BRAILLE RESEARCH NEWSLETTER

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Cognitive Processes in Braille Reading

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There are several ways in which braille reading by blind children may differ from the reading of print by sighted children. First, braille is a writing system which relies for perception on the tactual modality. Since braille is perceived through touch it may be interesting to ask what, if any, consequences there are for word recognition when the modality of input is based on tactual and not visual processing. William James (1890) suggested that the former method of processing might emphasise the synthesis of critical features from a successive input while visual processing lays emphasis on the analysis of critical features from simultaneously incoming information. This supposed dichotomy between the methods of processing between the blind and sighted has found some support from the work of O'Connor and Hermelin (1978). They found that use of the tactual or auditory modality can structure information processing mechanisms towards serial processing, and use of the visual modality towards parallel processing. Second, blind children and adults may bring to the reading process a different set of strategies or a differential emphasis on certain information processing strategies consequent upon alternative semantic experience and knowledge. Finally, the braille script is not at all similar to print except in that it is a broadly alphabetic orthography. The physical differences between print and braille, that is, the symbol-letter relationship, may be crucial in determining the manner in which the two scripts are read.

My research has been taken in two directions. An attempt to investigate the relative use of direct and indirect lexical access strategies by the blind and the sighted. That is to say the direct allocation of meaning to a letter-string (e.g. LOOK-SAY strategy) or the indirect approach based on the assignment of sounds to individual letters, and the subsequent synthesis of these sounds to form a phonological (sound-based) code which in turn can access meaning (e.g. PHONICS strategy). Secondly, the research has aimed at investigating the allocation of attention by readers who are interpreting either print or braille.

What impact does reading in the tactual modality have in terms of internal processing ability? Perceiving braille involves the construction of a tactual code representing the stimulus. What is of interest is the extent to which the use of this code interacts with subsequent information processing. Millar (1974,1975) has investigated short-term memory for braille letters by blind children. Studies of short-term memory had previously made use of visually presented verbal material, where adults typically recode and rehearse this phonemically (Conrad, 1964; Baddeley, 1966). Millar (1975) has found evidence to suggest that blind children can encode both tactual and phonological features of braille letters. That is, the letter-name codes affected recall from short-term memory (Baddeley, 1966; Millar 1975) and also the tactual information survived the perceptual process and affected recall. Overall, the evidence is consistent with the assumption that the blind children could manipulate an internal tactual code representing an external stimulus and that this could be used for some longer-term storage.

It is of interest in reading research whether or not a tactual code is equivalent to a visual code. In 'tactual' reading the tactual code is constructed sequentially. That is, the letter or letter clusters are felt in sequence and it seems likely that the code is thus formed from successively explored parts of the word (Nolan & Kederis, 1969). If this is the case, and if phonological recoding could be applied to each part of the word, in isolation, as it is perceived, then each letter or letter cluster could gain a phonological representation before the whole word has been explored. This might suggest that braille reading may lead to more extensive phonological coding than sighted reading. In 'visual' reading the visual code may be generated for a whole word simultaneously from the printed stimulus.

In a series of preliminary single word recognition experiments (Pring, 1982; Pring 1983a) the results indicated that blind children and adults can use a tactual code representing a letter-string in a very similar way to sighted readers' use of a visual code. The sensory representation can be used to access the internal lexicon or word store and retrieve an entry, thus providing spelling, sound and meaning information for a word. This process occurring without the necessity, either for the blind or for the sighted, to phonologically recode the letter-string.

Although the blind may rely on a consecutive manner of sampling braille, this appears not to prevent them from constructing a tactual code which allows direct lexical access to take place. Furthermore, in a word/nonword decision task, blind children and adults failed, under normal circumstances to differentiate a nonword such as BLOO (a pseudohomophone) from a control nonword such as PLOO. (Pring, 1983a: 1983b). This result differs from that usually observed in the sighted (Rubenstein et al, 1971;

Barron, 1978) where pseudohomophones tend to be confused with their homophonic word equivalents and thus take longer to reject as words. The confusion presumably arising due to the use made of the phonological form of the letter-string. This result may be interpreted as reflecting a blind reader's preference for direct tactual code access in a word/nonword decision task, rather than making use of a phonological code and indirect lexical access. Clearly the use of the tactual modality per se appears not to significantly affect the internal reading process.

Louis Braille is said to have observed that the dot was a much better medium for touch than, for example, the embossed print system of Huay's, already adopted at the Paris School for the Blind, in the early part of the 19th century. The question which is still of interest and a topic for research is whether or not the braille characters can impart the most amount of information unambiguously to the reader, given the limitation of the tactual modality. Loomis (1974) has suggested that the cutaneous sense is not equivalent in perceptual accuracy to sight. He suggests the two may be comparable if a low pass spatial filter is placed between the stimulus and subsequent visual recognition processes. Apkarian-Stielau and Loomis (1975) found that blurring vision produced very similar results in shape and pattern recognition to those for the intact cutaneous sense (see Hampshire, 1981, for a review). In a letter recognition experiment carried out by Nolan and Kederis (1969), the errors made by blind subjects were primarily brought about by shape misinterpretations; the subjects would 'miss' a dot and therefore misidentify the target letter. The braille orthography is stuctured such that each component of a braille letter is essential for correct identification. This means that braille letters have no redundancy at all, a fact not at all true of print (see Huey, 1908, p.99). Wallsten and Lambert (1981) have argued that the braille orthography itself lends difficulty to the task of reading, and provides harder feature detection processing than print. Even experienced braille readers can only read at about half the rate that sighted readers achieve (Nolan & Kederis, 1969; Shebilske & Reid, 1979; Harris, 1980). It is this notion that was the basis of a recent experimental study (Pring, 1983b). Evidence was presented which suggested that reading braille may have strong similarities with reading visually degraded print (i.e. a random dot pattern superimposed on print). Under such circumstances the reader may experience some difficulty with the early letter recognition process and as a result, bring to bear alternative semantic strategies in order to aid word recognition. In particular, the processing of the semantic context may play a more dominant role. If this is true, then since print is not usually viewed under degraded conditions, it may be that braille reading involves a greater use of context for word recognition than print reading. Some support for this interpretation came from a study mentioned above which compared the semantic facilitation effect between blind and sighted children. This effect, noted by Meyer, Schvaneveldt and Ruddy (1974) is where the word BREAD for example is recognised more quickly if it is preceeded by a related word such as BUTTER than if is preceeded by a neutral word such as LAMP. Certainly this area of research would seem important to pursue. I plan to carry out an experiment to investigate two aspects of contextual information and to compare print and braille readers on their use of such information. One aspect is the reader's knowledge and use of context at the letter level; that is, making use of orthographic predictability. The other aspect occurs at the word level; and relates to the reader's use of semantic predictability.

Finally, it might be of interest to briefly report the results of an experiment in auditory word processing (Pring, 1983c) comparing blind and sighted subjects. Here both groups of skilled readers performed a rhyme-detection task. They heard a cue word such as LAKE followed by three other words such as DREAM - TAKE - TABLE. Their task was to press a reaction time key when they heard the target-rhyme word. Both groups were significantly faster at detecting rhyme pairs which shared orthographic/visual/tactual features such as LAKE-TAKE relative to rhyme pairs that did not share these features such as LAKE-ACHE. In addition, in a second auditory letter-detection task, the blind subjects found it significantly harder to detect the presence of a letter in a pair of items if that pair contained a special association occurring in braille but not in print. In this case if the pair was of the type A-1, B-2, C-3, etc, in braille the letters and digits can share the same physical representation (albeit with a marker symbol denoting a following digit). These experiments appear to suggest that the experience of reading braille by a blind subject may affect auditory word and letter processing.

The research described here is an attempt to look at the cognitive process involved in braille reading by the blind, and to make a comparison with the processes underlying print reading by the sighted. At the present, a great deal more work is needed and the findings ought to be assimilated into the already growing knowledge we have about teaching braille and the tactile perception process.

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Telebraille: The New Telecommunication System for Deaf-blind People

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To enable the deaf-blind (d/b) to discuss directly through the telephone we have to design a device which can be compared to communication from "hand to hand".

The morse-system would be quite natural, with sound transferred into vibration. The Televibro morsephone developed by Toivo Savolainen was introduced at the WCWB technical aid congress in 1980. However, it has been proved that the morsecode is a problem. The d/b population is small and they live far away from each other and therefore training in using the morse-alphabet has been difficult to arrange. A great many d/b know the braille alphabet and therefore it seems that a telephone working this way has a better chance to become a technical aid especially for the d/b.

In the Telebraille-system one communicates in a different way from the usual way of reading braille. The message is received in the same manner that one writes braille using a braille machine (Fig. 1). The "sending buttons" are situated in a somewhat curved position which makes it easy to manipulate them through using the three middle fingers on each hand. The dots of the braille system are compensated by feelable "studs" that accompany the sending buttons, which makes it easy to move the fingers from the sending system to the receiving system and back (Fig. 2).

The receiving studs when not in use are situated under the keyboard so that they cannot be felt (Fig. 3). The message is sent through pushing down the sending buttons needed for one braille letter as when using a braille typer. The message is thus sent letter by letter. At the same time, the corresponding stud-group rises to be received by the other person using his Telebraille. The studs which have risen vibrate to make it easier to recognise them. (It has been proved that a stud which is immobile leaves a memory on the finger which makes it more difficult to receive the next mark).

Because the marks are felt with six fingers instead of one at a time, it is easier to recognise passively without moving the fingers. Our experiments have shown that a person used to typing on a braille machine spontaneously recognises the mark and the marks following each other become merged into words in the same way as when using the morse system.

The Telebraille as it is today is meant to be used as a "side telephone" to a normal telephone. The contact is established through the telephone. As the contact is established the call is moved via the linecoupling to the Telebraille and the phone is closed. The data is moved in braille code serially using 2250Hz frequency in both directions, the speed being a maximum of 90 marks per minute. In Finland the device is officially approved to be used through the telephone network.

A small amount of sample pieces has been used systematically for testing purposes during a one year period. At first the test-group consisted of only visually handicapped persons using the braille-typer each day. The goal was to test the aid's technical function and to develop a "traffic routine" which is needed for fluent communication. Later the test-group consisted of some young deaf-blind persons who are studying at the vocational school for visually impaired persons.

The experience so far has been most promising and a contract has recently been made with a local electronics firm to start industrial production of the device. Some small changes that make the device easier to handle and communication easier will be adjusted as the product is being developed. These are minor details that have arisen while the device has been in use. The first commercial models will probably be completed this year.

The device will continue to be improved. The goal is to add an alphanumerical system to the device. Some preliminary tests have shown that this could be done using some quite simple electronics.

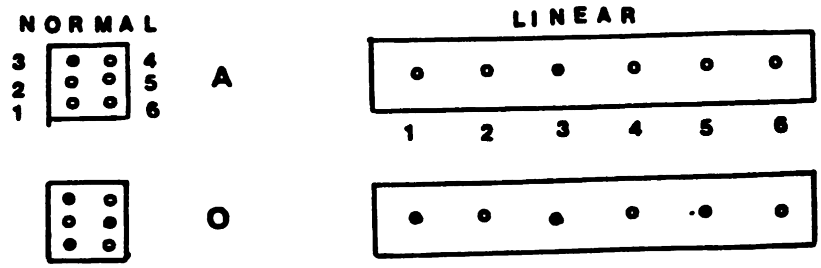

Fig 1

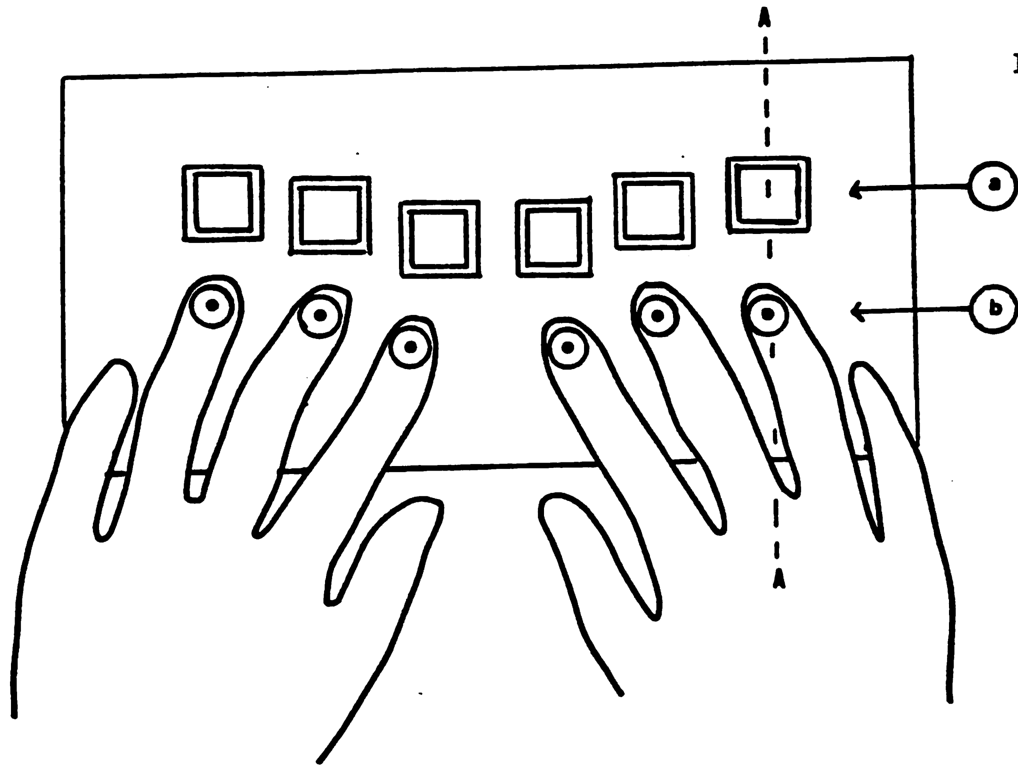

Fig 2

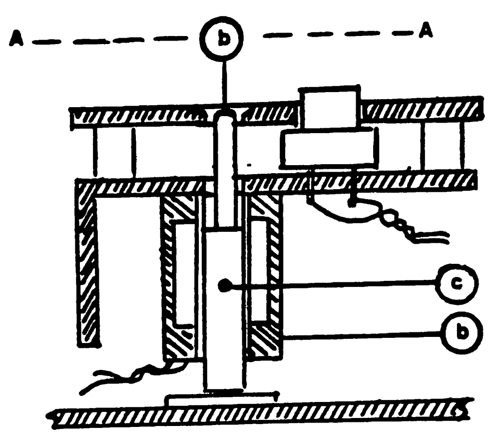

Fig 3

Computer Assisted Instruction of Braille Transcription

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The number of literary braille consumers is small when compared to the total number of legally blind persons in the world. A teacher of blind and visually impaired children will find that perhaps only one in ten of his/her caseload will utilise his/her braille skills or that of a transcriber. Yet despite this reality, the high level of braille skill required of teachers/transcribers cannot be minimized. Transcription of print into braille and knowledge of the braille code must be perfect in order to ensure that blind children and adults read and learn correct braille. An inordinate amount of time is required to teach and learn braille transcription when compared to the amount of later use by future teachers.

Methods of teaching braille to sighted adults who will use it later to either teach blind children or to transcribe braille books have changed very little since World War 1. The traditional method entails the use of two or three popular inkprint texts which present instruction enhanced by transcribing exercises. This method has been satisfactory, but changing trends and recent technology may be rendering traditional instruction inefficient due to the time factor. A method requiring less instructional time would be invaluable.

Computer Assisted Instruction (CAI) is a recently developed technology which may serve as an improved method of teaching and learning braille. Leading proponents of CAI feel that its educational promise lies in its ability to individualise and personalise the instructional process. Researchers have found positive results in achievement, retention, rate of learning and length of time needed to learn when using CAI in such areas as math, science, computer programming, and education. In addition, it appears that CAI is becoming more accepted as a useful aid in foreign language instruction, an area somewhat related to braille instruction.

It is believed that CAI for instruction in braille transcription may reduce the amount of time needed to learn the skill and also to reduce the time needed by the instructor for lecture and correction of braille assignments. Also, students may benefit from the immediate feedback and reinforcement provided by Computer Assisted Instruction.

A study was planned to test the hypothesis that CAI in braille transcription would aid students in achieving an equal or greater level of braille transcription proficiency and that less time would be necessary on the part of both instructor and students in accomplishing the proficiency. The objective of the project is to compare the traditional method of teaching braille with one utilizing Computer Assisted Instruction. This study was begun in the Department of Special Education at Western Michigan University, Kalamazoo, Michigan, USA, as a doctoral dissertation.

The first step was to employ a computer programmer to create a CAI program intended for use with the relatively inexpensive Apple II-Plus microcomputer. This type of computer was chosen because of the need to keep costs down. One criticism noted in many CAI studies was due to the expense of the large mainframe systems used in early research. The CAI Braille program is based on the "Instruction Manual for Braille Transcribing" by M.B. Dorf and E.R. Scharry, and utilizes principles of successful Computer Assisted Instruction. It includes short, concise instructional text, use of examples to illustrate new rules and symbols, and frequent tests with immediate feedback provided.

The CAI Braille program allows the student to input direct braille transcription using six keys on the typewriter keyboard (z,x,c,n,m, and comma) like a Perkins Braillewriter. The student is shown several frames of instruction introducing each new series of braille symbols and rules, is given the opportunity to practice brailling, and is then asked to complete the evaluation exercises. Full-screen displays of groups of braille symbols and their print equivalents (such as punctuation signs) can be referred to at any time during the lesson. (These displays are aptly named "Crib Sheets".) Upon completion of each braille exercise, the student indicates that he/she is ready for the computer to correct it.

The correction feature of the program displays two sets of braille; that of the student (which may or may not contain errors), and that of the computer. If the student has made any brailling mistakes, the words containing the errors are displayed in inverse form (black dots on white as opposed to white dots on black). In addition, the computer displays the words containing errors in their proper form in order to allow for comparison by the student.

This study has not yet been completed. The CAI Braille program is under revision so as to allow tallying of student errors and time-keeping functions. A pilot study will be undertaken to discern whether further revision is necessary. The final study is expected to be completed by the end of October, 1983.

Tactile Diagrams

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The need for visually impaired students enrolled in science classes to have continual access to information usually presented in pictures, drawings, microslides and photomicrographs is providing the focus for our research and development efforts. A vacuum-forming process is being used to make tactile diagrams that can be used in class activities, and for independent student study and review.

Our efforts are being guided by three basic needs:

One, there is a need to have a high degree of symbol consistency among diagrams that depict similar content. For example, the nucleus of a biological cell should be depicted by the same symbol in every diagram that includes the presence of this organelle.

Two, there is a need to use a series of sequential diagrams whenever increased magnification of selected parts of an object is desired. For example, the first diagram in a series can depict several adjoining biological cells (tissue section), the second diagram can illustrate the structure of one organelle found within the cell. In other words, a single diagram should not illustrate how one aspect of an object may appear when viewed through a light microscope and how another part may appear when viewed through an electron microscope.

Three, the student needs to retain a copy of the diagram and have an audio script so the student can study the diagram independently at any time.

A New CAM System for Tactual Graphics

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Present System

The method presently used in Sweden for making embossed graphics is based on the Nottingham and Thermoform system. A master relief is made by gluing different sheet materials, such as sandpaper, textiles, wire netting, or small tin or plastic symbols on a cardboard sheet. A copy is then made by vacuum-forming a thin sheet of thermoplastic over the master. By this method it is possible to make rather complicated graphics having a great variety of symbols, but the tactual "definition" is limited by the thickness of the plastic sheet. The complete, manual master design is labour-intensive and therefore rather expensive.

Early CAM-Systems

In 1972 a computer-aided system for the manufacture of embossed maps was demonstrated by Dr J M Gill at Warwick University in the UK. The system produced very find embossed maps but was based on laboratory equipment, and soon after the project was finished it was disassembled. Since then no computer-aided manufacturing system for tactual graphics known to the author has been in continuous or commercial use.

Development at Chalmers University of Technology

Inspired by the UN Year of the Disabled (1981) and a proposal from a teacher at a school for the blind, an idea arose to develop a computer-aided method for making tactual graphics, especially maps, at the Department of Highway Engineering at Chalmers University of Technology. The concept was:

1. To use standard computer-graphics equipment
2. To use standard numerically controlled milling machines
3. To use standard Thermoform equipment
4. To make only the necessary computer program unique

Money was sson granted and the project was carried out between August of 1981 and March of 1982. The above design objectives were reached and a working system could be demonstrated. The project is reported in: Internrapport nr 30, Instutionen for

Vagbyggnad, Chalmers Tekniska Hogskola (in Swedish: summary in English).

The function of the system is described together with fig 1:

1. The original: a map, a drawing, a photograph etc., serves as input to the computer via a digitizer. A picture of the digitized pattern is simultaneously drawn on the graphic display screen.

2. The whole picture-making process is controlled by using a "menu" on the digitizing table. From the menu, different symbols, such as straight and dotted lines, circles, and letters, are picked up and placed on the original (i.e. the graphic screen) by the digitizer pencil.

3. During and after input, the picture on the screen can be modified in different ways. Symbols can be deleted and extra symbols inserted, scaled, translated, etc. The necessary commands are given by using the menu. Finally, the picture created can be filed on a floppy disk for later updating, or converted into an NC milling code punched on paper tape. Letters are then automatically converted into Braille.

4. The punched paper tape is then loaded into the memory of the NC milling machine and a tool inserted, and a plastic sheet is fastened on to the milling bed. The milling is then started and normally requires no further action by the operator.

5. Depending on the sheet material used for milling the negative relief master, the vacuum-forming of the thermoplastic copy is made either directly on the negative master or on a positive master consisting of epoxy moulding.

The computer programs of the system have hereafter been further developed and have now reached a commercial stage, using the trade name TAKTILO-GRAFIKA. A version of the computer programs, in which the new Swedish thermo-expanding paper is used as an output medium, has been delivered to the semicommercial organisation RPH-SYN. RPH-SYN, a subdivision of the Swedish Ministry of Education, produces and distributes teaching aids for the visually-impaired.

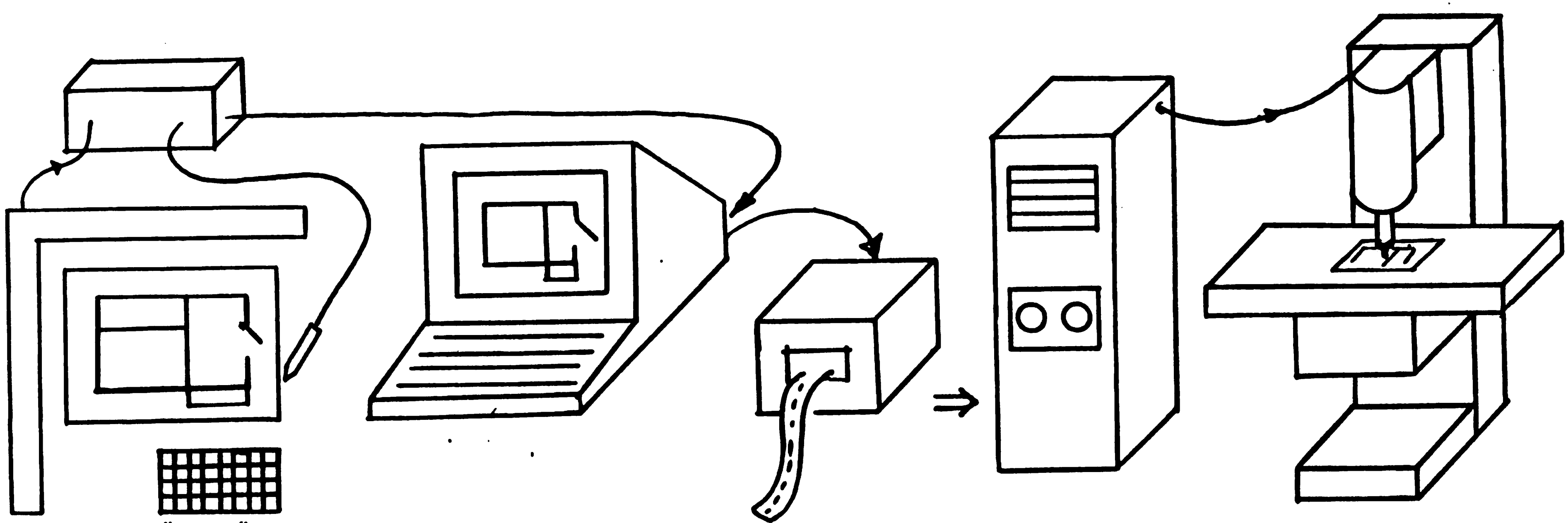
"Menu"
Digitizer
Micro-computer
Papertape
punch
ComputerControlled Milling machine

Figure 1

Now and Future

At present, a mini milling machine for on-line connection to the graphic computer system is under construction at Chalmers. Its purpose is to eliminate the intermediate step using punched paper tape and to reduce the cost of NC milling. the next step is to connect the present system to the standardized Geographic Information Handling System which is now being adopted by the National Land Survey of Sweden, the city planning departments, and the civil engineering companies. Extracting geographical information from their data files on line will simplify map-making considerably. Work on this project will probably be started at the end of 1983.

Braille Stereotypes and Duplicators

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This survey covers the two systems in common use for multiple copies of braille books and magazines - vacuum forming and embossed metal plates.

Vacuum forming machines can be used for producing copies of a single-sided braille master. The technique is that a sheet of thermoplastic is heated, then sucked down to conform to the shape of the braille master, and then cooled so that it retains this shape. The advantages of this system are simplicity and the low capital cost. The disadvantages include the high cost of the thermoplastic sheets and that plastic is not as comfortable to read as braille embossed on paper.

A stereotype machine embosses a pair of metal plates which are then used in a press for embossing paper. The metal plates can be used for producing hundreds or thousands of copies. The input to the stereotyper can be direct by a skilled braillist or from digital signals such as from a computer.

American Thermoform Corp, 8640 East Slauson Avenue, PO Box 125, Pico Rivera, California 90660, USA. Tel: 213-277 0516.
Model: Brailon duplicator
Description: Vacuum forming machine for duplicating braille on a sheet of thermoplastic. The plastic is placed over the original and clamped, the heating oven is pulled into position over the plastic, and vacuum is applied. Can produce 150 copies per hour.
Price: $1540; $105 for conversion to 240 volts

C R Clarke & Co, Carragamman Lane, Ammanford, Dyfed SA18 3EL, Wales. Tel: 0269-2329.
Model: Vacuum forming machine 375
Description: Vacuum forming machine for duplicating braille. Adjustable automatic timer with a maximum heating cycle time of 15 seconds. Supplied with 279 x 292 mm and 279 x 216 mm platens and clamp frames.
Price: £1003.97

Deutsche Blindenstudienanstalt e.V., Postfach 1160, Am Schlag 8, D-3550 Marburg, German Federal Republic. Tel: 06421-67053.

Model: Puma M Stereotyper
Description: Mechanical (pedal) stereotyping machine for embossing a pair of metal plates. One-hand operation. Interdot and interline braille possible.
Price: 13,813 Deutschemarks

Model: Puma E Stereotyper
Description: Electric stereotyping machine for embossing a pair of metal plates. Mechanical one-hand keys, electric carriage and mechanical line spacing. Interdot and interline braille possible.
Price: 18,078 Deutschemarks

Model: Puma ET Stereotyper
Description: Electric stereotyping machine for embossing a pair of metal plates. Electric one or two-hand keys, electric carriage transport and mechanical line spacing. Interdot and interline braille possible.
Price: 24,041 Deutschemarks

Model: Puma ES Stereotyper
Description: Full electrically-operating stereotyping machine for embossing a pair of metal plates. One or two-hand operation. Interdot and interline braille possible.
Price: 25,796 Deutschemarks

Model: Puma ESV Stereotyper
Description: Electric stereotyper controlled by magnetic tape (ECMA 34 cassette), 8-channel punched tape or direct from a RS232 interface. Interdot and interline braille possible.
Price: 90,000 Deutschemarks with RS232 interface; 100,000 Deutschemarks with cassette tape reader.

Model: Braille composition unit
Description: Basic unit for digital text-input on ECMA 34 cassettes or 8-channel punched tape for Puma ESV. One-line display.
Price: 15,900 Deutschemarks for magnetic tape; 18,100 Deutschemarks for punched tape

Model: Braille correction unit
Description: Unit for correcting the cassettes or punched tape. The unit permits insertion and deletion of characters.
Price: 61,500 Deutschemarks for magnetic tape; 62,500 Deutschemarks for punched tape

Model: Rotary printing press
Description: The folded and embossed metal plate is cut into two parts and placed over top and bottom rollers. Output speed approximately 7000 sheets per hour.
Price: 36,179 Deutschemarks

Model: Marburg printing box
Description: The braille characters are composed in a typesetting frame; each character is of three types (space, 1 dot or 2 dots). The typesetting frame comprises 700 characters. The sheet of paper is placed on the embosssed type, the pressure plate is placed on top, and the pressure roller is turned over the plate with a crank handle.
Price: 1343.00 Deutschemarks for single-sided system; 1837.40 Deutschemarks for double-sided system

F Kutschera & Co, Konigsworther Strasse 7, D-3000 Hannover, German Federal Republic. Tel: 32 15 05.
Model: Copytherm
Description: Vacuum forming machine for reproducing braille or embossed diagrams on thermoplastic sheet. Standard frames 27 x 34 cm or 21 x 29.5 cm (A4). Also available with cooling fan.
Price: 2905 Deutschemarks; 3325 Deutschemarks with cooling fan

Matsushita Research Institute Toyko Inc, 4896 Ikura, Tama, Kawasaki, Kanagawa, 214 Japan.
Model: Duplication system
Description: An optical reader detects the embossed patterns on the braille original and converts them to electronic signals. The braille can be proofread and edited on the screen of a microcomputer. The output is to a mechanical punch which makes a negative braille printing plate.

Ernest F Moy Ltd, Unit 5, Brunswick Park Industrial Estate, New Southgate, London N11 1JF, England. Tel: 01-361 1211.
Model: Braille stereotyper
Description: Electrically operated machine for embossing a folded metal plate. Mechanical carriage transport and line spacing. Maximum plate size 394 x 241 mm which provides a 36 cell line with 28 lines per page using interpoint or 23 lines interline. This is with the British braille dimensions; other specifications available as extra. This machine will accept 210 cells per minute and can be used by non-sighted personnel. One-hand operating attachment is available as extra.
Price: £19,000

Model: Proof Rolling Machine
Description: For obtaining single paper copies (or very short runs) from the brailled metal plate.
Price: £3500

Tele-Ekonomi, Hardemogatan 1, S-124 44 Bandhagen, Sweden. Tel: 08-99 04 85.
Model: Magnetic tape keyboard MIK 2002
Description: Microprocessor-based equipment for keying in text on digital cassette. Machine can be supplied with a 6-key braille keyboard and/or standard keyboard. Machine has 32 character visual display and can also be supplied with an interface for a 40-character 8-dot braille display. Last 40 characters can be checked at any time during the writing operation by the operator. Storage capacity of cassette is about 200,000 characters.
Price: c. 60,000 Swedish Kroner

Model: Text editor KTL 2000/2001
Description: A data terminal based around a Hewlett Packard 2649 VDU with read/write cassette unit. 6-key braille and/or standard keyboard can be supplied. The position of the cursor is displayed by dot 7 on the braille display. Full text processing functions; 8k of internal memory.

Model: Tape recorder DKB 2002
Description: A digital tape recorder with 32 character visual display which can be supplied with interface for connection to Marburg stereotyping machine, Sagem braille embosser, Triformation LED-120 or PED-30.
Price: c. 25,000 Swedish Kroner

Timson (Export & Sales) Ltd, Panton House, 25 Haymarket, London SW1Y 4EN, England. Tel: 0536-2611.
Model: Embossing press
Description: Reel-fed press for embossing braille on both sides of the web. Maximum speed 12,000 sheets per hour.
Price: c. £40,000

Triformation Systems Inc, 3132 SE Jay Street, Stuart, Florida 33497, USA. Tel: 305-283 4817.
Model: PED-30
Description: Embosses metal plates at 30 characters per second. The plate is turned over manually to produce interpoint braille. Maximum 40 cells per line and 32 lines per side. RS232 interface with a maximum input of 9600 baud. Weight 408 kg.
Price: $52,155

Reading Comprehension in Two Tactile Media
Braille and the Optacon

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The tendency persists in some sectors to consider Optacon reading a slower process than braille (Koenig & Rex, 1983). Such a view is contradicted by some of the literature (Goldish & Taylor, 1974; Thomas, Miller & Larson, 1979).

The Optacon came on the market in 1971. Its use is still fairly limited and teaching methodologies are still in the formative stage. On the other hand, braille has been established worldwide for decades. Scientific research on the relative merits of these two major tactile-haptic media is thus made very difficult.

It is important to address the question of whether braille or the Optacon is superior to the other, or whether they are equals and therefore one is complementary to the other. Upon the answers may depend future educational and rehabilitation decisions, because tactile-haptic reading remains the most concrete means for blind persons to read independently.

In the United States, braille has had a long-established place in school curricula for functionally blind students. Optacons and Optacon instruction became available to many when the former Office of Education Bureau for Education of Handicapped began its Optacon Dissemination Project in 1975.

The Project was four-tiered, providing training and equipment in turn for: 1) college/university faculty engaged in teacher preparation for the visually impaired, 2) certified teacher of the visually impaired in the schools, 3) blind students in the schools; and the fourth level actually fulfilled the Project's goal - loan of Optacons to students who became independent readers.

The Project was ended in 1980, and USOE/BEH subsequently distributed and transferred ownership of its Optacons to the fifty states. The Optacon is second only to braille as a tactile-haptic reading medium for blind children in U.S. schools (Huebner, 1980).

As a result of the Optacon Project, blind school children may be considered good subjects for research. This group is likely to have had some consistency and continuity in Optacon instruction, although not on a par with braille.

In 1981, a search was instituted for braille/Optacon readers in the public schools of 14 counties in northwest Ohio and two adjacent counties in southeast Michigan. The criteria for selection of individuals for the study were: 1) functional or legal blindness, 2) enrollment in a public school, 3) ability to read both braille and with the Optacon, although equal proficiency in both was not required. Seven subjects were found to meet the criteria.

The heterogeneity of these subjects can be noted in Table 1. With such a small N, the wide diversities among the subjects, and the impossibility of random sampling, no in-depth statistical analysis was possible. Individual case study results could provide correlation data.

Choice of a testing instrument was limited to those standardised and already available in braille. The Durrell Listening-Reading Test (DL-R), (Durrell, Hayes & Brassard, 1968-1970) had been adapted for use by the visually impaired and validated at the American Printing House for the Blind (Morris, 1976). One of the subtests, Part IV, provided assessment of reading comprehension with continuous text. Three levels of the DL-R provided for children enrolled as follows: Primary - Grades 1-3.5, Intermediate - Grades 3.5-6, Advanced - Grades 7-9, with potential for testing higher grade levels. Two parallel forms, DE and EF, were available as required by the research design.

The original print test texts had been modified in format for braille use by APH. The large print editions, as modified by APH were found to be unsuitable in type style and format for Optacon readers. Permission was granted by the orginal publishers, Harcourt, Brace, Yavonovich, Inc., to have the large print series typewritten. Typing was done on an IBM Correcting Selectric II, in 10 point Letter Gothic, 12 pitch, thus providing a fairly simple block style with few serifs and good word separation. One-and-a-half line spacing was used. The format was modelled after the braille adaptation.

The examiner was a paraprofessional, skilled in application of both braille and the Optacon, who had been instructed by the investigator in testing procedures. In accordance with the APH adaptation, time limits were not set for test completion. Subjects were tested singly, in as private an environment as possible. Five students were tested in the school they attended in the Toledo Public School system, which draws visually impaired students from surrounding districts and counties. The two other students, who were mainstreamed in their home school systems, were tested in their own homes.

Some procedures outlined for the DL-R Tests did not meet requirments of this study. With one exception, subjects read their tests orally, as an informal check. The examiner read aloud the direction, questions and response choices.

Braille test material was read with whatever finger and hand pattern each subject preferred. However, for Optacon reading, it was determined that most subjects lacked sufficient independent tracking skills; therefore, they were given the choice of freehand, mechanical Tracking Aid or the Automatic Page Scanner for camera movement. Use of the APS was encouraged.

The examiner controlled the APS and monitored Optacon output on the Visual Display. A comfortable reading rate with the APS was established by the examiner after observation during an individual's practice period. Forced pacing was avoided. Camera rate was increased or reduced as warranted. Subjects were advised to request retracing or rest periods at any time during both braille and Optacon testing.

Testing with parallel forms of the DL-R had been planned for approximately one week apart. Some subjects were tested first in braille and others with the Optacon. Some subjects were tested first on Form DE and others on Form EF.

Possible number of correct responses differed at each level of the DL-R Tests as follows: Primary - 40, Intermediate - 64, Advanced - 48. Raw scores were converted into percentages of possible totals of correct responses.

Correlation between the mean scores of braille and Optacon reading comprehension were calculated with the Pearson Product Moment Coefficient of Correlation.

The demographic data in Table 1 yielded three independent variables, Chronological Age (CA), Actual Grade Placement (AGP), and Sex. The Spearman rho formula determined direction and magnitude of correlation between each pair of dependent and independent variables. Other data could not be quantified for statistical purposes, but are of academic interest. The power of this study lies in its individual case studies.

Although different instruments had been used to measure intellectual capabilities and had been measured at different time-distances from this study, two groups emerged. Five

Table 1

Demographic and Performance Data on Subjects of the Study

Student ID #	IQ or Achievement	CA	Reading Level	AGP	Sex	# Yrs. Blind	Residual Vision	Years Reading Braille	Years Reading Optacon	Personal Use Optacon	WPM Braille	WPM Optacon	Test Time Braille	Test Time Optacon	Percent Correct Braille	Percent Correct Optacon
1	153 Interim Hayes-Binet	11.3	7.5 MAT	6.6	F	Birth	Sees 3 inch letters	5.6	1.0	Yes	130	37	35	155	77	62.5
2	96 Verbal WISC-R	13.6	6.4 MAT	6.6	M	Birth	Light Perception	5.6	1.4	No	110	20	30	270	58	33
3	97 Interim Hayes-Binet	8.6	3 Gray Oral	3.6	M	Birth	None	2.6	1.4	No	60	4	30	210	95	75
4	103 Verbal WISC-R	15.6	8.0 MAT	9.6	F	Birth	None	9.6	2.0	No	120	37	30	120	67	48
5	101 Verbal WISC-R	12.8	5.4 MAT	7.6	M	Birth	Some Peripheral, 20/400	6.6	1.4	No	90	18	35	160	73	48
6	111 Verbal WISC-R	13.8	7.4 MAT	8.6	M	Age 2 Progressive	Follows large Objects Can use CCTV	7.6	2.2	Yes	130	24	25	180	81	77
7	29 ACT	17.5	No data	12.6	F	Birth	Light Perception	11.6	1.3	Yes	130	60	30	47	98	98

Table 2

Correlations of Dependent with Independent Variables

Independent Variables	Dependent Variables: Braille Correlation	Braille Significance	Optacon Correlation	Optacon Significance
CA	0.0357	.939	0.2342	.613
AGP	0.1622	.728	0.3455	.448
Sex	0.1443	.758	0.2185	.638

Individual Case Studies

subjects clustered in the average range, and two could be considered superior.

Only Subject 6 showed relationships between Optacon score, IQ, CA, AGP, amount of residual vision, years of reading with the Optacon and personal use of the Optacon. Subject 7 showed definite, positive relationships between her Optacon score and all other items except amount of residual vision and year of Optacon reading. Other subjects showed marked inconsistencies.

There was a high positive correlation of .938 between Means of braille and Optacon comprehension scores. The Spearman rho correlations between the two dependent variables, braille and Optacon scores, and the three independent variables, CA, AGP, and Sex, are shown in Table 2.

Individual Case Studies

Subject 1

This female subject was 11.3 years of age at the time of this study. A congenital, progressive condition permitted her to see 3 inch high letters, but she was not recorded as ever having read print.

Subject 1 had been enrolled in self-contained classrooms for the visually impaired in Grades 1-4 and subsequently was mainstreamed into regular classes in her home school district. Her Optacon instruction was given during the summer of 1979, after which she was loaned an Optacon as an independent reader. Since mainstreaming, she had received no consultant or itinerant teacher services of any kind.

Table 1 shows that the subject scored 153 on the Interim Hayes-Binet at age 4.7 years and that in Grade 3 she scored a Grade Equivalent (GE) of 7.5 on the Metropolitan Achievement Test (MAT).

She was given both forms of the DL-R Tests during one day, beginning with the braille version. This arrangement was necessitated by time and travel limitations.

Her score of 77% at 130 words per minute on the Intermediate level braille DL-R was markedly below expectations. However, the braille score is in line with the Optacon score of 62.5%. She had begun Optacon reading with the APS at 20 wpm, rose to a ceiling of 47 wpm, and settled on a comfortable rate of 37 wpm.

A number of factors were apparent which could have affected her performance. These included fatigue, interruptions, and a reported anxiety about her performance.

Subject 2

This male subject was 13.6 years of age at the time of testing. He is congenitally blind, possessing only light perception. A two-year delay in grade level occurred in kindergarten. From Grade 1 onward, he had been enrolled in a self-contained classroom for the visually impaired.

Table 1 shows that the subject was very close to the Mean in the Verbal Scale score of the Wechsler Intelligence Scale for Children - Revised (WISC-R) which had been administered at age 10.5 years. Reading level was one grade above grade placement as scored in the MAT during Grade 5.

His teacher reported that Optacon instruction was given in approximately two one-hour sessions weekly.

He completed one-half the Optacon DL-R Test in one session. One week later, he completed both the Optacon and the Braille forms, Intermediate level.

His braille comprehension score of 58% at 110 wpm was 25 points higher than his Optacon score of 33% at 20 wpm, the lowest score for all subjects in the study.

Subject 2 frequently expressed his preference for braille. Because of metabolic problems, he was tested during different hours of the school day, but always appeared tired and easily distracted.

Subject 3

This male subject was 8.6 years of age and at 3.6 grade level when tested for this study. He is congenitally blind and lacks light perception.

He had been enrolled in self-contained classrooms for the visually impaired since Grade 1. His IQ of 97 on the Interim Hayes-Binet was recorded at age 5.6 years. His reading level on the MAT had been GE = 3.0 during Grade 2, although his teacher in 1981 considered his GE closer to 2.5.

Braille reading readiness began in kindergarten, and actual instruction in Grade 1. Optacon training was reported to be two one-hour sessions weekly. Subject 3 received the Primary level DL-R Tests although he was slightly beyond midpoint of the school year because of his teacher's appraisal of reading level.

He was tested with the braille DL-R version first. One week later he began the Optacon form; this was not completed until two weeks later due to subject's absence from school. On this final day, he required both morning and afternoon sessions and alternated between having difficulty with letter recognition and ease of sentence reading. He was the only subject to be distracted by the "noise" of a small serif at the top of lower case l. He scored 95% in braille comprehension at 60 wpm. His scores of 75% for Optacon reading at the average rate of 4 wpm contradicts the literature (Dallman, Rouch & Deboer, 1978).

Subject 4

This female subject was 15.6 years of age and at 9.6 grade level when the DL-R Tests were administered. She had been retained for an additional year at a lower grade level. Records showed that she is labelled congenitally blind and now has no light perception.

She had been enrolled in classrooms for the visually impaired through elementary school. Currently she was located at a senior high school in a resource room for the visually impaired, and was mainstreamed only for study hall.

Her IQ score on the WISC-R Verbal Scale was average when administered at age 14.6. At this latter age, her MAT reading score was GE = 8.0.

Braille was her primary reading mode. Her teacher reported intermittent Optacon instruction for approximately two years.

Subject 4 was tested first with the Advanced form of the Optacon DL-R, and with the braille version one week later.

She received a braille reading comprehension score of 67% at 120 wpm. Although her teacher had reported an average Optacon rate of 10 wpm, she utilized the APS for the DL-R test, and rose to a peak of 67 wpm, then determined her comfortable rate at 37 wpm. Her Optacon score was 48%.

Subject 4 appeared at ease during testing and was fully cooperative. The testing environment was the most secluded of any.

Subject 5

This male subject was 12.8 years old and at 7.6 grade level when the DL-R Tests were administered. He is congenitally blind, but has visual acuity of 20/400 and some peripheral vision, although records do not show whether this is bilateral.

He had progressed through elementary school in self-contained classrooms for the visually impaired. At present junior high school, he was placed in a resource room for the visually impaired, but took a number of classes in the mainstream.

Table 1 shows subject 5 with an average IQ as determined by the WISC-R Verbal Scale at 11.3 years of age. Reading level of the MAT showed GE = 5.4 during grade 6.

The primary mode for reading was braille. Optacon training was begun in Grade 6 and continued in Grade 7.

Scheduling the DL-R Tests for subject 5 was complicated by commitments to out-classes. This required two sessions to complete the Advanced level DL-R form for Optacon. At the second session, one week later, he completed the braille form also. His braille score was 73%, at the rate of 90 wpm. His Optacon score was 48% at 18 wpm. The between-scores spread of 25%, the largest for this study, was also that of Subject 2.

Physical, social and emotional factors appeared to affect test results. Another factor might have been Subject's difficulty in separating braille contractions from Optacon letter recognition, letter integration into words, and use of contextual cues.

Subject 6

This male subject was 13.8 years of age and at 8.6 grade level during this study. Although he had not been diagnosed as blind until age 2, his visual pathologies indicate that he would have been severely limited even in infancy. He retained the ability to track large objects, and occasionally read with the aid of a closed circuit television set.

The subject had been educated entirely in self-contained classrooms for the visually impaired. He was currently in a junior high school resource room for the visually impaired, but took many of his classes in the mainstream, and was to be integrated fully into a senior high school the next academic year.

His most recent IQ level, assessed at 11.9 years of age, was 111, based on the Verbal Scale of the WISC-R. Reading level on the MAT was 7.4, taken earlier in Grade 8. He had qualified for the loan of a student Optacon as an independent reader.

He was tested first with the Advanced level Optacon DL-R Test. This required two sessions, two weeks apart. On the second occasion, he also completed the braille test. He scored 81% on the braille version at 130 wpm. After a brief period of socio-emotional adjustment to the Optacon test, he scored only 4% lower, 77% at 24 wpm.

Subject 7

This female subject was 17.5 years of age and at 12.6 grade level when tested. Although beyond the usual grade level for the Advanced DL-R Tests, she was assessed because of her background. She was congenitally blind, and currently retained minimal light perception.

Subject 7 had been instructed in a self-contained classroom for handicapped children through grade 5. An itinerant teacher had supplied her with materials in mainstreamed settings from Grade 6 upward. She was college-bound.

Her home school district had no record of intelligence testing. However, she scored 29 on the American College Testing Program, ranking her in the 97th percentile, at age 16.5 years. The only indicator of possible verbal reading ability was her 97th percentile ranking on the Preliminary Scholastic Aptitude Test, Verbal Subtest, at age 16.

Her Optacon instruction occurred during a workshop for teachers at the University of Toledo in 1979. At the end of approximately 35 hours of training and practice, she read from a paperback book of her choice. She was supplied then with an Optacon on loan from USOE/BEH through the University of Toledo.

The DL-R Tests were taken in the Subject's home. Advanced braille and Optacon DL-R Tests were taken approximately two weeks apart. She was atypical in that she received the same score of 98% on both versions. Her braille reading rate was 130 wpm, and her Optacon rate with the APS averaged 60 wpm.

In summing up results from these seven cases, it is evident that no clear-cut pattern of recorded factors indicates good or poor reading performance in braille and with the Optacon.

Conclusions

Clearly, further research is called for. The most useful information from this study is the very high positive correlation between means of braille and Optacon reading comprehension scores. It is obvious therefore that braille and Optacon literacy should be equally achievable given equal instructional emphasis.

It is indicated therefore that the Optacon, in its brief and limited application to reading needs of blind students in U.S. schools, (Huebner, 1980) has a significant contribution to literacy.

Limitations of this research design and of external factors are acknowledged. Psychological, reading and ophthalmic data was not equal for all subjects. Measures of attitudes and efficiency would have been valuable. Such physical problems as hypoglycemia or minimal brain damage, and socio-economic influences such as changes in family structure, could not be quantified.

The research design provided for free-paced braille reading, while opening Optacon reading to the possibility of forced pacing.

The major limiting factor in this research was the small N of the tested population. Therefore, the high positive correlation between braille and Optacon reading comprehension Means cannot have external validity.

The generally close relationship between paired braille and Optacon scores is noteworthy when considering the long-term, established position of braille in curricula and the generally extra-curricular status of Optacon reading. It may be argued that students benefitted from braille carryover into another tactile reading medium. On the other hand, braille Grade 2 and the printed word may be considered as two different languages, so that the dichotomy between the two negates any practice effect.

The importance of early training in both media is indicated for motivation. The favored status of braille provided an obstacle to Optacon reading for children without insight as to their future needs.

The possibility of equal status for braille and the Optacon for any segment of blind readers in the U.S. is complicated by the low cost and availability of braille materials and the high cost of Optacon purchase and maintenance. There are also differences in federal and states' policies operating unevenly among blind populations. As electronic aids for blind persons increase in numbers and scope, policy-makers in the field must take more decisions about equipment, materials and instruction, and many choices cannot be "either-or". Braille and Optacon reading fulfill parallel but not identical needs.

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Braille Translation Programs

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The shortage of people skilled in transcribing text to contracted braille encouraged the development of computer-based braille production systems. In English, Grade 2 braille utilises 190 abbreviations and contractions whose use are governed by rules dependent on pronunciation and meaning. No computer program has yet been devised that can cope with all the rules of Grade 2 braille. For instance, a program frequently has problems with words which are spelt the same but are contracted differently eg DO the verb is contracted but DO the musical note is not.

Programs vary significantly in speed and accuracy of translation; what is acceptable will depend on the application. Virtually all programs will output perfect braille if a skilled braillist proof-reads the output and then modifies the input file. The programs also vary in their ability to format the braille output; this is particularly important when compositor tape input is being used.

The early programs were mainly designed for book and magazine production, but the advent of the microcomputer has encouraged the development of systems for the fast local production of documents in contracted braille. This is analogous to comparing a typesetting machine to a word-processing typewriter.

The problem of translating contracted braille to text is no easier than text to braille. There are many instances where the braille could be two things in print but the braille reader chooses the correct meaning from the context. The main application of these programs is to permit a blind person to input to a word-processing system in contracted braille; the input is often through a paperless braille device such as a VersaBraille.

Arts Computer Products Inc, 80 Boylston Street, Suite 1260, Boston, Massachusetts 02116, USA. Tel: 617-482 8248.
Name of program: Dottran
Description: Program for converting text to contracted English braille (American edition). The program is compatible with Unix, RT-11 and CP/M systems.
Price: $1700

Name of program: Bman
Description: Macro file for brailling Unix manuals.
Price: $249

Centre TOBIA, Universite Paul Sabatier, 118 Rte de Narbonne, 31062 Toulouse Cedex, France. Tel: 61-53 11 20 ext 407.
Description: Program to translate text to contracted French braille.

Department of Services for the Blind, State Office Building Annex, PO Box 758, Frankfort, Kentucky 40601, USA. Tel: 502-564 4754.
Name of program: Braille 1.99
Description: Program written in HPL to run on a Hewlett Packard computer 9800 series or above.
Price: $10

Duxbury Systems Inc, 77 Great Road, Acton, Massachusetts 01720, USA. Tel: 617-263 7761.
Name of program: Duxbury Braille Translator
Description: Fortran program translates text to contracted braille in the American, English, Spanish or Arabic code. This system operates on a minicomputer. Another version, written in Z-80 assembler runs under CP/M. Also tables for Halifax mathematics code available.
Price: $4795 for microcomputer version; $19,800 plus installation costs for minicomputer version.

Institut fur Angewandte Mathematik, University Bonn, Wegeler Strasse 6, D-5300 Bonn, German Federal Republic. Tel: 0228-733423.
Description: Program to translate text to contracted German braille.

Jupiter Technology Inc, 111 Gibbs Street, Newton Centre, Massachusetts 02159, USA. Tel: 617-965 5092.
Name of program: Quick Braille
Description: Program to translate text to contracted English braille (American edition) written in assembler language to run on a PDP-11 computer.

Maryland Computer Services, 2010 Rock Spring Road, Forest Hill, Maryland 21050, USA. Tel: 301-838 8888.
Name of program: Braille Production
Description: Translates text to contracted English braille (American edition) for output on a LED-120 or Theil embosser. The program is written in Basic and will run on HP125 computers under CP/M.

Price: $1000

Massachusetts Institute of Technology, Room 3-144, 77 Massachusetts Avenue, Cambridge, Massachusetts 02139, USA. Tel: 617-253 2220.
Name of program: Dotsys
Description: Program written in Cobol to translate text to contracted English braille (American edition). The program is table driven and users can modify the table to produce braille in other codes.

Raised Dot Computing, 310 South 7th Street, Lewisburg, Pennsylvania 17837, USA. Tel: 717-523 6739.
Name of program: Braille-Edit
Description: Program written in assembler language to run on an Apple II microcomputer. Translates text to contracted English braille (American edition) for output on a paper embosser (RS-14, LED-120, Sagem, Braillemboss or Cranmer brailler) or paperless braille device (VersaBraille). Also included is a reverse translator for input from a VersaBraille.
Price: $250

RB Aids for the Blind Ltd, Institute for Bioengineering, Brunel University, Uxbridge, Middlesex UB8 3PH, England. Tel: Uxbridge (0895) 37188.
Name of program: BITS
Description: The Braille and Ink-print Text-processing System includes a tyranslation program, written in Fortran, for producing contracted English braille on Sagem, LED-120 or RS-14 embossser or on a VersaBraille. The program runs under CP/M.
Price: £1000

Name of program: BASIS
Description: The Braille And Speech Information System permits input from a VersaBraille in contracted braille and outputs in print or speech. The system includes word-processing facilities. The program is written in Fortran and runs under CP/M.
Price: £500

Royal National Institute for the Blind, Braille House, 338 Goswell Road, London EC1V 7JE, England. Tel: 01-837 9921.
Name of program: Dotsys III F
Description: A Fortran version of the MIT Dotsys with tables to produce English contracted braille.

Braille to Print System

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The braille to printer system was developed primarily to assist blind students who may be working with teachers who do not understand braille. Many blind students use Braille as a means of communicating with teachers when submitting projects and/or exercises and in answering examination questions. This often means that the work must go to a braille transcriber before being submitted to the teacher or examiner, when using the braille to print system printed English text becomes available immediately in response to the operation of the Perkins brailler.

Other than punching nine holes in the bottom cover no modification is required to the Perkins brailler. Once the bottom cover has been removed, or the holes are provided, the Perkins brailler is placed on a base measuring 15" x 9" with a height of 1 1/2" which contains the electronics of the system, and operated in the normal way.

The speed and data handling ability offered by modern microcomputer technology provided the solution to the problem and the system consists of an electronic interface which gathers data from the six code keys and three function keys of the Perkins brailler before passing it on to the computer section where the translation to English text is accomplished through a program resident in 8K of EPROM memory. Under computer control the translated text is then output to a dot matrix printer.

Apart from one or two minor variations the system will print in plain English text by interpreting all the braille contractions, wordsigns and abbreviations as well as all punctuation signs, mathematical signs and numbers found in Grade 2 braille. Fractional numbers are included and print in the accepted text format, such as 325 5/8, 1/1000 etc., the percent sign also prints in the accepted way, i.e. 33%, even though in braille the codes designating the percent sign precede the number. Those familiar with braille will understand the difficulties in ensuring that the computer always makes the correct decision as to what is to be printed when it encounters braille codes which are used for more than one purpose, the second dot set in a braille cell is an example, this can be the contraction 'EA', the comma, the decimal point or the fraction denominator of one, there are of course many other similar cases.
The dot matrix printer prints text on lines of about 80

characters, however whilst the lines of print bear no relationship to the lines on the braille page, provision is made such that when a new paragraph is selected on the Perkins brailler the new paragraph will also be formatted on the printed page. The system keeps count of the characters which are to go on any one line of printed text and ensures that words are not split at the end of lines, thus if a word will not fit into the spaces remaining on a print line the printer will automatically select a new line. Should a hyphen be inserted at the end of a line of braille such hyphen will not appear in the printed text as it would be extremely unlikely that the word being hyphenated because it appears at the end of a braille line would be at the end of a print line. Hyphenated words other than at the end of a braille line will of course appear as hyphenated words in the printed text.

As the capital sign is not normally used in English braille, the output from the printer will be all in upper case characters. Should the braille operator use a capital sign (dot 6) it will not print anything on the printer; however the dot 6 may be used in the normal way as the mathematical separation sign.

Another feature of the system is that the printer may be commanded to 'double width' printing by the input of two consecutive 'dot 6' from the brailler, once in double width print format the system may be commanded back to normal size print by entry of two consecutive 'dot 6'.

Twenty-four of these units have been built and are undergoing field trials in Australia; it is possible that some minor changes may be necessary to the program in response to feedback from those now using the system, but generally it would be seen that teachers are finding the device extremely useful in their work with blind students. The system also has a place in assisting blind people in the workplace, and two of the machines are now performing well in such situations.

The current cost of construction of the electronics section of each unit is A$360.00 exclusive of sales tax, whilst the Tandy dot matrix printer (Model DMP100) costs A$499.00 inclusive of sales tax.

The braille to printer units are being manufactured on a one-off basis, however, if evaluation by current users indicates that the system will be useful to the blind community assistance from an outside manufacturer may be needed.

Braille Output from Viewdata and Teletext

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1. Introduction

In 1980 a Viewdata field trial was started in the Federal Republic of Germany with 6,000 participants in the Dusseldorf and Berlin areas. In parallel with this the various television companies have been transmitting Teletext trial programmes. In both cases the aim is to reach the greatest possible and statistically relevant group of people, to gather experience and to monitor the acceptance of the new media.

Viewdata and Teletext as information and communication media can, through appropriate textual treatment, throw open for our blind fellow citizens new avenues of information, education and job design.

2. What exactly are Viewdata and Teletext?

In the Federal Republic of Germany participants in the Viewdata field trial need a television set with a Viewdata decoder and a special "modem" (modulator-demodulator) connected via the telephone network to the German Post Office computer. In some European countries there exist small variations in the decoder and modem systems. With the exception of France, at the present time the Prestel system is used.

Teletext is transmitted by the TV companies and without decoder remains invisible. It is received in the same way as a normal TV picture and apart from the Teletext decoder it needs no additional appliances.

By means of these appliances all kinds of information can be transmitted to the television screen, either as text pages or as simple graphics. The term for this is a "frame".

The fundamental system of Teletext is characterised by the fact that all pages are transmitted serially. The user selects the required page and has to wait until it comes up.

Running-through of all the 75 Teletext pages currently available in Germany takes 18 seconds, which represents the maximum waiting time for display of the required page. In the case of Viewdata the required page is immediately displayed.

One frame consists of a maximum of 24 rows of 40 character positions, i.e. a total of 960 characters. This maximum is, however, not generally exploited to the full since the viewer (sighted) requires a pleasing, optically acceptable presentation. Frequently graphic presentations are used.

The first row, both in the case of Viewdata and of Teletext, is used as viewer instruction.

So much for the basic structure of a frame.

3. Who are the contributors to a frame?

In the case of Teletext as a TV information service, the content of the texts and their presentation are the responsibility of a production team.

The Teletext editorial team of the various German TV stations regards itself basically as a supplier of news flashes and is characterised, in comparison with Viewdata, by its higher degree of up-to-dateness.

For example:

- politics and economy
- weather reports
- sports reports
- TV programmes
- traffic information
- radio programme announcements
- consumer reports

Teletext can, at present, in the Federal Republic of Germany be received from 3pm to closedown.

In contrast to the Teletext supplier "television", with Viewdata we are concerned with a large number of suppliers of information, primarily companies and secondly institutions such as authorities, tourist offices etc. The distinction is made between suppliers - those offering information - and participants - those who receive it.

In comparison with Teletext, Viewdata has a great deal more to offer in the number of pages. At this point in time almost 600 suppliers are offering some 180,000 pages in Germany (in Britain 210,000). These pages are stored in a Post Office computer and can be called up for display on the screen as required. This total number of pages can be increased practically at will, depending on the capacity of the computers, and in so far as the suppliers (Information Providers) make their requirement known.

In the case of Viewdata the structure is such that the search for data has been made as simple and consumer-friendly as possible.

There is always a clearly-structured dialogue between participant and Viewdata computer. In the case of error, as for example input of a nonexistent page, the computer gives further instructions on screen.

Thus for a general description of the two media, which have as yet only been accessible to the sighted.

4. The technology of a Viewdata (BTX) /Teletext (VT) system for the blind

A system suitable for the blind consists, in addition to the appliances necessary for the sighted mentioned in section 2, of a further unit, the BTX/VT terminal, which is essentially a read-off and control unit. Such a terminal was developed by AEG-Telefunken and introduced in spring 1981.

The characters on the Braille line correspond to the lines that a sighted person can read on the screen. The screen can display a maximum of 40 characters per line which are relayed to a 40-cell 6-point braille line. The characters of an entire frame, consisting of a maximum of 960, are taken via an interface from the BTX/VT decoder of the television and fed into the page data bank of the operating desk.

When feed-in is completed the text can be reproduced on the braille line simply by pressing a key.

The user also has the following possibilities available by pressing the corresponding keys on the keyboard:

1. Page feed-in with simultaneous display of the first 40 characters.
2. Display next row.
3. Display row backwards.
4. Display same row again.

5. Direct selection of last row (24th row).
6. Direct selection of first row.

For instruction of the operator, after the last screen row has been displayed and a further key depressed - to get the next row - the message "please request new frame" is displayed.

Selection of the BTX or VT pages is as yet via the remote control unit for the televsion.

5. The Utility Value of BTX and VT for the Blind

The following is particularly intended to inform as to the BTX/VT information range in the Federal Republic of Germany. This is, however, comparable with that of other European countries. VT is especially characterised by the up-to-date-ness of its news service. The latest reports, whether of politics, sport or whatever, are always brief and precise.

In the case of BTX a topic is frequently covered by various information sources and thus also variously interpreted. The user, therefore, has to be selective and must decide from which source he wants to get the information. In principle it can be said that the information available is decided by the sources - i.e. firms and institutions (so-called Information Providers).

As an information source for the blind BTX can roughly be divided into two sectors:

1. Information for private purposes.
2. Information for professional or educational purposes.

Information for private purposes covers:

1. Up-to-date summaries on topics such as
   - News
   - Sport
   - Financial
   - Local (what is on in the user's locality)
   - Emergency services (doctors, chemists etc).

2. Information from authorities such as
   - Visiting hours
   - Address lists
   - Fees, etc

3. Travel and traffic information such as for
   Holidays
   Room availability
   Weather
   Timetables

4. Information on cultural and similar events, such as
   Theatre and concert programmes
   Film programmes
   Local events

5. Financial/commercial information such as
   Yellow pages
   Stock prices
   Jobs available

6. Household information:
   Recipes
   Hobbies
   Special offers

The second sector (professional and educational) covers:

- Internal company data transmission between headquarters and branches (electronic mail; letters, memos etc). Secrecy is thereby ensured.
- Information for freelance professions (e.g. medication lists, places for rest cures).
- Courses (like "Telekolleg"), e.g. for blind masseurs/masseuses who need to be informed about the latest medical developments. A further possibility is that students who for reasons of physical disability cannot get to school can be provided with exam questions via a BTX school programme. The answers can be given "covered-up", which means that they can only be read off on depressing a special key.

With this BTX/VT system for the blind not only is private access to a communications system of the future ensured; Viewdata can also contribute to the improved integration of the blind in the normal world of work. BTX will, however, also be of particular importance to institutions for the blind which from now on will have the possibility, with this medium, to ensure swift exchanges of information. Indeed these institutions can take on the task of adapting BTX (which to start with was not specifically designed for the blind) into a system which in its range of information and nature of presentation is in fact absolutely suited to the blind.

Given a sufficient number of blind BTX participants it would for example be a good idea to make group magazines and suchlike available via BTX, especially since in this way the whole process is quicker and cheaper.

Naturally, as far as adaptation for the blind is concerned, there is still a lot to be done.

In BTX and VT there are generally quite a lot of graphics which are intended to loosen up the text and make it more interesting for the sighted. Obviously these graphics cannot be translated into braille. For this reason a character has been introduced which indicates to the blind user, through the printing of all 6 braille points, that something is coming that cannot be translated. This special sign is also printed when there is a coloured background, since the control signal for this has been identified for the choice of colour.

First results with the appliances have shown that in the case of graphics with an essential content there is a distinct possibility of transmitting this content to the blind user. The text source needs only to write-in a brief description of the graphic text in the background colour of the graphic. The blind user gets this information by touch, the sighted user is not disturbed since he does not see this information on account of the colour selection.

Further suggestions for a blind-oriented design of BTX will result from an evaluation of the project "BTX for the blind field trial". This project is financed by the Deutsches Blindenhilfswerk (German National Institute for the Blind) and is being carried out by Professor Boldt of the University of Dortmund jointly with AEG-TELEFUNKEN. In the framework of this project pyshcological and sociological aspects of the new media are being investigated. It can for example be assumed that these media will have effects on the life-style, leisure activities and social communication of blind people.

In April of this year a further 5 blind participants in Berlin will be provided with a system.

On the subject of "blind-oriented design" it should also be noted that the inclusion of the deaf-blind in the circle of participants will be of the highest value. In this case, however, an institution will be needed which can handle the problems of text adaptation for the deaf-blind.

6. Prospects

With the production of a BTX/VT system for the blind a development has been made by AEG-Telefunken for the sighted and the blind in parallel. This has hitherto seldom been the case. Developments of appliances for the blind often follow on from, or are inferior to developments for the sighted, i.e. the non-handicapped.

Even though both media are in many countries still in the trials stage it is extremely important to offer blind fellow-citizens the possibility of taking part in trials with the new media BTX and VT together with the non-handicapped, of gathering experience and also contributing to the design of a development which, while intended for the sighted, does not necessarily have to remain so.

GLOSSARY

Character: A single numeric or alphabetic digit, a symbol, or a single graphic element.

Frame: A screenful of information, standardised in viewdata as 24 rows of 40 character positions. A number of frames may form a page, in which case they would each be identified by a sequential lower case alphabetic character. Only the "a" frame of a page may be directly accessed.

Keyboard: A desk-top device having a number of keys based roughly on the standard typewriter layout and additional keys for special character and control function.

Keypad: Usually, a hand-held device having a limited number of keys. Keypads used with viewdata terminals are either directly connected to the TV set or communicate with the set via ultrasonic or infra-red transmission. It is possible to incorporate characters additional to the digit 0 - 9, * and # , by either increasing the numbe of keys or using shift key techniques.

Modem: "Modulator-Demodulator", an electronic unit enabling data to be transmitted over telephone lines.

Page: The unit of information in the database. A page may be accessed by explicit addressing using the * n # command, or implicity by the use of single key choices 0 - 9. Routing is always to frame "a" of a page. A page may compromise a number of frames each of which may be accessed in turn by keying "#".

Prestel: The trade mark of British Telecom public viewdata service.

Teletext: A technique of transmitting frames of text via conventional TV broadcast system. This is achieved by encoding binary digits in the lines normally used for blanking. The display and coding techniques for teletext are compatible with viewdata so that the two services may be combined in adapted TV set.

Viewdata: A computer serves customers via the switched telephone system. The computer is organised to store frames of information which are transmitted at 1200 bits/second when requested by the customer.

Braille in Quebec

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Services Converto-Braille Cypihot-Galarneau is located at 123 Berri St., Hull, Quebec, Canada. It was founded over ten years ago by M Roland Galarneau.

The company has a number of objectives involving technical research into and production of braille. There are three currently major projects in progress. These are braille production, the design of a hard-copy braille terminal, and the design of a high-speed interpoint braille printer.

M Galarneau began some years ago by designing an electromechanical computer employing telephone relays. This equipment accepted keyboard input and generated French contracted braille which was fed out on a six level paper punched tape. This in turn, operated an electrified Perkins Brailler as a printer. This arrangement made it possible to provide braille text books to French-speaking blind students in the province of Quebec.

In 1978 this rather crude though ingenious system was replaced by a small printed board. A Motorola MC6800 microprocessor plus 16KB of ROM are used to generate either French or English Grade II braille. A separately programmed board is used for each language.

Material is entered on a conventional word processor and proofread on the screen. The material is stored on two 8-inch disk drives and converted to Grade II braille, either French or English as required, by the appropriate MC6800 board. (Five of these systems are currently in use). The text is then passed to one of two Triformation LED-120's. If a number of copies is required the system drives a stereotyper to produce interpointed zinc plates. However, even when plates are required, the material is first printed on the LED-120. It is much cheaper and easier to proofread and correct the braille at this stage than to wait until it has been committed to zinc.

The objective of the program is to provide student texts with a very fast turnaround time. Many government documents and pamphlets are produced in both English and French. Two hardware research projects are in progress. These are funded by research grants from the National Research Council and several other federal government departments.

Grapho'Braille

The Grapho'Braille is an unique design for a printer of hard-copy braille. A line of ten solenoids moves horizontally across the paper in one thirty-second inch steps; the paper moves vertically in the same increments. The system is under the control of a microprocessor. This system makes it possible to produce the conventional 40 cells, 25 lines per page format and also graphs. By shifting the braille lines through 90 degrees, the 80 character per line, 25 line format of the screen can be exactly duplicated across two pages.

Interpoint Printer

A total of 180 solenoids (90 for each side of the paper) are operated simultaneously to generate interpoint braille. The paper is moved through the printer in very rapid jerks, so that it is actually stationary when the plungers strike to form dots. This ensures that the paper will not be torn. An integral computer accepts all the material for a complete braille volume. The computer arranges this into pages and folios. This means that when the complete volume is produced, it needs only to be folded and bound; no further collating is required. Operating speed of the printer is 1,000-2,000 pages per hour. The printer has been tested mechanically. There remains only some software problems to resolve.

Recently Mr Galarneau has also incorporated a separate company named Brailtech. Its purpose is to create a separate entity to manufacture the braille production equipment.

Reading Machine for the Blind with Tactile Output Disc Unit

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A prototype reading machine has proved readily usable by all the twenty blind and five partially-sighted people who have so far tried it.The machine resembles the Optacon in being a direct-translation machine, and thus being usable for many languages, and for the reproduction of mathematical expressions, etc; character recognition is not involved.

A major difference from the Optacon is in the output unit, in which whole groups of words are displayed at a time in relief around a disc, which provides a continuous tactile output, at a speed controllable over a wide range, to suit the user. Cancellation of previous words occurs just before the setting-up of new words at about "3 o'clock" on the disc. The tactile track around the disc comprises a large number of small studs held by friction in holes drilled by a numerically-controlled machine, the studs being pushed up as required to form the character shapes, and pushed down by an oscillitating cancelling arm operating in a housing over part of the disc. A clutch lever allows the drive to be disengaged, leaving the disc free to be rotated by hand, to re-read previous words. Tests of the frictional system indicate a probable life of about ten million cycles per stud before renewal of the frictional material would be necessary.

A second major difference from the Optacon is that the reading camera is tracked, with motor drive, along the lines of print, typewriting or handwriting being read, leaving the reader free to concentrate on reading the output, two hands being usable for this much of the time, although line and page changing is done manually. The single motor which drives the output disc unit also traverses the reading camera, via a variable-ratio drive which allows the width of the reproduced characters to be varied as required, independently from their height, which is variable by an 11-position magnification selector control on the camera with an overall range of 0.5:1 to 2:1.

The machine is naturally much larger than the Optacon, and the present prototype, with a width of about 34 inches (more than half of which is to provide ample space for large books or periodicals) is not designed to be readily portable, but to have the reading material brought to it.

Ten of the blind people who have so far tried the machine were already users of the Optacon; some of this group expressed a definite preference for the Optacon, but others remarked on advantages of the disc machine. Among the ten not classed as Optacon users was a lady who had returned her Optacon as she was not progressing well with it, and a man who had failed the Optacon apititude test, both of whom were much happier with the disc machine. All 25 users were soon able to read from the disc unit, most within a few minutes of first coming to the machine.

Users' VersaBraille System Experiences

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The VersaBraille system allows users to adapt to modern job and school settings. This article describes some of the current one thousand users' applications including electronic writing, filing, and retrieval.

Many users connect the model P2 VersaBraille to a number of electronic devices daily, using the automated interfacing capabilities to change connections independently. This has meant increased efficiency and personal growth beyond the confines of immobile work stations and single purpose machines. Users are knowing that VersaBraille units are accessing hundreds of electronic devices.

Stand-alone applications

VersaBraille users say they are writing more efficiently. By using word-processing features to alter pieces of braille text, time spent rebrailling entire pages is eliminated. An author says, "When I write manuscripts now, it is much easier. For the first time I can go back to review and edit what I've written". She currently writes until she has a perfect braille copy before typing a manuscript.

Many people value portable filing. A special programs counselor uses his VersaBraille 8 hours a day and carries it with him to employer offices. He says, "I always have 200 client files in my pocket so I can discuss them with employers and call clients on the spot if I need to arrange an interview on short notice".

Many jobs require efficient retrieval of user entered information, a traffic technician arranges personnel household moves and expedites material purchases, files employee information, air bill numbers, carriers, and estimates on VersaBraille cassettes. He says, "It's speeded up tracing. I spend less phone time for information retrieval." A reservations agent, uses a VersaBraille and one cassette to retrieve recommended routings from all U.S. cities with over five thousand people. Another user teaches a self-contained class of severely retarded children. She is legally required to continually arrange and record each student's progress against goals. The insert function helps file progress notes adjacent to appropriate goals.

Interaction with other devices

By connecting $500 - $2000 printers to the model P2 VersaBraille, users automatically convert edited braille to print and eliminate typing time. A programmer uses the Versabraille fifty hours per week. With a printer, "It saves eighty percent of typing time when two drafts are involved". With control characters from the model P2, he controls underlining and character enhancements like bold type. A psychologist uses the VersaBraille with an Apple II computer and printer to maintain and review all patient files and print out monthly billings, automatically.

Connected to a printer, the Model P2 VersaBraille is an automatic form writer for creating and/or completing forms. One comment was "We have cassettes filled with blank copies of each of our forms. We read the questions and use the insert mode of the VersaBraille to answer." The Model P2 is then connected to a printer for printouts. Some users both insert answers into preprinted forms and create their own forms (by having the VersaBraille print out both the questions and the answers while controlling the spacing of both). Other users have developed methods for government claims representatives to use the VersaBraille with printers to complete seventeen Federal forms.

With phone couplers, model P2 VersaBraille owners use remote electronic libraries (databases) to expand responsibilities. A Police Department communications officer uses a VersaBraille to access the National Crime Information Center computer. With that and a local computer, he gives patrol officers information on licences, registrations, warrants, and all-points bulletins. A counselor has phone access to CHOICES, a career searching data base which asks questions and then directs users to descriptions of jobs of probable interest. A realtor reads multiple listings for the entire Miami area using the PRC Realtronix computer with his VersaBraille. A Department of Justice training specialist uses the Juris legal data base.

CompuServe, the Radio Shack data base, is the most popular with VersaBraille users. Evening connection costs five dollars per hour. One user who is both deaf and blind reads a daily newspaper for the first time in her life using her VersaBraille with CompuServe. She reads selectively from multiple papers for about forty cents a day. She also uses an electronic mailbox to communicate with people who can phone from terminals, TTY's, TDD's, or other VersaBraille units. In New York City, a life insurance salesman uses CompuServe for reading electronic mail, the New York Times, and financial news. He duplicates important information stored on VersaBraille cassettes by transmitting the information to his electronic mailbox with a phone coupler and retrieving it on fresh cassettes. An insurance planner uses CompuServe daily for stock market and Dow Jones averages and gets actuarial and financial information from other time sharing systems. All VersaBraille users have been able to access the World Book Encyclopedia through CompuServe for almost a year now.

Used as a terminal, the VersaBraille system provides computer access to programmers and "computer laymen". The VersaBraille is now being used successfully with approximately 200 computers. The VersaBraille also allows many people to use computer-resident information without using the computers. Information retrieval specialists periodically down-load computer-stored information to cassettes for stand-alone retrieval, "off-line".

Other users are remotely accessing office and school computers through phone couplers. A programmer uses a $200 acoustic coupler to interact with her office computer from home. The VersaBraille is being used with numerous Apple, Radio Shack, and IBM personal computers. The Apple II is the most popular with VersaBraille users, and it is being used by students at all educational levels and by growing numbers who own their own computers.

Sixty people now use the Braille Edit Program to link the VersaBaille and Apple computer for two way braille translation and text editing. This converts Grade II cassette braille into printed text or typing into Grade II braille.

The VersaBraille is used to improve transcribing efficiencies and make more braille available. VersaBraille cassettes are being generated automatically for Federal employers from publisher's computer tapes. Because the VersaBraille brings editing capabilities to the braille production process, pilot projects are also underway at major braille publishing houses involving transcribers using VersaBraille to make cassette masters which generate paper braille from Versabraille driven embossers.

Numerous keyboards are used for optimal data entry to the Model P2 VersaBraille system. Most terminals, typewriters, and stand-alone keyboards with RS232C connections are feasible. The Model P2 VersaBraille has generated other outputs. VersaBraille cassette text has been announced by a number of speech synthesizing devices. The buffer memory in the VersaBraille also prepares it to drive evolving full page braille displays, provided they are equipped with proper RS232C interfaces.