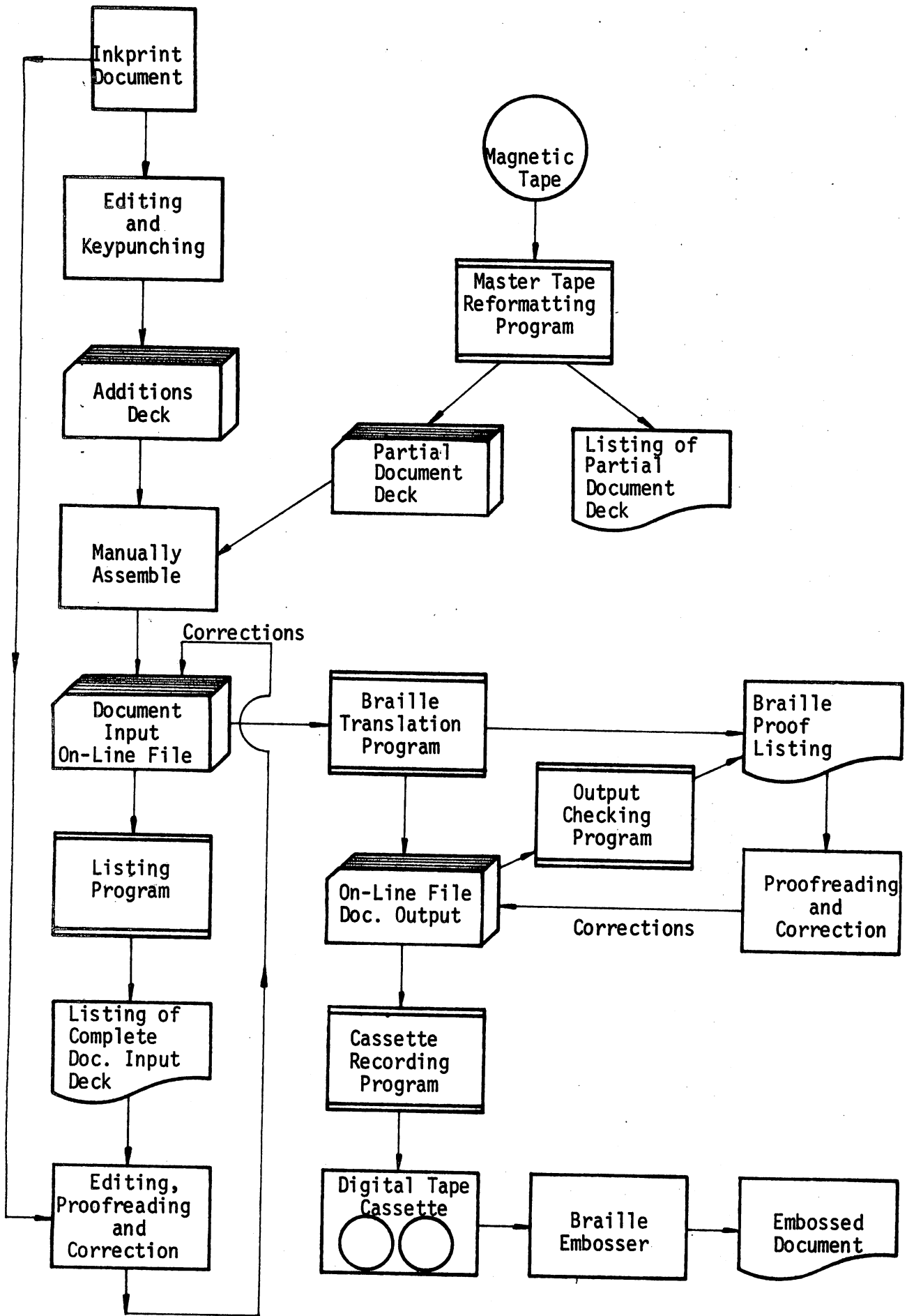


FIGURE 1. Information Flow Chart for Computer-Assisted Braille Production.

Missing text, title pages, tables, and charts must be key-punched from the ink print copy - after editorial decisions have been made and noted. For example, it is sometimes clearer to present tables and forms in prose, rather than to display them as they appear in ink print.

The keypunched additions are manually combined with the deck produced by the reformatting program to form the Document Input File. After the deck is listed, proofread for content and format, and corrected, it is ready to be processed by the Braille Translation Program.

The Braille Translation Program converts the Document Input File into Grade 2 braille, formatted into pages. Both a Document Output File and a proof listing are produced by the Braille Translation Program. The output file represents line-for-line and character-per-character the braille pages which will be produced. The proof listing shows the braille output in ink print characters so that sighted proofreaders can check for content, format, and correctness of translation. It is therefore not necessary for the proofreader to know how to read braille. Minor errors can be fixed by on-line editing of the output file (on-line). Major errors require that the input file be corrected, and portions of it be retranslated.

Finally, one or more output files can be combined and their contents recorded on digital tape cassettes. These cassettes drive an embossing machine to create any specified number of embossed copies. Continuous form "tag" paper is used, with embossing only on one side. A bursting machine has been adapted to separate the embossed sheets without crushing any of the dots. The final stages of labelling, binding, and packing the volumes are then carried out by manual methods. In addition to, or instead of, being used for embossing, copies of the cassettes are distributed to those having embossing machines.

The current cost of computer-produced braille is unfortunately not as low as the cost of braille prepared by traditional methods. The amount of tabular material to be reworked affects the per-page price. The main component of total cost is the editorial work and proofreading, made necessary largely by the complexity of the rules for the braille language. Other significant costs are the expense of special heavyweight braille paper stock, and the cost of running the translation program. Information Engineering is constantly looking for ways in which the various production costs can be reduced.

Despite the present expense of computer-assisted braille, this method is advantageous in any of the following circumstances:

- (1) Where speed of preparation is highly important.
- (2) Where text to be brailled is already in machine-readable form.
- (3) Where the document will be issued in one or more revisions.
- (4) Where the number of copies to be made is too small to justify making zinc plates to be run on a braille embossing press.

In the past 3 years, Information Engineering has prepared many thousands of pages of braille. Our experience includes processing charts, tables, and forms. Especially challenging was working out the representation of boards and men for a translation of a book of chess problems.

The kinds of publications which we think are suited to our capabilities include reference documents, directories,

newsletter, bank brochures, annual report conference announcements and proceedings, school materials (assignments, reading materials, quizzes, games), and instruction manuals.

Translation and other computer processing is done at the computer facilities of the UNI-COLL Corporation, Philadelphia. Editorial, embossing, and binding services are provided by Volunteer Services for the Blind, Philadelphia.

A Feasibility Study on a Braille Transcription
Service for Short Documents

J.M. Gill and J.B. Humphreys

Introduction

Braille readers often have problems in having short documents transcribed quickly into contracted braille. Typical documents are agendas and minutes of meetings, instructions for domestic appliances, local telephone dialling codes, knitting patterns and personal correspondence needed for reference. Typically the number of copies required is from one to six. This project is concerned with investigating the viability of using a computer-based transcription system based on existing technology.

Basic system

The basic system for producing short documents in contracted braille is:

- (i) A typist, with no computing knowledge, inputs the text on punched cards, paper tape or directly on a visual display unit. Control characters, for new paragraph etc., are also added by the typist as she inputs the material (i.e. the text is not annotated by someone else).
- (ii) A line printer listing of the text is produced in order to proof-read for typing errors.
- (iii) The text is interactively edited on a visual display unit with a program designed specifically for this purpose. This program has been designed for speed of operation, minimal computing requirement and for ease of use by operators with no experience of computing.
- (iv) The text is translated to a good approximation to Grade II standard English Braille, and the translation is stored on magnetic tape.
- (v) The braille is output on an on-line embosser.

Only the translation phase requires extensive central processor time; all other computer operations use less than 1% of the central processor time, and can be time shared with other unrelated programs.

The current output of the system is about 20,000 braille cells (circa 30 pages) per day. Allowing for multiple copies, such that on average about two copies of each document are produced, this means that 15,000 braille cells are translated per day, requiring about one to two minutes of central processor

time for translation. It is not envisaged that this can be increased with existing facilities (particularly staff) since the typist is currently the only full time worker on this project, and she also undertakes all proof reading and routine secretarial duties associated with the project.

Translation Program

The Sensory Aids Evaluation and Development Center provided Warwick Research Unit for the Blind with a copy of DOTSYS III which is a program, written in Cobol, to translate text to a good approximation to Grade II standard American-English Braille. The version currently in use at Warwick uses 13k words of store with initialisation overlaid and translates at 5000 words per minute to a good approximation to Grade II standard English Braille.

Evaluation

In order to evaluate the system a small scale pilot service was operated for producing single copies of short documents for blind subjects. In the first few months of operation the system was undergoing almost continual modification based on informal feedback from the blind subjects which made it impractical to start a formal evaluation programme.

The material transcribed can be roughly grouped as:

<u>Subject</u>	<u>%</u>
Domestic	10.4
Leisure	15.4
Religious	2.5
Education	25.4
Employment	29.1
Miscellaneous	17.2

Errors can be caused by typing errors in the text, incorrect control characters, incorrect choice of contraction by the computer program, malfunction of the embosser or damage to the braille in transit. Little is gained by just measuring the number of misconstrictions caused by the translation program unless one also measures the error rates for the various systems using manual transcribers. Once the error rate is relatively low, it becomes a very expensive operation to attempt to measure it accurately.

A practical measure of the error rate is the number of users who find the number and types of errors unacceptable for their application. For instance any error in a list of telephone numbers is serious, but a misconstriction may often go unnoticed.

A braille questionnaire was circulated to subjects who had used material generated by the most recent system. The results are (N=23):

1. Mean age = 40.3 years (σ = 12.6 years)

2. Occupations

Professional	9
Non-professional white-collar	7
Students	2
Manual workers	1
Not employed	4

"The following 4 questions use a 1 to 5 scale for answering. For example 1 is very poor, 2 poor, 3 average, 4 good and 5 very good. You should just write down the number which best describes your own opinion. In these questions I have just given you the end points on the scale although you can answer with any number between 1 and 5".

3. For your applications, the turnaround time is: (1 is so slow as to make the service useless and 5 is perfectly acceptable).

<u>mean</u>	<u>σ</u>
3.8	0.9

- | | <u>mean</u> | <u>σ</u> |
|---|-------------|----------------------------|
| 4. Are the miscontractions caused by the computer program: (1 is so bad as to stop you using the service and 5 is perfectly acceptable). | 4.6 | 0.6 |
| 5. Is the physical quality of the braille: (1 is very poor and 5 is good). | 4.3 | 0.9 |
| 6. Is single-sided, as compared with double-sided, embossing: (1 is so severe a disadvantage as to stop you using the service and 5 is perfectly acceptable). | 4.9 | 0.3 |
| 7. If there was a central document transcription service, or a number of regional ones, how much would you use it on average (braille pages per month): | | |

1. less than 10
2. 10 to 50
3. 50 to 100
4. 100 to 1000
5. more than 1000

mean = 2.5

σ = 0.9

8. Would you want the document service to transcribe specialist braille codes such as music, mathematics and computing?
If so, which ones?

<u>Code</u>	<u>Number</u>
Music	6
Mathematics	1
Computing	1

9. How many embossed diagrams would you want per month (on average):

1. none
2. less than 1
3. 1 to 100
4. 10 to 100
5. more than 100

mean = 1.4

$\sigma = 0.6$

Firm conclusions cannot be drawn from the survey due to the small sample size. However these results show that both the number of misconstructions and the use of single-sided braille are acceptable for this application. The lowest score was for turn-round time which varied from a few hours to two weeks for short documents.

Conclusions

This project has demonstrated that there is a considerable demand for short documents in braille, and that computer-based systems can potentially satisfy a significant proportion of this demand.

Acknowledgements

The project was funded by the Royal National Institute for the Blind and the Department of Health and Social Security, and the Science Research Council provided the essential computing facilities.

Further Information

Gill J.M. et alii "Design and Evaluation of a System for the Production of Short Documents in Contracted Braille".
Warwick Research Unit for the Blind, 1975, 173 pp.

Rationalisation of Braille Book Printing

J.L. Douce

A seminar was held on 3rd-4th May 1976 at the Rehabilitation Foundation, Heidelberg, W. Germany, to discuss the results of a major research project concerned with improving the availability of braille books. Attended by over fifty delegates from nine countries, the meeting included formal presentations by the group leaders of each section of the work, visits to inspect aspects of the work in the laboratories and extensive discussion periods.

This note is a personal record of the activities; accurate in so far as my memory permits, but not to be quoted as official statements in any way. Extensive documentation has been produced by Dr. Hans-Jochen Kuppers, Stiftung Rehabilitation, 6900 Heidelberg 1, West Germany 101 409, and I am grateful to him for much technical information.

The research has been specifically aimed at book production, with eventual printing from embossed plates in mind, and five particular aspects were identified as areas requiring attention before a well-organised production process could be founded. Thus the following topics have received particular attention:

1. Input of material by typist, or from paper tape.
2. Editing of material, using a V.D.U. computer terminal or a special purpose device with braille input/output.
3. Translation to (German) grade II braille.
4. Output to zinc plates.
5. Production of tactile diagrams.

The first morning was devoted to presentations, the afternoon to a tour of the equipment, with the second day devoted to further detailed discussions and finally a visit to the education department where the disabled (not solely visually handicapped) are taught professions appropriate to their handicap.

The project, costing about \$300,000 seems to have been very largely successful, due to the proper amount of resources being made available, and the skills of the teams at Heidelberg, Stuttgart and Munster in defining and achieving their objectives. At this stage, the devices are to be regarded as fully developed prototypes, whilst the relevant computer programs are completed.

Highlights of the individual elements are as follows:

1. Typed Input

This uses a stand alone commercially available CRT terminal, consisting of a golf-ball typewriter, dual magnetic-tape cassette system and electronics, of total cost about \$10,000. This terminal uses the Selectric correspondence code, and permits duplication from tape to tape with or without printing, either section by section (99 sections per tape), line by line, or word by word. Up to 15 characters per line can be added to any line without the necessity for duplication, due to the spare blank tape available at the end of each line. Up to about 250,000 characters can be stored per cassette. The terminal can be extended by VDU terminal, high-speed printer and computer interface.

Other units of very similar performance are currently available and this component may be regarded as relatively routine.

2. Editing

Two systems have been developed. First, using a

conventional visual display unit, text can be manipulated in the fairly usual way. This is aimed at removing printers control characters on paper tape, resolving ambiguities (close single quotation marks/apostrophe for example), modifying the layout, or inserting braille (e.g. an arrow is inserted as five braille cells by typing 25, 25, 25, 25, 1235, each number group specifying the required dot positions of one cell). This is currently used with the in-house computing facilities for limited braille production using a modified IBM 1403 line printer.

A more interesting development is the braille terminal, described in the document "Textautomat fur Blindenschrift". This currently accepts data on paper tape or computer magnetic tape with output to paper tape. Using a special keyboard (numerals plus braille plus control characters) any line of braille is selected by page and line number and displayed in two ways, a visual output (using light-emitting diodes) and in tactile braille using very nice solenoid operated braille cells developed at Stuttgart. This display gives good quality tactile output at a moderate cost, currently about \$31 per cell and expected to fall to about a quarter of this after a year. This cell is already used in 12 digit display units for the Texas range of calculators, the SR16 being demonstrated.

Lines can be manipulated in a fairly versatile way, though difficulties seem to arise when the new line exceeds the length available. It is intended that magnetic cassette input/output will be added, though this has not yet been achieved.

This seems a potentially useful device, the most serious limitation probably being its limitation of one line display at any one time. The braille output devices can be stacked, but an inter-line spacing of about one inch is required because of mechanical dimensions. No estimate of price could be offered.

3. Translation to Braille

It was interesting to learn that two distinct computer programs have been developed for translation of text to (German) grade II. A program aimed at book production, with an error rate of less than one per page runs about ten times faster than a more complex program designed to produce 'perfect' grade II, used currently primarily for research studies.

4. Output Device

Undoubtedly this plate embosser and the braille editing terminal proved to be the joint favourite items of attention for the delegates, and were focal points for informal discussions throughout the seminar. The embosser is designed to produce printing plates in zinc, tin or aluminium. It was seen operating from paper tape (using the MIT code) at a rate of ten characters per second. The machine is called a prototype, and I guess the midnight oil had been burning for a few weeks before the meeting, but on the days of the visit it appeared, and functioned, immaculately. The basic frame is that of the Marburg manual machine, seeming to give entirely satisfactory rigidity. The plates are mounted on a horizontal table, driven in two dimensions by stepping motors via flexible belts (these have glass fibre cores and negligible stretch). A fast response drive motor, with speed control, drives the punch via a cam system. The size of the braille cell is adjustable, since the stepping motors give a motion of 0.13mm per step and the number of steps for each braille cell (in horizontal and vertical direction) is preset from (internal) controls. A manual keyboard is available and working. This enables the position of the plates to be set (normally stepped from braille cell to cell) and any braille character typed in from a (six + space key) keyboard.

Some of the features which impressed the visitors are the obvious attention to good engineering design throughout, the wide use of proven commercial mechanical and electronic

components, and the high quality of the braille dots. The registration of two-sided braille seems to be entirely satisfactory and the whole unit is remarkably quiet in operation and quite compact. By varying the dot spacing, some simple diagrams can be produced. One truly remarkable feature to one familiar with the temperamental behaviour of prototype devices, was the nonchalance with which the system was frequently switched on and off with no detectable ill-effects.

Against this, the long-term reliability has not been proven. Due to recent commissioning only 40 sheets had been embossed by the day of the visit. The height of the dots was highly uniform, but individual dot heights cannot be adjusted. With current control electronics a missing carriage return (on the input tape or misread by the tape reader) wrecks the current plate, since it cannot be re-positioned correctly for further tape control. Only punched tape input has been implemented so far. In production, the plates must be inserted manually for two-sided braille, and of course paper tape reels must be changed more frequently than would magnetic tape reels.

The current status is that the Blindenstudienanstalt, Marburg, is to develop the machine, hoping to have the first half dozen available after about one year. Cost is a doubtful quantity, and the people from Marburg refused to comment on this. Very informal discussions suggest a lower figure of about \$18,000.

5. Tactile Diagrams

Two interesting systems are offered, both working from high quality artwork, not using computers for a change. The first system uses a special deep etch process (Nylo print) for male and female plates to be used in a conventional press. The trick here is to use a simple special optical system, with a 1mm space between master and reproduction, so that the two sides fit together properly and can be used in a conventional printing press. The quality is, in my opinion, acceptable. Variable heights cannot be achieved.

The second method uses silk screen printing with special 'effervescent' ink. This ink, when baked, gives off a gas causing a uniform swelling and greatly increased height. A bit messy, but again probably highly acceptable subject again to the above comments on height limitation.

Overall, several most impressive techniques have been produced. It's a pity the systems have been so paper-tape oriented, but this is not particularly serious in the long term, and was decided originally in view of (a) most compositor's tapes in Germany are of this form, and (b) tapes are easily and cheaply read a character at a time, so no electronic buffer memory is needed. However, at the current time I don't think any new system should select this medium. Even at only ten characters per second, a unit will require a lot of tape and associated storage space when working to full scale production capacity.

It is apparent that the three-year project has identified the factors limiting the economic production of books in Germany. By combining existing devices with specially developed elements a viable system has been evolved. It is hoped that the complete system will be implemented in the near future, and that the individual component parts will be given due consideration when any organisation plans to expand production.

The seminar was extremely well conducted throughout, and our thanks are due to Dr. Kuppers and his colleagues for the excellent organisation of the technical sessions and for the highly entertaining social evening at the historic 'Red Ox' in the old quarter of Heidelberg. I gratefully acknowledge the partial support of the American Foundation for the Blind to aid my participation in this event.

A Guideline for the Improvement
of Braille Production by Computer

P.R. Bagley

Here is my strong opinion on what must be done to make computer-produced braille cost-effective. It is borne out of more than three years of struggling with producing material for the Internal Revenue Service using a modification of the DOTSYS III translator.

The principal cost is in editorial work, to prepare the material for translation, and to proofread and correct the translated result. Compared to the cost of the editorial work, the actual computer charges are unimportant. Therefore, any approach which is intended only to reduce computer time will not be of much help.

The greatest saving will be made possible by eliminating the need to proofread the translated result for content (i.e. correctness of translation). You must be able to assume that, if the input is correct (for content), then the translated result will be also. There is no compromise possible - either you must be able to trust the translator 100 percent or you must proofread and correct the result. To be able to trust the translator means that you cannot have exception tables to take care of the translator's deficiencies. Otherwise, there will always be exceptions that were overlooked and which can be found only by proofreading the translation. Thus, the braille translation rules must be 100 percent programmable. The principal rules which stand in the way are those rules dependent on syllabication, on breathing, and on meaning. The contraction rules and the rules for letter signs are thus in for radical revision.

The second major area of editorial work is in formatting - which includes handling and positioning of headings, page numbers, footnotes, illustrations, etc. I do not believe it is humanly possible to avoid proofreading the translator output for format. It has not been possible, in my experience, to find all format errors by proofreading the

input to the translator. Hence, reducing the editorial effort involved with formatting can only be done by simplifying what has to be done. Main candidates for simplification are:

1. Simplify the rules for headings, so that the editor's work is limited to indicating what text constitutes a heading.
2. Move page numbers out of the text lines, so that when lines must be rearranged to accommodate corrections or changes, they do not have to be reset.

An additional minor improvement in cost reduction can be achieved if occasional typographical and format errors will be tolerated - at about the level committed by newspapers. It takes a tremendous effort to achieve a small improvement after the first proofreading and correction cycle.

Regarding my suggesting changes in the braille translation rules, I feel it not appropriate for me to do so. The criteria are very simple - the rules must be 100 percent programmable - but what the actual rules are does not matter to the programmer. But they matter very much to the reader (which I am not). The ultimate determination of a set of programmable rules can best be done by those who are braille readers who understand what "consistency" means - for the choice of rules is guided almost wholly by what is acceptable to the majority of braille readers.

Regarding changes to the format rules, however, I have suggestions based on what we have found to be tedious for editors - which braille readers are not in a position to judge.

The area of system design certainly has a major impact on production cost, but has nothing to do with braille rules. Naturally, I have very strong opinions on how computer-based

braille systems should be designed. I believe the system must make the editor's work as simple as possible: this implies on-line input, editing, and processing. Some of the system design details depend heavily on the translation and formatting rules, which have to be resolved first.

Braille Revision Study Project

We would like the opportunity to study systematically the revision of the braille rules to minimize the cost of producing braille by computer. The rule changes would involve both contraction rules and formatting rules.

The nature of the contraction rule changes would be principally the relaxation of restrictions on when contractions could be used, and the elimination of those conventions which saved only a tiny amount of space. Changes of conventions which require relearning (such as changing the meaning of a contraction or introducing a new one) would be done only in cases of extreme desirability.

Changes in format conventions would be principally to save space or editorial effort without reducing readability.

Word frequency and other studies would be made to measure the usefulness of proposed changes, and readability tests would be conducted with braille readers to determine acceptability, reading rates, and reading error rates.

The starting point for contraction rule changes would be G. Staack's A Study of Braille Code Revisions¹. The starting point for format changes would be our own extensive experience in producing braille over the past three years, in which we have to a large extent followed the braille code for textbooks.

¹Gerald Staack, M.I.T. Masters Thesis 1962.

The dimensions of the project could be tailored to fit the amount of money available. Modest trials could be made for as little as \$5,000. An extensive study could cost as much as \$125,000. We think a pilot project should be funded for \$20,000-\$25,000; at the end of this pilot there will be enough data to have a sound basis for determining what additional work should be done.

Partial List of Potential Areas for Change

Contractions	Dates
Letter signs	Page numbering
Indentation	Headings: position, level indication
Tables	Forms
Illustrations	Italics
Units of measure	Capitalization
Nested Parentheses	Splitting of text between volumes
Running heads	Footnotes

Duxbury Systems

Products and services

Duxbury Systems, Inc. is a pioneer in the application of minicomputer-based systems to braille translation and related text-processing tasks. Its principal product is the Duxbury Braille Translator, a software system that will translate English to formatted Standard English Braille (Grade II) at speeds in excess of 1,000 words per minute, when installed in a typical minicomputer, and at proportionately faster rates when installed in larger computers.

This software may be purchased or leased by itself; or Duxbury systems will be pleased to work with its customers in defining and acquiring entire systems including main-frame and peripheral hardware in addition to the Translator.

Duxbury Systems also offers translation services, working from any desired source medium (inkprint, compositor's tape) to any desired output medium (including finished braille in small quantities), and offers consultation services in connection with any aspect of braille automation, including questions of feasibility, user acceptability, cost, and phaseover planning.

Typical System Operation

In a typical application of the translator, text for one or more braille volumes is recorded and edited on a data file using standard typing procedures. The translator system, using this file as input, produces another data file containing the information necessary to drive an embossing terminal or stereograph. This output file can be edited, if desired, and may be reused as often as necessary for additional braille copies. The various data files will be physically represented on storage media such as magnetic tape cassettes or magnetic disks depending on the particular hardware configuration.

Pricing Information

The software system, including complete installation with test demonstrations, full documentation, and a one year maintenance warranty is priced at \$22,000 when installed on any appropriate NOVA or ECLIPSE computer manufactured by the Data General Corporation. There is an additional conversion fee for installation on other types of hardware (a FORTRAN IV compiler and at least 64K bytes of core storage are required). Using Data General equipment a basic but complete system can be configured for under \$40,000 including both hardware and software. A medium-to-high volume system may run to \$60,000 or so.

Using Punched Cards for Automated Braille Embossing

N.C. Loeber

In 1967, the Lutheran Braille Workers, Inc. (LBW) began using a modified keypunch machine to produce braille master plates. Before introducing this equipment, LBW used volunteer operators working at one production location to make the master plates with large and heavy braille plate embossing machines. The size of the equipment necessitated centralisation of the work and limited the number of volunteers that could participate. Such a method restricted the number of plates that could be produced. The punched card braille system designed by the author enabled LBW to increase the number of its work centres and the variety and volume of braille material which it could distribute free of charge to anyone requesting it. For example, during 1974, LBW provided over 50 embossing centres with master plates for the production of over 3,000,000 sheets of braille paper that was bound into more than 35,000 volumes. Most of the master plates were produced using the punched card system. While more modern technology is now available, this simple technique of producing master plates with a modified keypunch is a possible solution for locations that do not have access to more elaborate equipment.

The punched card system used by LBW works in the following way:

Volunteers prepare punched cards using the transcribing card punch and an automated braille writer:

The volunteer reads from the printed text and uses a keyboard much like a conventional typewriter to punch the card. By pressing a single key, the machine automatically punches the hole(s) of the appropriate number and position in the card to represent the complete braille

configuration required.

The volunteer then puts the punched card into the machine again. This time, the machine reads the card and prints out the contents of the card in braille on a sheet of paper for proofing. The volunteer checks the accuracy and format of the braille embossed output and corrects the punched card if an error exists.

Volunteers send the complete and accurate punched cards to the central work centre:

Operators at the work centre place the punched cards in a card reading machine. This machine actuates the stereotype embossing machine that embosses dots on the master plate. By reversing the plate and shifting it slightly, the operator embosses on both sides of the plate.

Operators send the embossed master plates to other work centres for printing:

The printing work centres produce the braille embossed pages using the master plates and small roller presses. They then bind the pages and package and distribute the books.

This system has been successful for LBW because it is relatively inexpensive, provides for the use of many volunteer workers, and increases the number and variety of braille pages that can be printed.

KOBRL Numeric Code:

An Inkprint Output for Computer Transcribed Braille

K.O. Beatty

A common difficulty with computer transcription of braille is that production of embossed braille from the "transcription" requires expensive special output devices. Consequently, although there are hundreds of computer facilities with the potential for transcribing, most of them cannot produce an output usable by the blind.

The KOBRL* numeric code provides a computer output that may be directly used as the instructions for operating a Perkins Brailier, hand-slate or, other manual device to produce embossed braille. The simplicity of interpretation was clearly demonstrated by an eight year old girl who, with less than one minute of instruction, used a Perkins Brailier to produce standard English Braille by reading a computer print out in KOBRL numeric code. She had no prior knowledge of braille or the code and had never even seen a Perkins Brailier before.

The six data positions of the braille cell form two columns of three dots, like the six on a die or a domino. The usual practice is to number the positions from 1 to 3 starting at the top of the left column and from 4 to 6 starting from the top of the right column. In this system the dots used to form a specific symbol are designated by number. Description of the symbol thus requires as many numbers as there are dots in the symbol.

The KOBRL code is based on treating the six dot positions as a double octal system. The positions in the left column are designated as 10, 20 and 40 starting from the top. The KOBRL numeric code for any braille symbol is then the sum of the numeric values of the positions occupied by the dots in the symbol. This sum is always a two-digit number provided we use a zero to indicate that there are no dots in a given column. For example, the braille symbol

*Pronounced co-braille

for the word "for", which consists of all six dots, is 77 in the KOBRL code. The symbol for the word "the", which consists of the dots, 2,3, 4 and 6 in the usual braille numbering system, has a value of 65 in the KOBRL code.

To make the computer output easily read, our practice has been to use hyphens between the number pairs corresponding to the braille symbols forming a word. Spaces are left between words.

In the KOBRL code, the symbols for the alphabet are:
10-30-11-13-12-31-33-32-21-13-50-70-51-53-52-71-73-72-61-
63-54-74-27-55-57-56

The sentence "I like to read." becomes
04-21 70 62-72-20-13-26
in Standard English Braille.

To produce embossed braille using a computer transcription output in KOBRL code is a simple matter. The six embossing keys on the brailler are labelled 40, 20, 10, 1, 2, and 4, respectively, starting from left to right. To produce the correct embossed symbol, the operator presses the combination of keys whose numbers total to the KOBRL code number. Since each combination of keys totals to a different number there is no possible ambiguity.

Embossing on a hand slate is only slightly more difficult. The dot positions values must be memorized since they are too small to label. Also, the column values must be inverted because it is written backwards on the hand slate. Thus the right hand column contains the 10, 20 and 40 and the left the 1, 2 and 4. The combinations are so simple, however, that they are very quickly learned by almost anyone*.

*It has been suggested that this is well within the capabilities of many retarded persons and that embossing braille from a numeric code instruction might be a useful and satisfying occupation for some of these people.

The KOBRL numeric code has been demonstrated or described to interested people from time to time. Almost invariably someone suggests that the computer output could be read optically with the signal from the optical reader used to actuate an electrical device to operate the braille. When this was suggested recently in the presence of a blind computer programmer, he immediately pointed out that the majority of people come well equipped with two optical readers and did not need electrical input in order to operate a braille. It is at this widely distributed source of optical readers available at every computer facility anywhere that this code is aimed. We believe that its use could be of significant value to the thousands of blind people scattered across this country and around the world.

A newly developed computer program to transcribe braille is described in another paper**. This SPITBOL program, capable of transcribing at a rate of 500 to 1000 words per second, outputs in the KOBRL numeric code, thus permitting conversion from inkprint to embossed braille by untrained persons using only widely available equipment.

**SPITBOL Transcription of Braille to KOBRL Numeric Code.

SNOBRL Transcription of Inkprint into
KOBRL Numeric Code

K.O. Beatty

There are thousands of blind persons in this country whose need for brailled material is highly individualized. The blind college student, lawyer, insurance agent, social worker, housewife, computer programmer, automechanic, disk jockey, etc., each require brailled material appropriate to their immediate problems. The only way these needs are now met is by trained volunteers who have spent from four to six months learning braille. The number of volunteer braillists is quite limited and most of them are kept extremely busy transcribing material wanted by more than one person (e.g. novels). As a result, the individualized need can rarely be met promptly enough to be of any value in solving the blind person's day-to-day problem.

A program called SNOBRL has been written in the SPITBOL version of SNOBOL4 which transcribes inkprint at a rate of 500 to 1000 words per second into a numeric code called KOBRL. This numeric code, described in another paper,¹ is easily interpretable as the instructions for operating a Perkins Brailier, hand slate, or other manual device to produce a good quality Standard English Braille version of the original inkprint. The input to the computer is the text to be transcribed. The only editing needed is to insert an asterisk or plus sign before letters which are capitalised.* Consequently any willing sighted person with five minutes instruction can, by use of this SPITBOL program, produce an embossed braille version of inkprint at a rate comparable to that of a trained braillist.

Braille is a 63-symbol dot code based on the presence of absence of dots in each of the six specified positions that form the basic braille cell. Individual braille

*Braille has no upper and lower case letters as such so capitalization is indicated by a special braille symbol immediately preceding a letter symbol.

symbols may stand for letters, letter combinations, whole words, punctuation, and special signs. There are also some two-symbol combinations which stand for groups of letters that in some cases also are whole words. Transcription into braille consists of substituting these braille symbols for the letters, letter combinations, words, punctuations and special signs of inkprint according to a rigid set of rules.² These rules specify the hierarchy of preference of alternative letter combinations and place restrictions on when they may be used at all.

It is not an easy matter to write a transcription program that is completely rigorous with regard to all the rules in every situation. The SNOBRL program avoids some of this difficulty by including as initial data the KOBRL numeric code for the correct transcription of several hundred words. The codes are associated with the words they represent by being assigned as the values of the respective words. An important key to the success of the program is that it provides for addition to this vocabulary on a selective basis as the need is demonstrated. In this way it is possible to approach a completely correct transcription as closely as desired.

The program is written in the SPITBOL version of SNOBOL4, a string manipulation language, which has operations for forming and separating strings, testing their contents, and making replacements for them. These are precisely the functions involved in transcribing. The text to be transcribed is separated into tokens one at a time. A token is defined as any group of symbols bounded by blanks. Using the indirect reference capacity inherent in SNOBOL, tokens are replaced by their values (i.e. their KOBRL numeric code equivalents) if these tokens and their values have been entered in the vocabulary.

If there is no non-null value for the token, its content is tested and it is broken into substrings whose values are non-null. The token is then replaced with the sequential concatenation of the values of the sub-strings. This is

ultimately always possible by using the individual symbols of the token as the substrings since values for every such symbol have been included in the vocabulary.

Selection of a strategy for breaking the token into sub-strings is the essence of the programming problem. This strategy, together with judicious selection of the vocabulary to be included, determines the speed and correctness of the transcription. A detailed description of the program, which contains about 125 non-I/O statements, is beyond the scope of this paper, but the general approach is worth outlining.

With the few exceptions discussed later, the vocabulary consists of individual symbols and whole words. Consequently a token which contains numbers, punctuation, or capital signs will not be recognised even though these are appended to a word which is in the vocabulary. Since in braille numbers require special treatment, an unrecognised token is first checked to see whether it contains any numbers. If it does the token is sent to a special subroutine for transcription.

Nonnumeric, unrecognised tokens are first broken down into three substrings consisting of any nonalphabetic prefixed symbols, any alphabetic string, and any nonalphabetic suffixed symbols. Any one or two of these substrings, of course, may turn out to be null. The symbols in each of the nonalphabetic substrings are then replaced symbol by symbol with their KOBRL values. If the word is not in the vocabulary, it is replaced letter by letter with the corresponding KOBRL numeric values. The three replacement strings are now concatenated and form the value or "transcription" of the original token.

In the event that the token does not contain as a substring a word that is in the initial vocabulary, the token is tagged and put into a new word list along with its value. Each time that same token appears it is counted and replaced with its value. Along with the final transcript, the output

lists each of these new tokens and their frequency of appearance. As presently programmed, no count is kept of the frequency of appearance of words in the initial vocabulary, but this could be easily added.

As mentioned above, the initial vocabulary consists basically of individual symbols and whole words. Presently, we also include the words 'the' and 'i' preceded by the capital sign. So many sentences start with 'The' that this does save some time in transcription. We have also included a few suffixes, viz., -ed, -er, and -ing (each of these suffixes has a special symbol in braille), and any unrecognised alphabetic substrings of tokens are checked for these suffixes before resorting to letter by letter transcription. The root word is checked against the vocabulary if a suffix is found. If the root word is not known (actually, the root plus 'e' is also checked) the root is transcribed letter by letter and the KOBRL value of the suffix is concatenated to it.

Correct braille must conform to the rules previously mentioned. It is obvious that the transcription produced by the program described above will consist of some completely correct braille, viz., those words which were in the original vocabulary and those words which are correctly spelled letter by letter. It will also contain some letter by letter transcriptions for words whose correct transcriptions would include one or more letter combination symbols. While such a transcription is readable by a blind person, it may slow down the reader if there are too many words not transcribed in Standard English Braille (American Version).

One way to avoid this problem while still using a vocabulary look-up approach is to have the vocabulary contain all the text words that require other than letter by letter transcription. To approach this on a general basis would require a vocabulary of tens of thousands of words. Yet, it may be resolved on a specialised basis with a fairly limited basic vocabulary.

Studies such as those by Kucera and Francis⁴ have shown that there are about 150 words which make up 50 percent of the word-tokens in almost any reasonable length sample of current American English writing. A vocabulary of 1000 words, however, will account for only another 10 or 15% of the word-tokens. It is apparent that a general vocabulary to anticipate all the possible words, even a 5000 or 10000 word sample, might have to be longer than the sample itself.

What has been done in the SNOBRL program is to use an initial vocabulary list of only a few hundred words. This includes all of the 185 short form words of braille plus other words from the high frequency end of the Kucera and Francis tabulation. A 500 to 1000 word portion of the material to be transcribed is run through the computer. As mentioned, the output lists all words that were transcribed letter by letter and how often each appeared. The words in this list together with their correct KOBRL values are now added to the vocabulary and a larger portion of the text is put through the computer transcription process. Transcription and vocabulary enlargement may be repeated as often as desired. When the number of letter by letter words in the output is satisfactorily small, the transcription is considered complete and embossing is carried out.

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SAMBA and RUMBA: Systems for Computer
Assisted Translation of Braille Music

W. Watkins and J. Siems

Introduction

In May, 1971, the American Printing House for the Blind (APH) undertook a project, in cooperation with the Library of Congress, Division for the Blind and Physically Handicapped, to develop a system for computer assisted translation of braille music. To date, progress has been made toward the implementation of two systems for this purpose - SAMBA (Systems Activated for Music Braille Automation), and RUMBA (Representations Utilizing Music Braille Alphameric).

SAMBA

Input

In collaboration with Music Print Corporation of Boulder, Colorado, APH has developed a music typewriter-to-card punch, capable of encoding standard music notation of virtually any complexity. In addition to alphanumeric, the type font contains 38 music graphics which can be used singly, or can be superimposed, to produce computer-identifiable symbols. Forward and backspacing generates codes, as does movement up or down the music staff. In this way, a two-dimensional array is represented by a succession of punched codes and a typed copy of the music text is produced for subsequent proofreading.

Porgramming

The translation programs written for the SAMBA system are, at present, limited to translation of relatively simple single-staff monophonic music with a significant amount of human intervention. The programs, written in assembler

language, are sizable, requiring some 350,000 bytes of storage (including the APH literary braille translation programs) and require five runs on an IBM 7040 computer.

Auxiliary Programs

Several programs have been written for peripheral operations. One of these is a program to display music input on the printer. Music typewriter graphics not available on the printer are represented by two-letter symbols. This two-dimensional display may be compared with the inkprint copy to determine whether or not a section of music text has been correctly entered into the computer.

Output

The automatic stereograph machines developed at APH for literary translation are usable for music braille, as the same cell configuration and page format are common to both codes. From computer-prepared instructions, these machines emboss metal plates which are subsequently used in conjunction with presses to produce multiple paper copies.

Discussion

The high degree of complexity of music notation in general, and the braille music code in particular, which ramify in computer factors such as lengthy run times and high volume internal storage requirements, render inconclusive the possibilities for the practical application of a highly automated system for the production of braille music - further research is indicated.

RUMBA

Input

The first step in the operation of RUMBA consists of the conversion of music into the RUMBA language, which consists of alphameric equivalents of braille music signs, by an input specialist of whom a thorough knowledge of the braille music code is required as well as certain fundamentals of Grade I literary braille. Because most titles, credits, and literary footnotes are translated into grade II braille, it is usually necessary to have them translated prior to the encoding step in order for the input specialist to maintain an accurate cell count on the braille line.

The input specialist indicates the RUMBA language on coding sheets consisting of rank and file numbered blocks corresponding to the cells on a braille page; this allows for an accurate line and page count to be maintained.

After completion by the input specialist, the coding sheets are keypunched into cards or magnetic disks.

Processing

If the music to be processed is vocal music (and therefore contains lyrics), it requires extra initial processing to edit the lyrics and thereby prepare the data for the basic music translation programs, RUMBA 1 and RUMBA 2. If the data contains no lyrics, the file goes directly to RUMBA 1.

Programming

The programs for RUMBA, written in assembler language, have as their function the implementation of the language used by the input specialists. In its present form the RUMBA system requires two runs to transform the coding sheet terminology into braille symbols. The first run analyses the data for indications of the various modes and recognises the material as musical or literary, page text or footnote,

parenthetic or non-parenthetic, etc. It then edits for translation. The second run converts the music symbols to the appropriate signs of the braille music code and translates literary material to grade I or grade II braille.

For the second run the APH Braille translation program is required along with an additional RUMBA program. The latter effects the recently adopted music format feature of placing the inkprint page number in the upper left corner of the braille page and also handles certain aspects of spacing which are characteristic of music.

A table of signs used in RUMBA processing is contained in a file of cards. The file is arranged in logical sections with headings. At the beginning of the first run the table file is read. The headings are ignored; and the entries are sorted for look-up.

In order to accommodate vocal lyrics, a program was written which makes modifications before the data is read by the other RUMBA programs. Music text containing lyric lines is read by the edit program and changed as necessary so that the repeat signs and words containing "in" will be processed correctly by later programs. The RUMBA lyrics program recognises the input symbols which distinguish both from the mnemonic code. Provision is also made for preserving the applicable status as the data alternates between page and footnote material.

The RUMBA programs, including the lyrics and literary braille translation programs, require approximately 200,000 bytes of storage.

Output

Automatic stereograph machines are utilised in both the RUMBA and SAMBA systems.

Discussion

The RUMBA System is complete, is in production, and is not limited in the types and complexities of braille music it can produce. Training of input specialists requires approximately eight weeks, based upon a 40 hour week, which contrasts with the two-to-three years apprenticeship usually necessary for a manual transcriber. While less convenient to use than the SAMBA input system, it is a viable alternative to the manual process of producing metal plates at a stereograph machine, and it does not require an in-depth knowledge of grade II literary braille.

Computers and Music Braille

P. Howard Patrick and Rosalind E. Patrick*

Abstract

The first part of the paper is a comparison between three systems for the computer-assisted translation of braille music: the SAMBA (Systems Activated for Music Braille Automation) and RUMBA (Representations Utilizing Music Braille Alphamerics) systems developed by the American Printing House for the Blind, and an adaptation of the IML-MIR (Intermediary Musical Language - Music Information Retrieval) system. The second part of the paper offers suggestions for the future development of systems for both the computer-assisted translation of braille music and the computer-assisted instruction of braille music.

The Present

Computer-Assisted Translation of Braille Music

At least three prototype systems for the computer-assisted translation of music braille have been developed and described in the literature: two systems, SAMBA (Systems Activated for Music Braille Automation) and RUMBA (Representations Utilizing Music Braille Alphamerics), have been developed at the American Printing House (APH) for the Blind (1) a third, developed by one of the authors of this paper is an adaptation of the IML-MIR (Intermediary Musical Language - Music Information Retrieval) system which was originally designed for computer-assisted analysis

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of music (2). Table I and Table II contain a comparison of the Input, Translation, and Output features of these systems.

Table I: Input System

IML-MIR SYSTEM

APH SYSTEMS

Input

IML is a one-dimensional horizontal alphanumeric language very similar in syntactic construction to music braille. Limited to music which can be reduced to one line per staff i.e. vocal music (monophonic and polyphonic), band parts.

SAMBA: no language. The operator tries to represent (in a two-dimensional format) the printed page. (The necessity of a two-dimensional input format is open to debate.)
RUMBA: language uses alphamerics representing braille cells.

Hardware

Can be prepared directly on:
1. a keypunch
2. teletype console
3. CRT console

SAMBA: requires a music typewriter which is not generally available; possible source of production "bottleneck."
RUMBA: can be prepared as in the IML-MIR system.

Training

Language takes about $\frac{1}{4}$ hour to learn.

SAMBA: No information available.
RUMBA: thorough knowledge of the braille music code, and fundamentals of Grade I literary braille.

Coding

Average page of music takes about 20 minutes.

SAMBA and RUMBA: no information available.

Problems

Proofreading and editing.

SAMBA and RUMBA: proofreading and editing.

Table II: Translation and Output Systems

IML-MIR SYSTEM

APH SYSTEMS

Language

All in FORTRAN

SAMBA and RUMBA: all in ASSEMBLER.

Programs

Two passes -

1. IML translation program
2. MIR-Braille retrieval-translation program

SAMBA: five passes -

1. Input deck to music characters
2. Music characters to music units
3. Music units to edited music units
4. Edited music units to braille sign names
5. Braille sign names to braille

RUMBA: two passes -

1. Analyse data for indications of various modes, and recognises the material as musical or literary, page text or footnote, etc.
2. Converts music and literary symbols to braille code.

Storage

400,000 bytes

SAMBA: 350,000 bytes

RUMBA: 200,000 bytes

Run-time

Sample data of Kyrie 1 of Missa L'homme Arme by Josquin:

IML translation = 10 secs

MIR-Braille program = 28 secs

(durations are CPU time).

SAMBA and RUMBA: no information available.

Output

9-track computer digital tape which can be used as input to a braille embosser, e.g. LED 120.

Automatic stereographic machine

The RUMBA system is not really a computer-assisted translation system since the translation is done by the operator when preparing the input - it is therefore a "computer-assisted printing system" for music braille. The principal limitation of the SAMBA system is the input which uses a specially designed music typewriter. This restricts the widespread use of the system since few establishments can afford the expense of such equipment. The commitment by APH in 1971 to develop and refine such a typewriter is understandable. Their progress reports indicate the general opinion of authorities in this field was not favourable toward using a keypunch language. Despite several years of research and development, no system using a keypunch language input was fully operational at that time. However, since then, the situation has changed considerably. In the summer of 1972, after some 10 years of development, the IML-MIR system using keypunch input became fully operational. The five separate programs of the SAMBA system seem cumbersome and inefficient. Furthermore, they are all written in ASSEMBLER and this restricts their portability.

At present the IML-MIR system is limited by the IML language which cannot accommodate keyboard music. Since the MIR system is not dependent on the input language in IML, however, any form of coded music could be used as a data source. The present IML-MIR system can serve as the basis for the development of a more comprehensive computer-assisted translation system for braille music. It is true we are limited to vocal music, but it may be preferable to refine the system using this type of music before attempting more complex music and solving the programming problems that will undoubtedly arise on "easier" text.

It is apparent from the above comparisons that no one of these systems is a panacea for computer-assisted braille music translation; further research and development is needed.

The Future

Computer-Assisted Translation of Braille Music

Obtaining the money required for development of computer-assisted music translation systems is a major problem, and it would seem advantageous for translation to be achieved by adapting a system which is not dependent on the limited market of blind users for its major source of revenue. Compositors' tapes for inkprint editions can be modified for braille production in literary braille (3).

For literary braille it can be argued that investment is needed in this area to keep pace with the information explosion. This is not the case with music: no new music will be written by Bach, Beethoven, and Brahms! Unlike literary braille, music braille is an international language, and its market is not restricted by the language of the country in which it is used. The world-wide nature of the music braille market cannot be overemphasised, and it is more than adequate reason for some form of international funding.

The principal system for the computer-assisted printing of music, still being developed by Stefan Bauer-Mengelberg and his colleagues, is DARMS (Digital Alternate Representation of Music Symbols, also known as the Ford-Columbia language) (4). Obviously when this system is fully operational it should be adapted to print braille music, and thus provide a possible source of braille music editions of new music. But what about the vast body of music already in inkprint and for which new editions are unlikely?

Music already in print is being coded into some form of machine-readable code for research purposes, i.e., the computer-assisted analysis of music. Researchers at Princeton University have coded 20 Masses of Josquin Desprez in IML, Leeman Perkins of the University of Texas at Austin is coding the music of Ockeghem, and Prof. David Crawford

of the University of Michigan is coding Josquin Motets. Other researchers have coded music in various languages (many of them derived from DARMS). Researchers agree that the most difficult problem is the coding and proofreading of the material. Once the music is coded, no matter what the language, it is not a major task to write a program to translate the old data and reformat it into a standard code.

The user of the computer in music scholarship is limited at present, but its use is expanding. The availability of music for the blind is similarly limited, and the need is continuously expanding, but the relatively limited market for braille music severely hampers production of material. These two areas (i.e. computer-coded music and braille music) allied can benefit mutually both sighted and blind musicians.

Computer-Assisted Instruction (CAI) of Braille Music

Another area which can and should be developed, since all the necessary hardware exists, and the financial resources needed are not as large as that for the computer-assisted translation of braille music, is the computer-assisted instruction of braille music.

For the blind person, participating in a musical experience as a listener, performer, or educator, is often hindered by an inability to read music braille. Music braille is derived from literary braille, and the latter has to be learned first. The extra time required to learn music braille, and the limited number of people qualified to teach music, means that the number of people available to teach music braille is small.

The Education for All Handicapped Children Act of 1975 (PL 94-142) states that school districts must now provide all educational services for the handicapped. The use of

computers for the instruction of braille music is a possible avenue to compensate for the small numbers of qualified teachers of braille music.

CAI in education has been increasing slowly over the last decade, although not as quickly as many people expected. This slow growth is due to many reasons among them lack of instructional programs, lack of documentation, lack of texts, financial cutbacks, and poor distribution networks of material (5). Yet the concept of CAI is still valid. CAI allows students to develop at their own rates, frees teachers to deal with students' individual problems, and provides an added avenue of individual intellectual development.

The use of CAI in music has been limited. Many of the concepts of music are ill-defined and difficult as yet to organize in a computer program. Because of the small number of students in music, CAI is not very cost-effective. The representation of music using normal keyboard characters is also difficult; many projects have used instead cathode ray tubes displays with light pens. Finally, it is an advantage for a student to hear the music as well as read it. This last problem has now been overcome by computer-driven sound-generating devices which can be attached to a Teletype. The sound is limited to a square-wave signal, but most pitches are available (6). The recent organization of the National Consortium for Computer-Based Musical Instruction (NCCBMI) should promote more active development in this area (7).

CAI for the blind has only recently become feasible with the development of braille Teletypes such as MIT's Brailleboss (8), and the Triformation Systems LED 120 (9). An early attempt at CAI in mathematics was felt to be successful (10).

Many of the previously mentioned problems will not be an issue for the computer-assisted instruction of music braille. Regarding distribution networks, the Division for the Blind and Physically Handicapped for the Library of Congress

already distributes educational material and talking books through developed and widely publicised channels. These channels can also be utilised to distribute documentation and copies of any CAI programs.

The problem of trying to represent graphic musical symbols is nonexistent, since all symbols are represented in embossed braille cells. The problem of translating ill-defined and abstract concepts of music into the form of a computer program is also not relevant, because the program will only attempt to assist in the instruction of the language of music braille (not music), and this language is already defined in the primers (11). The CAI program would provide additional drill material using an interactive capability.

Thus the use of CAI for music braille is not only feasible, but highly desirable. It provides immediately an additional instructional tool in an area of limited numbers of qualified personnel, and requires no new technical developments. Enhanced instruction in this area should increase the number of people able to read music braille, and thus help to create a greater demand for music published in braille.

Summary

More and more information is now being processed into machine-readable code. The translation of such codes into braille can be done efficiently and simply with the aid of the computer. The design special input languages and systems specifically for the blind is unnecessary and expensive. The blind and music scholarship are two Cinderella areas of public and private support; and research and development in the use of the computer in associated fields will always be hampered by fiscal restraint. It can only be to their mutual benefit if areas of joint concern are researched and solved simultaneously.

Footnotes

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Computer Coding of Music Scores Using An On-Line Organ
Keyboard

S.G. Gillies and S.J. Goldsack

Much of the research work carried out so far in the field of music allied to computing has been concerned with analysis of existing musical compositions in order to study the technique of certain composers. Other work has involved the automatic composition of music by computer, and there are techniques for the generation of computer-plotted staff notation scores.

All this work has in common the need for a written representation of musical notation that can be understood both by the user and the computer. A number of languages have been designed over the last few years for this purpose. Some of these have been developed for particular purposes and projects, but a small number are suitable for encoding any piece of music. Once such a language has been chosen, there remains the considerable problem of translating the staff notation into this language.

Work is in hand at Imperial College (London, England) to automatically produce a coded form of a music passage played into a computer via an on-line electronic organ keyboard. The objectives of this work are to develop a system for generating tapes to be printed on a braille printer, or to drive a package to draw staff notations on a plotter.

The information describing a piece of music falls roughly into two categories. We decided to use an approach whereby information which is almost naturally presented as English text is input using a teleprinter, while information concerning note pitches and times is presented by automatic analysis of key depression on the organ keyboard. In this way we avoid the difficulties of representation of the notes using a teleprinter and also avoid difficulties of musical analysis which are inherent in a full analysis of the keyboard during performance of the music as written. For example, we have not attempted to play right and left

hands simultaneously: this seems to cause unnecessary scrambling of information which is very difficult to unscramble in the computer.

The long term objectives include the coding of orchestral scores with many staves, different clefs and sometimes two or more voices per staff (as, say, in a Bach fugue).

We have therefore developed a bar editor which will enable the user to build up, within the computer store, a data structure to contain the passage he is to play. He specifies, via the teleprinter, the fixed parameters of the passage - e.g. title, composer, key and time signatures, number of staves, clefs, voices, etc. He can then play on the keyboard any pre-selected part of the piece he chooses, so filling the empty structure with real notes.

Errors are corrected by replaying earlier passages where necessary. Listing of parts of the data structure may be made on the computer console, to assist with checking. When the user is satisfied that the piece is complete and correct he can request the computer to produce the output in coded representation on a tape for subsequent input to an analysis program, a plotting program, or a braille encoder.

Our hardware uses a standard 4-octave organ keyboard with a CAMAC interface to a GEC 4080 computer. The keys are scanned 50 times/sec by software which reads the current value of the state of the keyboard and compares it with the previous state to discover which keys have been moved. After a contact-bounce threshold has been passed, each state change either generates a new note-record or completes an old one, generated by an earlier key depression.

Timing is obtained from the real-time clock in the GEC 4080, and synchronism with the keying of the music is obtained by generating a metronome output. The performer selects his desired playing speed, and the real time analysis software relates note lengths and start times to the bar lines determined by reference to the metronome.

We have not yet made a final decision regarding the external language to be used. It is likely, however, to be one of those already available, quite possibly the Ford-Columbia representation designed by Stefan Bauer-Mengelberg. This has a one to one relation with standard staff notation and appears to be the most widely used by other researchers.

A plotting package to draw scores in staff notation has been developed, designed to draw music symbols in the traditional style suitable for printing. All the normal musical characters are available. The package is designed to run on a CDC 6600 computer, using a "Kingmatic" flat-bed plotter and it is intended that it should accept as input a tape produced by the bar editor.

This work is still at an early stage. The bar editor is not yet fully operational. Certain problems are anticipated with the fine tuning of the program that interprets the notes played. A very high standard of playing may be necessary to ensure that the correct note values are read. It may, for example, be necessary to play passages with many short notes at a reduced metronome speed. We are confident, however, that we have a cheap but effective technique that can lead to rapid transcription of music from conventional staff notation into standard braille notation.

Translating DARMS into Musical Braille

B. McLean

DARMS is a language for representing musical scores to a system of score-printing computer programs. Its name is the acronym for "Digital Alternate Representation of Musical Scores." A system analogous to the one for score-printing but which automates the production of braille keyboard scores using DARMS input data sets is now being developed. Preliminary problems in the formalisation of the DARMS-to-braille translation system are discussed here.

The highly mnemonic DARMS language, with its extensive abbreviation facilities, is much easier to learn, use, and proofread than braille. The encoding of scores into DARMS, rather than directly into braille, with a computer program performing the translation of DARMS into braille, would hasten the development of a large library of braille scores considerably. The resulting scores would have to be of the same quality as those prepared by encoders using braille directly. The idea is to spare encoders any unnecessary expenditure of time in the preparation of braille scores, but naturally not at the expense of braille readers who want to have the abbreviation facilities of the braille language used in scores. Is a general translation of DARMS into braille computable which would be not only correct but also sophisticated in using the full power of braille?

An abbreviated braille score is computable from a DARMS score in principle because DARMS contains all the information that braille does and more. DARMS represents what an optical scanner would detect on pages of a score, viz., exactly the visible symbol shapes at locations on a background. A DARMS score is a complete, unprocessed set of descriptors which describes the graphic image of a printed score, and for all computational purposes it is the actual score. A braille encoding of a score, however, selects, sensibly, essential musical meanings from the printed score and ignores some of the purely graphical

information; for example, stem directions are not encoded. Information is lost in a translation from a score into braille and there is a loss of information in a translation from DARMS to braille, but a DARMS-braille translator would be impossible to construct if there were more information contained in a braille score than in a DARMS score.

Musical braille has facilities for abbreviating certain constant features of a score, just as literary braille is in large part a system for contracting frequently encountered letter groups. For example, repeated chords and measures may be encoded only once and then be referenced upon subsequent appearance. DARMS has such abbreviation facilities and many more which may be translated into the braille abbreviations. DARMS encoders who also know braille could insert control information into a DARMS score to specify exactly which abbreviations are intended in braille. A sophisticated translator is therefore at least conceivable because the input language contains all the information needed to compute an abbreviated braille result.

Practical problems are the specification of the syntax of musical braille and the specification of the semantics of DARMS expressions in terms of associating with them their braille counterparts. A syntactically correct sequence of braille characters can be semantically correct only if the rules for the layout of characters on a page of braille score are obeyed. For example, certain abbreviated braille codes, e.g., the repeated measure code, may not begin a new parallel (the braille equivalent of the printed score "system"), but must be spelled out in full. There are many other layout-contextual restrictions in braille and therefore translation is not a straightforward symbol-for-symbol mapping from DARMS into braille. For any DARMS expression there will not be associated a unique sequence of braille characters, but rather a set of alternatives from which one sequence will be chosen depending upon layout and other conditions.

A construct recently formalised in metalanguage and compiler design theory is perfectly suited to specify the syntax and semantics of the translation, incorporating such condition-setting information as layout rules (1). The construct is the attributed translation grammar which consists of the specification of (1) the syntax of the source language (DARMS) in a metalanguage such as BNF or TBNF (2, 3); (2) the semantic actions associated with each production of the syntactic description of the source language; and (3) the attributes of phrases, syntactic variables, and semantic actions which must be consulted to ensure semantic well-formedness of the object language (braille). Attributes such as current page, parallel, line and cell placement and keyboard format type (bar-over-bar, line-by-line, section-by-section, or open-score) are explicitly defined as variables in the grammar and given values during the translation. The attributed translation grammar is a comprehensive, concise, and pragmatic way of defining all data structures and their real-time interactions during translation.

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Computer-Assisted Transcription of Braille Music

Sally Wilkinson

The feasibility of using a teletype linked to a computer to transcribe keyboard music into braille formed part of an M.Sc. course for the writer whose mother-in-law has been manually transcribing music for upwards of 60 years. All technical support was given by Mrs. Wilkinson, Senior, since her daughter-in-law knew little music and no braille at the start, in the autumn of 1974. The aim was to develop a simple method of input for the music to the computer and to set up files which could be used to set up the braille either on or off line. By mid-summer 1975 a system had been produced which was capable of setting up any number of lines of music, the capacity of a braille page being the only limitation. Music of considerable complexity could be transcribed by a knowledgeable brailist and the system was sufficiently simple to allow unskilled operators to use it successfully after about an hour's practice.

The method of input was based on that used at the R.N.I.B. where a sighted reader dictates the music to a blind operator. To do this the teletype keyboard was defined as having three modes of operation. The prime mode was music mode. Keys were given musical interpretation in what seemed the most logical manner. For example, the notes A-G were the letters A-G and the octave signs were the shifted values of the corresponding numbers, so that fifth octave was the % sign. Rest was allocated the key R and treated as a note for input. Time values were input by the right hand immediately following the note to which they applied; they were paired so that the shifted value of the key was the associated time value in braille, i.e. / indicated the semibreve and its shifted value ? a 1/16. The intervals were allocated to adjacent keys as far as was practicable to aid the user. Accidentals, similarly, were grouped and associated keys were used for the opening and closing of long slurs. The keyboard also offered direct access for the user to short slurs and staccato. The numerals were given their

face value for use as fingering and also for the input of time signature etc. Music mode had two keys reserved to enable it to call the other two modes, literature mode and braille mode.

Literature mode enabled the user to input directly all braille cells which share the same print equivalent in both Grade II braille and Braille Computer Code (B.C.C.). This is only about 36 of the 64 combinations since the numerals in B.C.C. have a unique representation and do not require a number sign to precede them as in Grade II braille. When the keyboard was in literature mode the system preceded all input with the appropriate cell and terminated it, automatically, with a dot 3. One key in literature mode was reserved to recall the system to music mode.

Braille mode could be similarly called from music mode and also had a key (the *, as in literature mode, which is infrequently used in braille music) to enable the user to return to music mode. In braille mode the user had direct access to any braille cell since they keys each had the B.C.C. equivalent of their face value. Using braille mode a skilled brailist could set up all combinations of cells not catered for in music mode thus enabling any music to be transcribed by the system.

The computer used was the DEC system 10 at Hatfield Polytechnic. The preliminary work was done in Extended BASIC but the system was finally written in Extended ALGOL 60. This prototype program used about 8K of core. The main requirement for the language is that it should offer excellent string handling and, preferably, be readily readable. The demands of the transcription process were such as to extend the compiler to its limits.

The requirements for the transcription of music into braille split conveniently into two disparate parts. On the one hand there is the need to carry out all the protocols for the disposition of the score and on the other the

setting up of the music itself. With regard to the disposition of the score the system successfully carried out the following automatically:

- (i) dealing with pieces starting with an incomplete first bar
- (ii) setting up the bar number in the first line of every parallel
- (iii) setting up the ink-print parallel in the second line of the parallel as required by the layout of the ink-print
- (iv) adjusting all lines to align the line distinguishing cells such as right hand and left hand
- (v) examining the first cell in each line of the first bar of a braille parallel and inserting dot 3's when required
- (vi) ending the piece with the braille equivalent of the double bar line and, finally, centring the end of piece signal on the following line. Elaborations of the double bar line, such as repeats, were not catered for, neither was the system capable of starting a new braille parallel after a double bar line in the middle of a piece.

The music content was examined a line of a bar at a time. The program carried out exhaustive checks to establish the validity of the input presented and elementary editing facilities were offered. For example, if a note was not followed immediately by its time value a message was output asking for the time value to be input before the analysis of the bar continued. Illogical input, such as an accidental following an octave sign, was drawn to the user's attention and the offending input could be replaced, omitted or an insertion made. Any input which had already been accepted was not accessible at that stage. However, at the

end of each bar line the user was given the option to reject the bar as set up and thus errors could be corrected by the input of the bar for a second time. A count of the beats in each bar was kept and at the end of a bar line any discrepancy was printed to indicate error and aid the user in finding it. Once a bar line was accepted there was no means of editing it further.

Provided no bar required more than 30 braille cells for its representation the system was capable of setting up the music correctly. Since the analysis was line by line no account could be taken of introducing the music hyphen, thus the system could not set up music containing overlength bars. A revised system could overcome this by carrying out the analysis bar by bar and indicating to the user if a line was overlength. The writer is convinced that it would be possible for the user to indicate an acceptable beat on which to break the bar and for a more elaborate system to set up the music hyphen, helped only by the user supplying the necessary octave signs for the start of the continuing bar. The writer feels that for the system to establish the octave sign automatically would involved very sophisticated coding techniques bearing in mind the complexity of the rules governing octave signs. For that reason the system required the user to supply octave signs at the start of all bars (not a requirement at present in the U.K.), since the system automatically sets up braille parallels as required without user intervention.

The prototype system suggests a method of setting up music in braille using limited equipment. The writer invited three sighted musicians and a blind musician to try it and found that after about an hour's tuition all could get results, those with a good knowledge of braille music finding adaptation easy even though they had no previous experience with a teletype. This implies that the system offers a practical approach to the transcription of music into braille. Re-design of the music mode keyboard would enable the facilities offered automatically to be substantially increased. The incorporation of a compatible

Grade II braille system would enable literature mode to offer still wider facilities.

Computerised Braille in the Netherlands

M.J. Vliegenthart

The National Braille Committee in the Netherlands completed the revision of the current system for contracted braille in Spring 1976.

Parallel to the final report, a computer program has been published as a doctoral thesis. The program is written in Algol 60 for translation of text into the new contraction system.

The research on automatic translation has been stopped as far as literary texts are concerned. A great challenge will be the automatic translation of scientific formulae for mathematics, physics, chemistry, etc. The research for possible solutions may go in parallel with the aims for unification of the scientific braille code.

A Braille Letterpress for the Blind

A final report submitted to
The Smith-Kettlewell Eye Research Foundation

G.W. Ohlson and Frank A. Saunders

Project period: November, 1973 - October, 1975

Amount awarded: \$300.00

Overall aim and summary of activity

We have constructed a prototype letterpress device using movable letterpress type for the production of braille materials. Unlike current methods of braille reproduction, this hand-operated braille press is eminently suitable for use by the blind for the production of limited quantities of specialised material, such as scientific reports, informational brochures, and time-dated literature.

Feasibility was demonstrated for a process whereby the embossing components of a braille cell could be cast in hot metal, thus providing a reliable and inexpensive source of movable type for use by blind persons in typesetting braille material. Sufficient type was cast to set three full pages of braille text.

The concept of type-cast braille cells was extended to include the flexibility and speed of the Linotype process. Molds were developed for the braille cell components and were made compatible with standard Linotype magazines, so that complete lines of braille text could be cast and assembled into page format.

Two Linotype machines, at a replacement value of \$10,000 (used equipment) were donated to the Smith-Kettlewell Eye Research Foundation for use in this project by the San Francisco Newspaper Printing Company. The machines are currently undergoing necessary modifications and are

temporarily housed in San Rafael, California.

An electronic interface is being prepared which will control the braille linotype by means of ASCII-coded punched paper tape, as generated by a standard Teletype, and as transmitted by all TWX telephone lines. With this provision, the punched tapes routinely used in automatic typesetting (such as weekly newsmagazines and many books) could be used to produce braille editions of these materials, without the intervening need for time-consuming hand transcription.

The success of this initial feasibility study suggests the possibility of a sheltered workshop operated by blind persons, dedicated to the preparation, proofreading, and publication of brailled materials for the blind community.

Detailed description of project activities

Hand-set movable braille type, composed and proofread by the blind. As originally conceived by Ohlson, the concept of movable braille typesetting divides the braille cell into three horizontal segments. Each segment contains either (1) two dots, (2) one dot, which can be oriented either left or right, or (3) no dots. These three segments are sufficient to construct all 64 possible braille cells; they are easily assembled by hand from three component bins, and are easily redistributed following the printing run.

Molds for casting the individual segments were prepared in the IMS Instrument Shop by Jack Shore. Using these molds, MacKenzie-Harris, Inc. cast sufficient type to compose three full pages of braille text. With these prototype materials in actual use, we were able to estimate the time required (approximately 30 minutes) for a moderately proficient blind person to compose one page of braille type.

Each composed page is immediately available for proofreading by the blind person who has assembled it. The completed pages are then transported to a conventional print-

shop with a cylinder-type proof press, which embosses the customary braille paper by rolling it across the type matrix.

The life of the individual braille segments is estimated at over 20,000 impressions.

The advantages of the above approach are numerous:

- (1) Composition and proofreading of the braille text is under the direct control of the blind person who originates the material.
- (2) The method is labour-intensive, requiring no sophisticated machinery, processing, operating costs, or maintenance. The method is highly suitable for use in developing countries where communication facilities are otherwise limited.
- (3) The process permits interpoint, or double-sided embossing of each page.
- (4) The format is flexible and direct, permitting the incorporation of raised-line drawings and other tactile representations. It should find a particular application in the education of the blind, both for the production of brailled texts and supplementary material, and for the preparation of books in which the text is both printed and embossed, for the convenience of sighted teachers, parents, and peers of blind schoolchildren.

Linotype composition of whole-line slugs of braille type. Linotype setting of braille, like conventional print, offers several advantages over the hand-composing process. These advantages include speed, flexibility of format, and ease of redistribution of used type. The latter advantage is significant; a page of hand-set type must be broken down and returned to the individual segment bins prior to re-composition, while used Linotype slugs are simply melted

down for recasting.

An additional major advantage to the Linotype process is the possibility of control by punched paper tape. Text may therefore be prepared and edited off-premises; the completed tape is then delivered to the printshop for braille casting and printing.

Finally, much contemporary literature, from books to periodicals to daily newspapers, is at present composed from ASCII-coded paper tape or magnetic tape cassettes. These "masters" are discarded after use. Given the proper encoding and transformation, these tapes could be used to produce a near-simultaneous braille edition of the printed text, at significant savings of time and cost. The alternative, hand transcription into braille, is expensive, is dependent upon sighted volunteers, and requires weeks or months of advance preparation; braille copies are usually prepared in single unit quantities.

A computer-controlled process. Linotype preparation of braille, while simple in concept, has certain technical requirements which to date have prevented the concept from being put into practice. Each 5-inch line (or slug) of braille will contain 20 braille cells; each cell will be assembled from two vertical segments, one for the left half and one for the right. Each half is selected from 7 possible segments: dots 123, dots 12, dots 13, dots 23, dot 1, dot 2, and dot 3. There are seven left segments and seven right segments, plus a blank segment used in either position, for a total of 15 different segments.

The ASCII code fed into the Teletype reader contains cell-by-cell information. Each cell must be divided into left and right halves, the appropriate segments selected, and the appropriate Linotype channels accessed to build the character. At the completion of each line, a slug is cast and transferred to the column for printing. This encoding task normally would require the services of a dedicated minicomputer, and therefore has not been

practical or cost-effective to this date. The task, however, is ideally suited for the low-cost microcomputer assemblies (\$3000-\$4000 at current prices, and declining) and read-only-memories which have just become available. We are preparing a simulation of such a system to demonstrate its feasibility, its flexibility, and its simplicity of operation.

The advantages of contracted braille. Conventional braille is a direct letter-by-letter encoding of alphabetic character to braille cell. Significant savings of space and reading speed are achieved by the use of contracted braille, referred to as Grade II and Grade III, as employed by sophisticated and well-educated blind users. The preparation of contracted braille material is expensive and requires skilled transcribers. The tape-controlled Linotype process offers several important advantages in this regard. First, the input tape can be prepared by the blind author who has written the material, using contracted braille at his volition. Second, a significant number of contractions, e.g. 'and', 'the', '-tion', can be stored in the micro-computer's read-only-memory as a dictionary; when these words are encountered in an uncontracted input tape, the contracted or uncontracted transcription can be selected according to the readership for which the material is being prepared.

The preparation of educational material. At present, a significant need exists for educational material printed both in conventional type and in braille, and in any language. Potential users include sighted parents reading to their blind children, while allowing the child to "read along" in braille as a training exercise; sighted teachers conducting classes for blind and sighted children; blind teachers conducting classes for blind and sighted children; blind teachers conducting classes for blind and sighted children; and other educational and reference materials intended for use by the blind as well as the sighted.

Little such material is currently available. The Thermoform process, which produces raised-line drawings and braille in plastic, is not suitable for simultaneous printing; the plastic is brittle and bulky and aesthetically unaccommodating. A process called Twin-vision¹ involves the embossing of printed materials with an addressograph-multigraph press; the process is slow, expensive, and it is difficult to get replacement type. As a much preferable alternative, we envision the preparation of multicolour printing plates and linotype-cast braille plates; braille-quality pages are first printed via conventional plates and then embossed with braille plates, fully utilizing the economy of lithography.

Educational and vocational implications. In brief, these include:

- (1) Great simplicity and flexibility in preparing braille training material with expanded inter-character and inter-line spacing, for teaching material to recently blinded adults (e.g. veterans.);
- (2) The preparation of sufficient quantities of compatible ink print/braille elementary educational texts to make possible true integration of blind and sighted children within the classroom;
- (3) The gainful employment of blind persons in transcribing braille material, rather than the current dependence upon sighted volunteers;
- (4) The gainful employment of blind persons in operating braille printshops featuring inexpensive, rapid preparation of material for the blind community.

¹Jean Norris, Publishing Division, American Brotherhood of the Blind, 18440 Oxnard Street, Tarzana (Los Angeles), California 94351

Future Plans

The two Linotypes and a recently donated proof press with a 14-inch cylinder are temporarily housed in a warehouse. A machinist is contributing his time in reconditioning and adapting the equipment for braille use.

We intend to solicit start-up, seed support for the first year of operating, starting approximately January 1, 1976. The estimated annual budget is \$22,500., including rental of space, salary for one full-time operator, and consumable supplies required for normal print shop functions.

Intermediate support funds will be sought from the Bureau of Education for the Handicapped (U.S. Office of Education) and from the Rehabilitation Services Administration. Once the feasibility of the concept has been demonstrated, and once a market has been established, we believe that the braille print shop can approach a self-supporting status, partly through individual services to blind users and partly through contract printing of educational materials for State and Federal agencies.

French Embosser/Terminal

SAGEM (Societe d'Applications Generales d'Electricite et de Mecanique, 6, avenue d'Iena, 75783 Paris, France) announces the serial production of a braille embosser/terminal (REM 8 BR) designed to be fed machine-readable input. Specification:

Code utilised: alphabet reduced from the CCITT No. 5 to 7 significant bits plus one parity bit adapted to writing braille.

Character structure: 10 to 11 bits (single or double stop).

Transmission speed: 110 to 150 baud (adjustable with interrupt).

Telegraphic capability: margin greater than 40 percent.

Embossing speed: 10 to 15 characters per second.

Cell definition: 6 dot (three lines, two columns).

Cell dimensions: circa height 5mm (.2 inches), width 2.5mm (.1 inches).

Cells per line: 31

Horizontal spacing: 6.35mm (.25 inch) (4 characters).

Vertical spacing: 10.16mm (.4 inch).

Paper stock: fan-fold supply.

Local commands: carriage return, end of page.

Working environment: 0 to 50 °C.

Storage environment: -5 to 70 °C.

Mains power supply: 115/127/220/240 volts, +/- 10 percent,
50/60 Hz.

Power drain: about 120 VA

Approximate dimensions: height 235mm (9.25 inches) width
525mm (20 inches), depth 525mm (20 inches).

Weight: 25kg (55 pounds).

Conforms to advisory specification V-24 of the CCITT; usable
with dedicated telephone line.

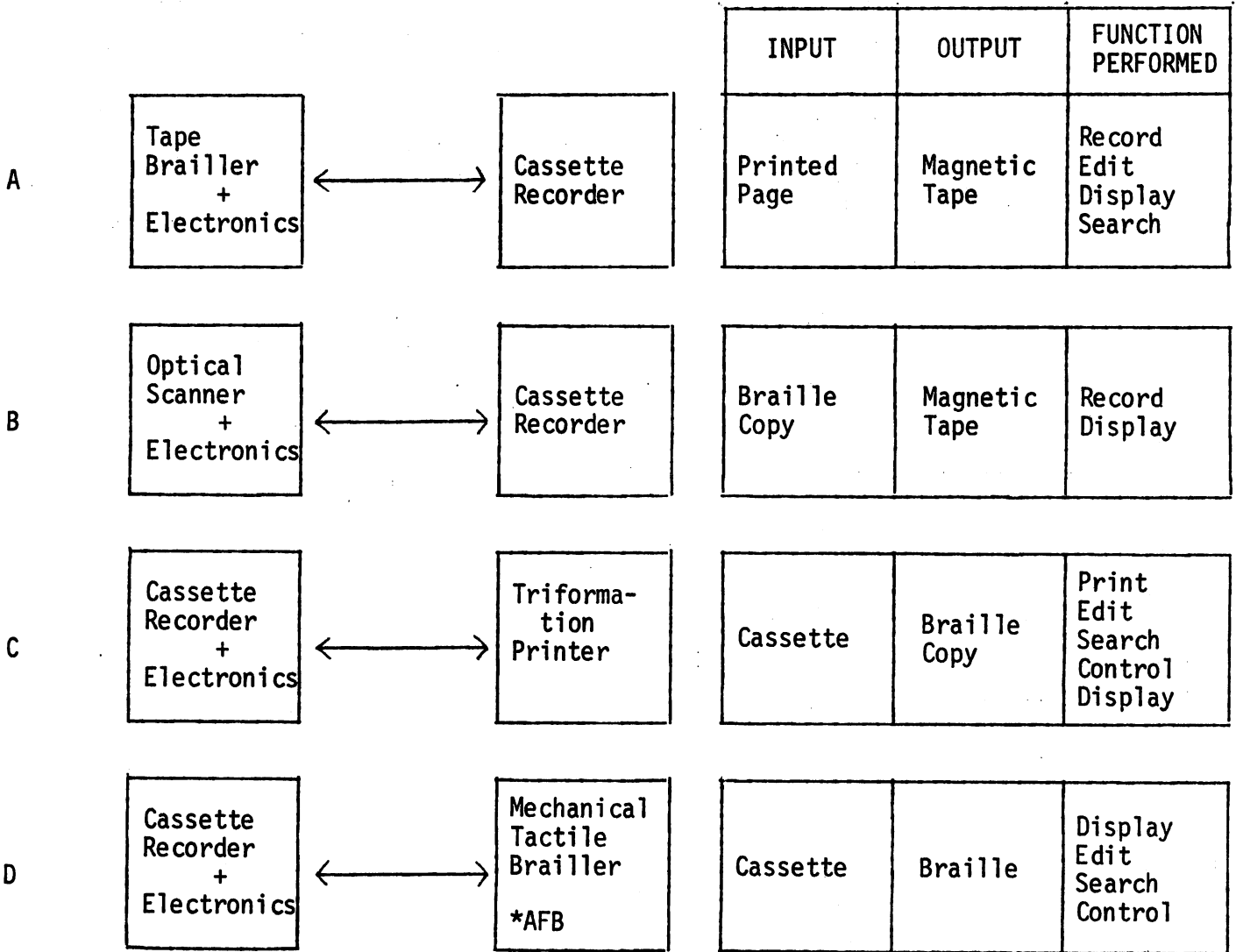
Price: NF 10,000 (approximate U.S. \$2114)

Editors' footnote: The physical quality of the braille,
submitted with this specification, was
exceptionally fine.

The Maure "Smart" Terminal System

In a collaborative enterprise involving the AFB; Electro-Mechanics., Inc., of Hartford, Connecticut; the Connecticut Braille Association; and possibly the Department of Education of the State of Connecticut, a design has been drawn up for a multipurpose braille system that will aid volunteer groups in enhancing the availability of braille. The heart of the system comprises a device that will generate braille information and record it on cassette tapes via keyboard entry; the device also contains those added components (ROM program chips, UART, and additional keyboard interface keys) that will allow several additional functions to be performed. Among these are: search and editing capabilities of the recorded braille information; playback of braille information in both optical and tactile forms generated cell by cell across a line of text; capability to act as a recording device for an optical scanner for capture of already brailled text, plus a display to verify the scanner's performance; formatting the tape; monitor of an external printer's operation; driving a transitory page-at-a-time braille display (see description of press braille scheme in this Newsletter); and search, display, and editing functions for the blind user. Since the ergonomics of the terminal are still being worked out, we append here a schematic illustrating the several applications of the terminal. Further details will be carried in a future issue.

Further information can be obtained from D.R. Maure, Electro-Mechanics Inc., 150 John Downey Drive, New Britain, Connecticut 06051, U.S.A. (Tel. (203) 224-3183).



ADVANTAGES	DISADVANTAGES	DEVELOPMENT COST	PRODUCTION
<ol style="list-style-type: none"> 1) Speed 2) Less labour 3) Lower cost copy 4) Less storage space 	<ol style="list-style-type: none"> 1) New equipment req'd (Triformation) 2) Higher cost brailier 	\$9,000 - \$30,000 ?	\$500 - \$1500 + Cassette
<ol style="list-style-type: none"> 1) Lower cost copy 2) Less storage space 3) Uses existing copy 4) Uses existing brailier 	<ol style="list-style-type: none"> 1) Labour same 2) Retrofit second copy only 	\$50,000 + \$6,000 if available	\$3,000 (?)
<ol style="list-style-type: none"> 1) Lower cost copy 2) Less labour 3) Faster copy turn-around 4) No Thermoform 	<ol style="list-style-type: none"> 1) Requires investment 2) No figures (manual) 		\$9,000
<ol style="list-style-type: none"> 1) 25c/copy vs \$7.00 2) More accessible 3) Teaching aid 4) Job opportunities 5) Less storage space 	<ol style="list-style-type: none"> 1) Major development 2) Cost of Mech. Brailier 3) Accessories required 	\$100,000	\$3,000

Grade II French Automated Braille

J.M. Charpentier

The aim of the project is to develop a program to translate French ink print into contracted grade II braille, and is in two parts:

The first part examines the text step by step which has been typed in by an operator. The lines are 40 characters long. Each time, the program checks if the character is of various types:

- (i) a separator (e.g. blank, semicolon)
- (ii) a digit
- (iii) an already contracted braille expression
(e.g. "c'est-à-dire")

If one of these conditions applies, the separator, digit or expression will be translated first. If none of these conditions applies, the program stores the character and studies the next character until it finds a separator. I think that this program will be able to translate mathematical signs by adding a small subroutine. When the program has found a separator, it has a word and this word is sent to the second part of the program.

The second part of the program translates words into contracted braille. This requires several operations:

(i) Some words like 'afin', 'route', 'université' are already translated. The first thing the program will do, is to see whether the word is already stored in a library kept on a peripheral.

(ii) The second operation is to see if the word ends in 's', 'es', 'e', or by a suffix like 'able', 'ation', 'que'; in this case, these terminations may be added to the words already translated.

(iii) After these operations, the program will examine the word character by character; each time it checks whether it is before a group of characters represented by a single braille sign. If it isn't, the letter is translated and the next letter will be studied. If it is, the program will test the different conditions these groups have to perform e.g. only at the end of the word, only after a vowel. When all the conditions have been checked, the group is translated and the first character after the group is studied. When the whole word is translated it is output.

At present each braille sign is represented by a number; in July I will take delivery of a braille terminal made by SAGEM.

The operator must comply with a few rules:

- (i) accents are represented by:
 - + = acute accent
 - / = grave accent
 - * = circumflex
 - = = dieresis

the sign must be placed before the letter to which it refers (this will probably be changed for something more convenient).

- (ii) at the end of a line, the operator cannot put dashes.
- (iii) a dash must be between blanks.
- (iv) a dash of function must be between letters.
- (v) foreign words must be preceded by <.
- (vi) proper names must be preceded by >.
- (vii) \$ before 'ae' or 'oe' in case of Latin words (e.g. et coetera = et c\$oetera).

This program can run on a WANG 2200 system. This system has a capacity of 12k words and the libraries can be stored on cassettes or discs.

Up till now, I have worked only with cassettes and the computation time is rather long; so I think that with a disc unit, this time will be reduced.

Braille Projects at Paul Sabatier University of Toulouse

Monique Truquet

The Computer Science Department at Toulouse has put the finishing touches to a program which translates ink print texts into grade I and grade II braille. The project has two aims: first to translate school-books, novels, and then to apply this technique to computer-assisted instruction.

Research

We have started to automatically produce Spanish grade II braille but as we need further information about the use of some Spanish contractions this work has been stopped. We are just beginning to translate mathematics into braille; the braille system is so complex and it needs so many characters that we are having some programming problems.

Teaching

We would like to adapt our method to computer-assisted instruction for physics, mathematics and computer science.

The Society SAGEM¹ is trying to produce a braille embosser which will allow the blind students to work alone. The keyboard of that device will be the same as that for sighted people and this necessitates the creation of an 'informatic braille' adapted to computer science.

Production

At present we translate literary texts - French into grade I and II and some foreign languages into grade I. These braille texts will be used by a blind association for their pupils. But in the near future, it is possible that we will be translating books and magazines for a library.

¹Societe d'Applications Generales d'Electricite et de
Mecanique

In addition to blind schools, blind students of the literature University are interested in our translations. Some of them, three years ago, have applied to a National Concourse and due to our translations they have been admitted. At that time braille texts were printed from right to left on a normal IBM 1403 and they were read on the reverse from the left to right.

Now the braille documents are produced on a braille embosser built, on our request and due to IRIA², by the Society SAGEM. This embosser can run off-line or as an interactive computer terminal.

Conclusion

We would like to finish Spanish Grade II braille when we receive the necessary information. We would like to make contact with French and foreign persons interested in the automated translation of braille mathematics. I think we need a new grade II braille which is more logical and easier to be programmed.

²Institut de Recherche d'Informatique et d'Automatique

Research at Münster University

H. Werner

A program for the automatic translation of ink print into braille, Grade 2, was developed at the Computation Centre of the University of Münster by W. Dost, B. Eickenscheidt, and H. Werner. It is now available in a Mark V version. The program has been used for the last eight years to produce a braille news journal for the blind using excerpts from the two German news-weeklies. Die Ziet and Stern. Five thousand copies are distributed, every two weeks, at no charge to the reader.

The program has been used also in three other German-language braille producing centres - in Heidelberg, in Leipzig, and in Vienna.

Full documentation of the program will be completed shortly, and will be made available to anyone interested.

Using the experience gained in using this program, and in producing the news publication, we are embarking upon the creation of a new concept for the translation program. It will be based on the long-term linguistic investigations of Dr. Splett, and the logic research of H. Slaby; and will incorporate refinements of the linguistic-analytical approach and new methodological approaches.

In the last several months we have discovered increasing interest in our braille work, and have been visited by, and asked questions from, several East European countries, and from as far away as Australia.

Automated Braille Research at the National
Physical Laboratory

J. Howlett

Work is being done in the Information Systems Group of the Division of Computer Science, National Physical Laboratory, on the automatic production of braille from an interactive information system.

The NPL Design Office and Workshops in cooperation with the Division of Computer Science and Computer Field Maintenance Ltd., have developed an attachment for the production of high quality braille, for use with a chain printer attached to the NPL Data Communication Network. The output will in the first instance be from "Scrapbook"⁽¹⁾, an interactive system for document production storage and retrieval, which was developed by the Information Systems Group. Scrapbook is widely used throughout NPL by both scientific and office staff who have no knowledge of computers and could be a powerful communication aid for the visually handicapped. The intention is to offer braille as an alternative to ink print.

The attachment is experimental and being patented. Minimal software has been written for the production of Grade I braille. The next step will be to consider the provision of a fast "Grade 2" braille translator possibly using a micro-processor.

In addition, the human/computer interaction group are studying the use of an interactive information system by a blind person. Various possible media such as tones, transient ("soft copy") braille, and synthesised speech are being considered.

⁽¹⁾ Cashin, P.M., Robinson, M.G. and Yates, D.M. Experience with Scrapbook, a non-formatted data base system. Information Processing 74: Preprints of IFIP Congress 74, held at Stockholm, August 1974, edited by J.L. Rosenfeld, Amsterdam and London, North-Holland, 1974, 5, 1012-1016.

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IEE News, June, 1976, p. 3.

Hampshire B.E. & Whiston T.G. *"Factors in the Design of Braille Provision Systems"*.

New Outlook for the Blind, Vol. 70, No. 4, April 1976, pp 137-142.

Truquet M. *"French Grade II Translator Program"*.

AFIPS Conf. Proc., Vol. 45, June 1976, pp 205-207.

"A System of Braille Notation on Mathematics, Physics, Astronomy and Chemistry: A Manual. Parts I & II".

All Russia Association of the Blind, Moscow, 1975

444 pp. Copies in English available from B. Zimin.

"A System for Producing Braille Special Codes which is Compatible with Automatic Translation Programs".

Warwick Research Unit for the Blind, March 1976, 7 pp.

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