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edited by

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Editorial

This issue presents an unusually varied menu of papers touching upon a variety of interests. Beyond our usual practice of noting the current state of the production of braille devices and peripherals, we range from art to microcomputers considered as tools for communication.

We are particularly pleased to publish Dr Foulke's paper, based on that which he delivered at a recent conference in Haifa. Amid the burgeoning interest in microprocessor based systems, and the virtually explosive atmosphere (at least in the United States) in which microcomputer developments revolutionise applied work almost every week, he sounds a necessary and overdue note of caution on behalf of the users of such systems.

We are pleased to inform readers that the result of our invitation to submit papers for the BRN has been encouraging. We offer apologies for the late appearance of this issue, for reasons beyond our control, and assurances that further issues will be appearing at brief intervals.

L L Clark

Microcomputers, VIPs, and the Communication Network

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Abstract: One serious handicap caused by visual impairment is experienced when visually impaired people must perform tasks that require reading and writing print. With microprocessors, microcomputers and a judicious selection of peripheral devices, visually impaired and visually unimpaired people can exchange written information comfortably. However, solutions of this sort involve high technology, and without careful planning, they can easily become so expensive that solutions they promise will never be enjoyed by more than a few. I will explore an approach that might make these solutions affordable by those who need them.

Introduction

The major handicaps people experience as a result of the disabilities caused by visual impairment are encountered when they engage in tasks that demand independent mobility, communication by reading and writing print and acquiring information from visual displays such as the dials on instruments. The disabilities responsible for these handicaps can be significantly reduced by the intelligent application of technology, by using residual vision more effectively, or by using other perceptual systems to acquire the information that can no longer be acquired visually.

One can argue reasonably that of the two handicaps the one resulting from limited ability to travel independently is the more serious because independent mobility is an instrumental skill. Many of the tasks in which VIPs (visually impaired people) want or need to engage are only performed at certain places, and regardless of the skills with which they may have prepared themselves or the technology that may be available to serve them, if they cannot get to those places, they cannot perform the tasks. However, the mobility problem has proved to be surprisingly intractable. Significant progress has been made by devising methods to train blind pedestrians to travel independently, but even after training their mobility falls far short of the mobility of sighted pedestrians and technology has not closed the gap. As a result of developments over the past few years we now have a powerful technology at our disposal, but we lack the basic understanding of human perceptual and cognitive abilities that is needed to guide the application of technology.

There is greater cause for optimism in regard to the handicap that results from the inability to read visual displays of information and to display information visually. For quite some time it has been apparent that computers could be used to solve the display problem, but until the advent of microcomputers it was also apparent that because of their high cost and limited availability, computers would not provide a general solution to this problem. However, microcomputers have arrived, and if we take proper advantage of their capabilities, we stand a good chance of solving the display problem inexpensively and, therefore, of making that solution available to large numbers of VIPs. But if microcomputers are not exploited carefully they may amount to little more than another expensive solution that is available to only a select few, and we will have missed our chance. It is about the different ways in which microcomputers have been and might be used that I want to talk today.

The Display Problem

Much of the important communication that takes place among humans depends on the ability to read and write, and to exchange written messages, and it is the print code that is used for most of this communication. Of course, those who are blind or whose visual impairments are severe would be excluded from written communication altogether if there were no alternatives to the print code and would lose the opportunity to participate in many of the world's most important affairs. They would feel the full force of this handicap were it not for the partial solution offered by such alternatives to print code as braille and recorded speech.

Because there are serviceable alternatives to print, the handicap with which VIPs must contend is not as debilitating as it might be, but it is still a handicap, and particulary so when they work co-operatively or competitively with sighted peers at school or on the job. Braille is an esoteric code known by only a few. Those who know it can exchange written messages with each other, but they cannot exchange written messages with the readers of print with whom they must interact, and readers of print make up an overwhelming majority whose members cannot, in reason, be expected to go very far in accommodating to the disabilities of the few VIPs in their midst. It would be possible for VIPs to exchange with their sighted peers messages that are written by recording speech and read by listening to recorded speech, but information stored in this way is so difficult to retrieve and to read selectively that sighted people with print as a ready alternative could not be expected to tolerate for long a system of communication based on the exchange of recorded messages. The intercommunication of blind and sighted peers can be facilitated by human assistance, but human assistance is expensive.

Fortunately, there is now a widely available technology that can be brought to bear on the solution of these problems. Computers make feasible the development of systems that can solve the display problem by translating from print to braille, and from braille to print; and that can produce parallel displays of text in braille and print and for that matter in the form of synthesised speech. Such systems can store large quantities of information and find stored information for blind and sighted operators alike. They can serve as powerful tools, useful to both blind and sighted operators for the composition and editing of text, the computation of quantitative results, and many other functions.

Much of the visually displayed information that is not readily available to VIPs is acquired not by reading displays of written language but by reading the dials on instruments and machines. The counters on dictating machines and copying machines are familiar examples in the office. In the factory there are pressure gauges and thermometers. In the machine shop there are measuring devices that permit the exact positioning of cutting tools and precise measurement of the materials that are being formed. The laboratory abounds with instruments which use transducers to obtain the electrical analogues of natural events that provide information displayed on analogue and digital meters. The information displayed by these meters is essential. It constitutes the feedback that is needed for the regulation of processes and it provides knowledge of the outcomes of processes. VIPs who cannot acquire this information easily are seriously handicapped. However, as in the case of written text, computers can solve the display problem by processing the electrical analogues that inform visual meters to obtain the signals that will cause auditory or tactile meters to display equivalent information.

Computers capable of solving the display problem have been available for many years, but until recently they have been too expensive for individual ownership, and only a few VIPs who happen to have access to computer facilities established for other purposes have had the opportunity to use computers to solve their display problems. However, we are now in the throes of a revolution brought about by the introduction of microcomputers that is changing the ways in which millions of people play and work. Because microcomputers have real computing power, are easy to operate, and relatively inexpensive to own and maintain, there has been an enormous growth in the number of computer users, and computers are being used in many ways that could not have been justified when they were large, expensive to buy and expensive to maintain. Microcomputers are now common fixtures in the offices of small companies which could not have afforded computer services before the revolution. They provide instruction for students and record the outcome of that instruction. They are programmed by students for the solution of problems. Many thousands of hobbyists use them simply as toys because they are fun to play with and affordable. Because microcomputers are well on the way toward becoming ubiquitous, our perception of computers is rapidly changing. We no longer see them as incomprehensible devices that are operated by highly trained specialists who are the guardians of impenetrable mysteries. Anyone can now own and operate a computer and can program it to perform personal services that run the gamut from frivolous amusement to the solution of problems at school or work. The impact of microcomputers on the lives of VIPs could be even more profound and beneficial. However, before this can happen, certain impediments must be removed.

The Peripheral Problem

Microcomputers, like large computers, can go a long way toward solving the display problem that is principally responsible for one of the major handicaps of VIPs; but in order for this possibility to become a reality there is another problem that must be solved. It is not a problem with microcomputers themselves, but with the peripherals by means of which they display information in those forms that can be used by VIPs. In some cases display devices that would be useful are still under development. In other cases they have been developed and are commercially available but much too expensive. Many of the peripheral devices that can be operated by microcomputers were developed before the microcomputer revolution was well under way, and their developers supposed that they would be connected to the large computers maintained by organisations such as companies, universities and government agencies. When a peripheral is used in this way, its cost is a small fraction of the total cost of the computer installation, even if the peripheral is a special purpose device that costs several times as much as a standard peripheral; and the value to an organisation of the service performed by the specialist who uses it may very well justify its cost. In any case, the specialist uses it for the purposes of the organisation and not for personal purposes beyond the purpose of remaining employed.

When a VIP who is not a highly trained specialist contemplates using a microcomputer for personal purposes such as composing and editing the text of a term paper or letter, keeping a record of income and expenses, and so forth, he will discover shortly that the peripheral he must have to gain access to the services of the computer may cost him several times as much as the microcomputer to which he connects it. He may pay as little as $800 for the microcomputer, but several thousand dollars for the privilege of reading its output in braille or of listening to an output of spoken words and characters. Table 1 is a list of peripherals, including interactive terminals and display devices together with their approximate prices that typify the choices available to those VIPs who want to find out how they can use microcomputers to their benefit. I imply no criticism of the devices listed in this table. They are all well engineered and quite serviceable. The prices charged for them are certainly not expressions of avarice on the part of their manufacturers, but simply reflections of the realities with which one must contend when a technically complex device is offered for sale in a market that is vanishingly small in comparison to the market in which such devices as CRT terminals and matrix printers are sold to sighted computer users. Nevertheless, if a way is not found to lower the barrier imposed by the prices that must be charged for these devices VIPs will simply find that the microcomputer revolution has passed them by. They will be precisely where they were before the revolution, and the services of microcomputers, like the services of their predecessors the large computers, will be available to only a select few. If this problem is not solved such devices as automatic braille page embossers and terminals with transitory braille displays or speech displays will, in the future as at present, be purchased for the most part by a few companies, universities, schools, libraries and state and federal agencies. Most of the VIPs who could benefit from the use of microcomputers will be repelled by the formidable costs that must be met in order to use them, and they will never know what they are missing.

Table 1 Peripherals for VIPs

Device Name	Type of Peripheral	Manufacturer	Price (US $)
LED-120	Automatic brailler embosses a line at a time	Triformation Systems, Inc. a	15,921
LED-15	Automatic brailler embosses a character at a time	Triformation Systems, Inc.	8,125
FSST Model 3 (Free Scan Speech Terminal)	Interactive terminal with speech display	Triformation Systems, Inc.	3,995
Digicassette DC20M	Braille reading machine and interactive terminal with transitory display	Triformation Systems, Inc.	4,850
VersaBraille	Braille reading machine and interactive terminal with transitory display	Telesensory Systems, Inc. b	6,700
Total Talk	Interactive terminal with speech display	Maryland Computer Services, Inc. c	5,900
Brailink 3	Interactive terminal with transitory braille display	Clarke & Smith International Ltd. d	13,000
VERT (Verbal Emulator Real Time)	Microcomputer that adds speech display to standard CRT terminal	Automated Functions, Inc. e	5,895

a Triformation Systems Inc
P O Box 2433
Stuart, Florida 33494
USA

b Telesensory Systems Inc
3408 Hillview Avenue
Palo Alto
California 94304
USA

c Maryland Computer Services Inc
Thomas at Bond
Bel Air, Maryland 21014
USA

d Clarke & Smith International Limited
Melbourne House
Melbourne Road
Wallington, Surrey
UNITED KINGDOM

e Automated Functions, Inc
4545 Connecticut Avenue, NW
Washington DC 20008
USA

One approach that can be taken in seeking a solution to the price problem is to think in terms of more modest peripherals which, because they provide a bare minimum of functions, can be made available at a lower price. By itself, this approach will never eliminate the price barrier, but it may make a useful contribution. As a case in point, consider the project carried out by Mrs Bettye Krolick, a volunteer transcriber of print music into braille, and Mr Robert Stepp, the engineer who developed the system she wanted (1). Mrs Krolick realised that she could work more effectively if she could enter the characters required for braille music on the keyboard of a microcomputer, proofread and edit the CRT display of those characters, and then use the microcomputer to drive an automatic braille page embosser. She could afford the microcomputer, but if she had to pay $10,000 or more for one of the commercially available automatic braillers, this approach would be out of the question. Instead, she asked Mr Stepp to help her find a solution. He modified a Perkins Electric Brailler, costing $400, so that the pins that emboss dots can be operated electrically, designed the solid state logic needed to convert the ASCII characters sent by the microcomputer to the parallel code needed by the brailler, and provided a buffer in which to store characters sent by the computer so that the brailler can emboss characters at a rate that is slower and more variable than the rate at which they are sent by the computer. This automatic brailler embosses characters at a rate of 9 or 10 characters per second. The operator must return the carriage manually, advance the paper to the next line manually, and manually put in a new sheet of paper when a sheet has been filled. In comparison to the printers now in use its performance is quite unspectacular. However, it does emboss braille of high quality, it is fast enough for many purposes, and it could be made available at a selling price many times less than the selling prices of automatic braillers that are now commercially available (2). With a little additional development it could be made to function as an interactive terminal, and we might be quite surprised at the number of VIPs who would be willing to tolerate the inconvenience of such a terminal to gain access to a microcomputer.

In the long run the best way to lower the price barrier imposed by the high prices that must be charged for sophisticated peripherals - the barrier that keeps VIPs from realising the benefits of microcomputers - is simply to avoid using them whenever possible by designing systems which are software intensive. If a microcomputer system is designed to require peripherals which perform only those functions that cannot be performed by the microcomputer itself they can often be reduced to simple hardware components; for intance, a transitory braille display apparatus instead of a transitory braille terminal. Consider the following example.

A VIP is shopping for a microcomputer with which he can communicate through an interactive terminal capable of displaying a full line of braille characters at one time. Here are a couple of the options that he might consider. He can purchase a microcomputer for perhaps $1,500, and one of the transitory braille terminals manufactured by Clarke & Smith. This terminal affords a number of facilities. It has a keyboard, a facility probably provided by the microcomputer as well. It makes use of a microprocessor supported by read-only and random-access memory, which enables it to manipulate text in a number of useful ways. However, this facility could also be provided by a program run on the microcomputer. It has a built-in minicassette deck so that it can store information for later use. However, the microcomputer probably also has provision for storage on cassette or disk. The terminal can display a line of up to 40 braille characters at one time and this is the one facility that cannot be provided by the microcomputer. If the VIP decides to go this route he will pay approximately $13,000 for a terminal with facilities which, for the most part, could be provided by the microcomputer to which it is connected.

Or he may decide to buy a microcomputer system of the type sold by Futura Computer Products (3). He will pay $8,000, and for that money he will get a microcomputer with 48K bytes of working memory, two disk drives, a transitory braille display apparatus of the type developed by Schoenherr (4), and an operating system with the software needed to support the transitory braille display apparatus, an assembler and several higher level programming languages. The only component in this configuration that is not a component of a conventional microcomputer is the transitory braille display apparatus, and the facilities provided by the system are similar to the facilities of the alternative system. Eight thousand dollars is still a rather high price, but if the Clarke & Smith terminal were connected to a microcomputer like the one sold by Futura Computer Products, the total price of that configuration would be approximately $16,000. Thus, the system sold by Futura would be significantly less expensive. It would be even less expensive than it is were it not for the high cost of the transitory braille display apparatus which accounts for nearly half of its price.

To take another example, suppose instead that our VIP does not read braille and that he wants a microcomputer which displays its information by speaking. Again, he has a couple of options to consider. He can purchase a microcomputer for perhaps $1,500, and an interactive talking terminal such as the Total Talk manufactured by Maryland Computer Services and sold for $5,900, or the FSST Model 3, manufactured by Triformation Systems and sold for $3,995. The talking terminal has a keyboard, but as before the microcomputer may have one as well. The talking terminal has a microprocessor supported by read-only and random-access memory that allows it to store in working memory and manipulate a large quantity of text, but this facility could also be made available by a program run on the microcomputer. The talking terminal has a visual display unit. Some microcomputers have visual display units as integral components, but most do not; and so the visual display facility need not be redundant. However, it may also be altogether unnecessary, because the VIP who will use the system may have no occasion to share its use with sighted peers.

Alternatively, our hypothetical VIP may decide to purchase a microcomputer for around $1,500 and a Type-'N-Talk for $395 (5). When Type-'N-Talk is connected to an RS 232C port of a computer, or when it is inserted in the line that connects a printing terminal or CRT terminal to the RS 232C port of a computer, it translates text generated by the computer into spoken words. Without intervention, Type-'N-Talk processes the stream of characters between adjacent spaces in the text. Programmers and others who need to identify each character would not be able to use this display. However, with software that causes intervention by the computer to which Type-'N-Talk is connected, it can be made to pronounce each character generated by the computer and can therefore provide a full speech display for a relatively low cost.

By making these comparisons, I do not mean to imply any criticism of the interactive terminals I have discussed. They are excellent terminals which reflect truly imaginative engineering. When they are used in large computer facilities or connectd to time-sharing services over telephone lines they do a commendable job of meeting the need. When they are connected to microcomputers they may very well afford more convenience of operation than the alternative approach. However, their cost is prohibitive for most of the VIPs who could use microcomputers to their benefit.

The Limited Application Problem

A microcomputer system that relies on software run on the microcomputer for the performance of as many functions as possible, and that uses the simplest and least expensive peripheral that will do the job, is an important step that may be just as important. The system should be designed for flexibility, so that it can be used for as many purposes as possible. With the advent of solid state and especially integrated circuit chip technology many developers have used microcomputer components, such as microprocessors and chips with read-only memory, to construct a number of single function devices. The talking calculator, the talking thermometer and the talking multimeter are familiar examples. There are many situations in which single function instruments are clearly needed and we are fortunate to have them; but the VIP who operates a microcomputer system should be aware that it can also solve the display problem solved by the single function instrument if the appropriate transducers or meters are connected to it and if it is programmed to do so.

The VersaBraille is a reading machine that uses a transitory braille apparatus to display text. The operator can use a built-in keyboard to write text which can be entered in working memory for editing or reading or in storage on a cassette. The VersaBraille gives braille readers an ability to search for and retrieve information that cannot be realised as well when they must search text displayed in braille on pages in the conventional way. One model of the VersaBraille can be used as a computer terminal. Properly employed the VersaBraille is a very useful machine, but its functions could also be implemented on a general purpose microcomputer system that uses a transitory braille display apparatus. The VIP who used his microcomputer system in this way would pay a price. He would, for instance, lose the convenience of portability. However, he would be served by a braille reading machine with the functional capability of the VersaBraille and he would not have to spend another $6,700 for this capability.

Dr David Lunney and Mr Robert Morrison, both members of the Chemistry faculty at East Carolina University (6), have provided a truly impressive example of the use of a microcomputer system to replace a large number of single function instruments and devices. In the Fall semester 1977 a blind student named Richard Hartness enrolled in the Freshman Chemistry class taught by Dr Morrison, and there were no provisions for making the contents of the course accessible to a blind student. Dr Morrison discussed this problem with Dr Lunney, engaged his interest, and together they began to search for those adaptations of instruments and procedures that would allow Mr Hartness to function independently and effectively in the Chemistry laboratory. They soon realised that although all of the laboratory instruments could probably be modified so that a blind student could read their meters, the cost of modifying many different instruments would be prohibitive. Instead, they decided to use a microcomputer equipped with a speech synthesizer to which all of the standard laboratory instruments and transducers could be connected. With support from the US Office of Education, they have nearly completed development of this microcomputer system which they call ULTRA (Universal Laboratory Training and Research Aid). Table 2 lists many of the transducers and instruments that can be connected to and interpreted by ULTRA.

Table 2 ULTRA Flexibility

1. ph Electrodes
2. Specific ion and reference electrodes
3. Spectrophomometer
4. Infrared spectrophotometer
5. Scanning ultraviolet-visible spectrophotometer
6. Nuclear magnetic resonance spectrophotometer
7. Spectrophotofluorometer
8. Gas chromatograph
9. Liquid chromatograph
10. Piston Buret with optical sensor
11. Conductance cell
12. Temperature probe
13. Calorimeter
14. Electronic balance
15. Temperature probe for electric oven

All of these instruments and transducers can be connected to ULTRA with little or no modification. For the most part the speech synthesizer is used to announce their readings. In some cases, continuously varying values of variables that must be monitored continuously are displayed as tones that vary in frequency. In addition to these functions ULTRA provides the services of a full, scientific calculator, and it has a number of programs for processing the data it collects. Finally, it has a flexible operating system whose facilities include an assembler and several higher level programming languages, and it can also serve as a computer terminal. The estimated price of ULTRA will be between eight and ten thousand dollars. The cost of all the modifications of instruments that would be needed to make ULTRA unnecessary is now known, but one can safely guess that these modifications would cost many times as much.

An Optional Solution

ULTRA performs a rather special set of functions that may not be of interest to many VIPs, but the approach taken by Dr Lunney and Dr Morrison in designing it is a powerful one that invites generalisation. ULTRA, itself, could easily be augmented by adding options in both hardware and software that would allow it to accommodate the needs, preferences and interests of a much more numerous and less specialised group of VIPs. What we need, if microcomputers are to become realistic possibilities for VIPs at large, is a microcomputer system which affords a selection of entry options, display options, storage options, input/output options and software options that will allow each VIP to design the microcomputer that best serves his present needs and can be redesigned by adding options as his needs change.

Table 3 lists some of the options that might be available to users of the microcomputer system I have in mind.

Table 3 Options for VIPs

ENTRY OPTIONS	Typewriter keyboard Braillewriter keyboard
DISPLAY OPTIONS	Transitory braille apparatus that displays a line at a time Transitory braille apparatus that displays a page at a time Brailler that embosses a character at a time Brailler that embosses a line at a time Speech synthesizer with fixed vocabulary Speech synthesizer with unlimited vocabulary

	Video monitor for displaying standard or enlarged print Printer
INPUT/OUTPUT OPTIONS	Serial ports for use with RS 232 devices Parallel ports for exchanging data with and controlling external devices Parallel ports with analogue-to-digital and digital-to-analogue converters
STORAGE OPTIONS	Cassette 5-inch diskette 8-inch disk
SYSTEM PROGRAM OPTIONS	Operating systems such as CP/M Assembler Higher level programming languages (FORTRAN, BASIC, Pascal, etc) Programs for communicating with entry and display devices and I/O ports
USER PROGRAM OPTIONS	Full scientific calculator Print-to-braille translator Braille-to-print translator Text editor Spelling editor

Of course, a microcomputer capable of supporting these options would need ample working memory and should have a standard, flexible and widely used bus structure (such as the S100 bus) to facilitate its connection to external devices. Table 4 presents examples of the selections of options that might be made by several typical VIPs.

Table 4 Individualisation by Combining Options

VISUALLY IMPAIRED HOBBYISTS	Terminal made by modifying Perkins Brailler Cassette for storing and loading programs Card with read-only memory for storing operating system BASIC
VISUALLY IMPAIRED OPERATOR OF UNIVERSITY SWITCHBOARD	Braillewriter keyboard Transitory braille apparatus that displays a line at a time One disk drive

	Disk-oriented operating system File containing names and telephone numbers of staff and faculty members Program to search file for requested numbers
VISUALLY IMPAIRED SOCIAL WORKER	Printing terminals such as I/O Selectric Speech synthesizer One disk drive Disk-oriented operating system Calculator program Program for putting information on forms in the right places Text editor Spelling editor
VISUALLY IMPAIRED SHOPKEEPER	Terminal made by modifying Perkins Brailler Matrix printer One disk drive Disk-oriented operating system BASIC Program for computing income tax Calculating program
VISUALLY IMPAIRED CHEMISTRY STUDENT	Typewriter keyboard Speech synthesizer Matrix printer Two disk drives Disk-oriented operating system Assembler Several higher level programming languages Programs for processing data received through I/O ports connected to laboratory instruments
VISUALLY IMPAIRED LAWYER	Typewriter keyboard Automatic brailler that embosses a line at a time Daisywheel printer One disk drive Disk-oriented operating system BASIC Text editor Print-to-braille translator Braille-to-print translator
VISUALLY IMPAIRED PROFESSOR OF ENGINEERING	Braillewriter keyboard Typewriter keyboard Transitory braille apparatus that displays a

	page at a time Matrix printer Video monitor to facilitate work with students Two 8-inch disk drives Disk-oriented operating system Assembler Several higher level programming languages Programs for receiving data through ports to which laboratory instruments are connected Text editor Spelling editor Print-to-braille translator Braille-to-print translator
VISUALLY IMPAIRED COMPUTER PROGRAMMER	Braillewriter keyboard Transitory braille apparatus that displays a full page Matrix printer Two disk drives Drive-oriented operating system Assembler Several higher level programming languagess

The combinations of options shown in Table 4 constitute a very small fraction of the possible combinations. I attach no special importance to the combinations I have suggested. Their only purpose is to illustrate the flexibility of the microcomputer system I have in mind. You may disagree with my selections. If you do, please feel free to make your own selection. By so doing you help to prove my point, which is that it would be possible to design a system that could be tailored to meet the present needs of VIPs and changed to keep pace with changing needs; and which with proper planning could be offered at a price that would allow them to join the microcomputer revolution.

Footnotes

(1) Mrs Bettye Krolick's address is 602 Ventura Road, Champaign, Illinois 61820, USA. Mr Robert Stepp's address is 509 East White Street, Apartment 8, Champaign, Illinois 61820, USA.

(2) Dr T V Cranmer, Director of the Division of Special & Technical Services, Kentucky State Bureau of Rehabilitation

Services, State Office Annexe, Frankfort, Kentucky 40601, USA, in collaboration with Mr Taylor Davidson, the Division's Chief Engineer, has also determined modifications that will make a Perkins Brailler function as an automatic brailler, and will provide a parts list, and mechanical drawings and schematic diagrams on request.

(3) The address of Futura Computer Products Inc. is 3028 Aquadale Lane, Cincinnati, Ohio 45211, USA.

(4) Dipl.-Ing K P Schoenherr, Aid Electronic GmbH, Berlin, Wilhelm-von-Siemens-Strasse 16-18, 1000 Berlin 48, German Federal Republic.

(5) Type-'N-Talk is manufactured by the Votrax Company - Department RT, 500 Stephenson Highway, Troy, Michigan 48084, USA.

(6) The address of Dr David Lunney and Dr Robert Morrison is: Department of Chemistry, East Carolina University, Greenville, North Carolina 27834, USA.

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Tangible Graphics

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In this report, I would like to describe one of the ongoing projects in our laboratory at Queen's University. It is concerned with an aid which has already proved useful in mobility and orientation, and has considerable potential in education and science-related professions. I am referring to 'tangible graphics', nontext spatial graphic displays which use raised symbols to permit blind users to examine the display with their hands rather than their eyes - e.g., maps, pie charts, line and bar graphs, diagrams, pictures, and so forth. Additional information concerning the display is included typically in an accompanying braille text.

The use of tangible graphics displays is not new, but systematic research that assesses the potential value of different graphics formats has been minimal. This report will therefore describe the results of the first stage in a research programme aimed at developing and evaluating an effective tangible graphics system for the blind. The study evaluated the use of tangible line graphs for the presentation of two-dimensional information of the kind typically used in the sciences. In the past, line graphs have only been used informally to teach the blind.

Three issues concerning the usefulness of these graphs were investigated. The first dealt with potential limitations placed upon performance by two characteristics of the blind user population, i.e., age at onset and duration of total blindness. It was anticipated that individuals, regardless of their visual limitation, would be capable of learning to read such graphs because simple information regarding the configuration of curves and position of points in graphic space can be obtained very well by the haptic system.

The second issue considered the effectiveness of different modes of presenting information in the format of a line graph. Because graph reading tasks are relatively simple it seemed reasonable to allow the design to follow the standard visual style fairly closely. The four designs used in the present study were chosen because they had been used (although not assessed) previously in various tangible displays. They can all be produced cheaply and relatively easily by nonexperts, with no sophisticated technology necessary. In the past, most tangible graphs have been produced like visual displays with only "ticks" that mark off the major axes to serve as guidelines. Such a 'no-grid' mode of presentation may be very effective when only simple configuration information is required, e.g., is curve S steeper than curve T?, does Y increase monotonically as a function of X?; are curves A and B converging, diverging or parallel?; etc. With these tasks one might expect that with fewer interfering (e.g., grid) lines present, it might be easier to locate and follow the appropriate line functions. But when accuracy is important, as when determining the position of points in space, the ticks are unlikely to prove satisfactory as reference lines. A few graphs, therefore, have been produced with full grid on the graph ('grid-on-graph') surface, i.e., with ticks extended across the graph space in both directions. With this design, one might expect that the additional lines would hinder speed in obtaining configuration information, but improve accuracy in the point-position questions. With a 'grid overlay' design the grid is produced on a separate sheet from the no-grid display, aligned with the latter but attached only at the top. Thus, a person can choose to ignore the potentially interfering grid lines when determining the position of a given curve or intersection point and when answering configuration questions. However, when it is necessary to know the coordinates of a point the point can be found on the no-grid display and its position read subsequently from the grid overlay. The same logic holds for the use of a 'grid-underlay' mode, but the grid is now completely attached to the underside (facing down) of the no-grid surface. To use the underlay the reader must coordinate movement of the hands, palm to palm. Moving the hands in this way is a natural and comfortable task, and should be contrasted with the awkward hand coordination demanded by the overlay. Grid overlays and underlays have been used occasionally with tactual maps (e.g., Kidwell & Greer, 1972), but never to my knowleldge with graphs.

Lastly, since little is known about how to read tangible displays effectively, the current study served to document some of the exploration strategies used to answer questions about the graphs using each of the various graph designs ('no-grid', 'grid-on-graph', etc.).

The results of this systematic assessment of tangible line graphs are quite encouraging. They suggest that the presentation of spatial information in the form of tangible graphs is indeed a viable source of information for the blind reader, regardless of age at onset or duration of blindness. With only about one hour of practice subjects were able to learn to read the graphs relatively well; and yet, very few of the participants had ever encountered a tangible graph before. Of the four graph designs evaluated, the grid-on-graph andd grid-underlay modes proved most effective overall in terms of performance (error frequency, error magnitude and reaction time) and preference. The overlay was considered sloppy and unlikely to become easier with practice. And as predicted, the no-grid design was preferred when answering 'configuration' questions, but proved most inaccurate for determining the 'position' of points. The actual details of the experiment, including all statistical analyses, are documented in Lederman & Campbell (in press). Also included is a careful discussion of the various exploration strategies used, as well as suggestions for further design improvements.

In the past, it has been most common to translate visual designs into their raised tactual counterparts. Designers have usually assumed that what works for vision will do so for touch as well. With some simple formats, e.g., line and bar graphs, simple geometric shapes and pictures, etc., visual-to-tactual translation may be quite appropriate. The results of the study reported above support this notion. However, it is also likely that direct translation of certain other formats, e.g., complex pictures and geographical maps cannot be interpreted easily by the haptic system (perhaps if overall spatial layout is required). For example, the exceptionally slow, sequential nature of haptic input may prevent or hinder a holistic impression of the graphic information. And loss of vision, especially early in life, may further hamper a person's ability to read complex raised line drawings with facility. With complex displays it is likely that something entirely new will be required. Matching the particular demands of various graphics formats and designs to the normal processing characteristics of the haptic system is necessary, and requires an understanding of both the capabilities and limitations of that system. Only in this way can effective tangible formats be chosen, leading in turn to the development of better methods for designing and reading these formats.

In keeping with this 'human engineering' approach the second (current) stage in the tangible graphics project involves an investigation of the nature of haptic space and form perception in the sighted (blindfolded) and in the blind. As little is known about this important topic it is hoped that such work will provide more comprehensive information concerning the feasibility of presenting various kinds of spatial information to the haptic system. The work involves major collaboration with Dr. Roberta Klatzky of the University of California (Santa Barbara), and the assistance of Mr. Paul Barber, a research assistant working in my laboratory at Queen's University.

References

Kidwell A. and Greer P., "The environmental perceptions of blind persons and their haptic representations". New Outlook for the Blind, Vol 66, No 8 (Oct 1972), pp 256-276.

Lederman S.J. and Campbell A., "Tangible graphs for the blind". Human Factors (in press).

Stereo Copier

Matsumoto Yushi Seiyaku K.K. (Matsumoto Oil and Fat Pharmaceutical Company) have developed a stereo copier for reproducing maps and diagrams in an embossed form.

The system consists of three components:

1. Capsule paper is uniformly coated with hundreds of millions of thermally-foamed microcapsules which expand to hundreds of times the original volume upon absorbing the energy or light of heat.

2. A copier similar to a plain paper copier.

3. A developing machine thermally treats the capsule paper.

An ink print version is converted to an embossed version with the height of the raised parts depending on the contrast of the print version; heights range from 0.2 to 1 mm.

The price of the complete system is about 25,000 Dutch Florins ex works Rockanje, The Netherlands. The price of 200 sheets of capsule paper is about 200 Florins. Further details from F J Tieman BV, Molendijk 20, 3235 XG Rockanje, The Netherlands (Tel: 01814 2772, Telex: 24764 TIMAN NL).

Establishing a Small Braille Production Centre

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Introduction

There is no optimal solution to the problem of setting up a small braille production facility. This is due in part to the lack of commercial interest in this problem and in part to the fact that the deployment of new technology has been limited by a lack of investment. The field has been characterised as suffering from "benign neglect"; while the demand for the talking book increases year by year, the demand for braille stays relatively constant.

Because of the economies that can be realised, it is worth considering the operation of a joint tape talking book/braille/ large print production organisation. The relatively high cost of braille production can thus be offset partially by the economies to be realised in sharing overhead, some space and possibly some staff with the overall guidance and direction of a single manager.

One factor limiting braille production is the acute shortage of people skilled in transcribing text to contracted braille. To alleviate this problem many of the larger braille production centres use computers to translate text to braille. The English Grade 2 code utilises 190 abbreviations and contractions governed by a complex set of rules dependent on pronunciation and meaning. These rules are not amenable to direct implementation by a computer. One result is that existing computer systems can only produce a good approximation to Grade 2 braille. The number of incorrect uses of contractions is quite low, but human intervention is required if the output is to be "perfect" Grade 2 braille. For many braille readers, speed and availability may be more important in most applications than keeping to the precise official specification of Grade 2 braille.

The advent of the microcomputer has encouraged a number of organisations to produce braille even though they had no expertise in this area. For instance, a trade union is installing a microcomputer system so that information can be circulated in braille as well as in print.

The Choice of a System

The first step is to estimate with care how much braille one would like to produce. Typically a small production facility may produce per month one newsletter (60 copies of 15 braille pages), and one hundred documents (3 copies of 10 braille pages). It should be considered whether what it is planned to produce best meets the needs of the braille reading population - or whether it is the easiest to produce.

In any case, when production in braille is expanded it is likely that increased production will be concentrated on smaller quantities of a variety of texts. Since a large proportion of the cost of producing braille is invested in producing the first copy, the cost of each braille volume will be greater for smaller production runs than for longer ones. Some materials may be better handled in talking book form.

Funding. The next step is to decide upon the amount of available funds to cover the costs of buying equipment, maintenance, materials (braille paper, binders, covers, etc), staff costs and overheads. It is usually easier to find money to buy equipment than to run it. Further, most electronic equipment should be amortised (its value decreased to zero) over ten years; beyond that time the equipment may become too unreliable to consider keeping it (but there are some exceptions). Simpler machinery can give many more years' service with a minimum of routine maintenance. For most electronic equipment it would be wise to count on a maintenance cost of 15 per cent of the purchase price per year.

Some of these costs can be met through contractual arrangements with organisations of and for the blind. There are also organisations such as banks and insurance companies which are prepared to pay for their booklets to be made available in braille.

Space Requirements. Braille is a bulky medium. The expansion in size of an ink print version of an ordinary volume to its multivolume braille version may be 20-fold. Additional space must be counted on for the production system - collating and binding the braille pages, the storage of the completed volumes before they are distributed, and the space required in the master and duplicate copy library. A braille press for producing magazines will require about ten times as much space as the vacuum forming system used for small quantity braille production; say, 10 versus 100 square meters.

Sometimes planning ahead can alleviate some of these problems. If, for example, the full number of anticipated copies needed is produced all at once, the storage problem is compounded. It may be useful to consider a system in which an extra copy of a book is produced on the same day that a request is received for it. This problem generally does not exist for the special case of magazine production, since the circulation of the magazine is usually well defined before the production run is begun.

Another factor influencing storage space depends on whether the production system used makes braille embossed on only one side of a page (single-sided embossing) or on both sides (interpoint or interline embossing).

Staff Selection. The choice of a braille production system may be influenced heavily by the availability of suitable staff. The staff running the production system may have to be trained in the rules of the braille code. They will in any case need to be trained in the layout requirements for braille books, particularly those that include tabular information. Most difficult of all are the specialist codes, as for mathematics or music, since these require persons with dual understanding of the subject matter and the special braille codes used for them.

Stages of Production. The seven stages are:

(1) The choice of the material to be transcribed.

(2) Editing of the ink print text to show how it should be laid out in braille. It is a particularly time consuming process for textbooks which include tables. Diagrams present another major problem, and it is often preferable to substitute a short paragraph of descriptive text. Otherwise the diagram or map has to be created in a tactual form and inserted into the braille text at the proper place.

(3) Production of a master copy, including proofreading of the braille text to check on the possibility of mistakes in the material and on correct use of contractions and layout requirements. This is a slow process.

(4) Production of multiple copies.

(5) Collating and binding. Collating requires a large working area and is usually done by hand. Whether stitching, wire coil or plastic comb is used to bind the braille pages will depend on the quantity of braille to be produced.

(6) Adding of an ink print label to each volume giving author, title and volume number.

(7) Packing and distribution by mail. The braille must be protected from damage in the post.

Currently Available Systems

As has already been pointed out, no system can be counted as ideal; every choice involves some compromises in terms of cost of production, the degree of sophistication of operators required, or the number of copies possible. Table 1 summarises the main characteristics of typical systems.

Table 1 Braille Production Systems

System	Requires skilled braillist	Capital cost of equipment	Cost of master braille page	Cost of braille copies	Dot quality	Braille embossed on paper	Braille embossed on plastic	Double-sided embossing	Requires collating
Simple transcription	*	D	B	B	A	*	*	*	
Back-filled master	*	D	B	C	D	*			*
Screen printing	*	C	A	C	D			*	*
Stereotype	*	B	A	D	A	*		*	*
Vacuum forming	*	C	B	B	C		*		*
Electronic system for braillist	*	B	C	C	B	*			
Electronic system for typist		B	C	C	B	*			

A - very high; B - high; C - medium; D - low.

Simple transcription. In this system a braillist embosses directly on paper or plastic using a mechanical braillewriter. Using the most widely distributed machine (the Perkins braillewriter) only one side of the paper can be embossed. The Stainsby machine, however, can produce interpoint or interline braille. Since the devices are of relatively simple mechanical design the reliability is high. More than one copy can be made at one time by using thin paper or plastic; unfortunately the dot quality, normally superb, suffers when this is attempted.

The main advantages of this system are low capital cost and a minimum of maintenance; this system is that most often used by volunteers working in their own homes. Among the disadvantages are the low quantities that can be achieved in production and the difficulty of correcting errors without redoing a whole page.

A good transcriber is able to produce as many as 30 braille pages a day, including proofreading and the correction of errors. If the error rate is high, as with a poor transcriber, productivity drops sharply due to the difficulty of correcting errors.

Back-filled master. A master copy is produced on a braillewriter. Then the back of the braille page is covered with a paste which hardens as it dries; this may require heating so that it hardens properly. Copies are made on sheets of paper by passing the master and paper between a pair of rubber rollers. The simplicity of the system is appealing. However, the resulting dot quality is fairly poor, and the master copy will not survive a large production run.

Screen printing. There is a number of variations of this technique. The best is that in which a master is made by punching holes in a sheet of stiff card or plastic, each hole corresponding to a braille dot. Ink is then forced through the holes and down on to a sheet of paper. The ink on the sheet has to be dried carefully so that it adheres to the paper. The method requires a great deal of care to ensure good results. Since thin paper is used, the bulk and weight of the resulting braille book is considerably less than those in which normal heavy braille paper is used.

Stereotype. A braillist uses a heavy-duty machine for embossing a pair of metal plates. Errors are difficult to correct. A typical production rate is about 10 plates a day per operator. Copies are then made in paper using a flat bed or rotary printing press, adapted or built especially for printing braille. The dot quality is very good (more so for the flat bed than the rotary press) since the paper is compressed between the pair of metal plates. The metal plates are ideal for long production runs, but they are clumsy and space consuming to store for future use.

For large production runs, considerable space is required for storing material awaiting collation as well as for the collating itself.

Vacuum forming. A paper master is made using a braillewriter. Plastic copies are then made from it using a vacuum forming machine. This operates by heating the plastic sheet that is in contact with the braille master, and drawing out the air from under the master to the shape of the braille dots. Then the plastic sheet is cooled, and it becomes rigid and retains good memory of the master. The whole process takes about 20 seconds. The best plastic sheet is calendered polyvinyl chloride; the calendering gives the sheet a texture which makes reading by touch easier. Since the plastic material does not absorb moisture from the fingers it is less comfortable to read than paper. Copies can be made at a maximum rate of 150 per hour. Pages need to be collated and bound; ring binding is the simplest method.

Electronic system with input by braillist. There is a very large number of possible combinations in this group, all aiming to give the braillist the possibility of correcting errors simply, and also the possibility of producing a number of copies.

A typical system would involve the braillist keying in the information; this is stored on a digital cassettte. Proofreading and correction of errors is accomplished by the braillist reading the braille display and using simple command key instructions to correct any errors that are found. Copies can be embossed in braille on an embosser at speeds varying from 10 to 250 cells per second. Alternatively, a device can be used which automatically embosses metal plates to use on a flat bed or rotary press for large production runs. The output from the braille embosser is fan-folded, so it must be separated; this is best done with an automatic guillotine.

An advantage of this system is that the braille is stored in machine readable form on a compact cassettte; copies can be made from this "master" whenever they are required.

Electronic system with input by typist. This system is a refinement of the foregoing system. The text can be entered by a typist who has no knowledge of the braille code. Translation of the ink print text to braille is done automatically by the system's computer. The output is on an embosser as before.

The typist uses a conventional keyboard and the text is displayed on a visual display unit where proofreading and editing of errors can be done before the information is stored. Storage is on a fairly inexpensive medium such as a floppy disc. A computer program translates the text to contracted braille; the output of that translation is also stored on a floppy disc. If "perfect" braille is required, a braillist will have to make corrections to the data. The typist can then instruct the computer to produce the required number of braille copies serially on the embosser. A printer is often added so that the text can be produced in both ink print and braille from the same input file.

Such a system can be bought part by part or as a complete package. A typical cost would be £8,500 for the complete system including a microprocessor, visual display unit, pair of floppy disc units, high quality printer, braille embosser (15 cells per second), and necessary programs to produce contracted English braille. These systems cannot usually cope with special codes such as mathematics or music.

The Future

Analysis of growth in talking book and braille production has indicated a steady growth in talking book use, and a constant demand for braille books. However the availability of braille material may affect that demand. A potential growth area for braille is the use of digitally encoded braille, but it may be several decades before this technology is used by the majority of braille readers.

Another area of interest is the utilisation of optical character recognition. This could permit a blind person to have a device which "reads" a book and displays it as braille. Similar devices, albeit expensive, already exist with speech output.

The digital tapes used for producing printed books can be used for braille production. However these tapes contain much information not required for braille production, so a computer program (preprocessor) is needed to convert the data to a form acceptable by the braille translation program. Even then it may be necessary for a human to add extra formatting commands. Unfortunately lack of standardisation by printers means that a preprocessor will work only for one type of tape. A totally automated system is feasible when the format is predetermined; for instance the automated production of bank statements of account from digital tapes has proved very successful in the UK.

In the short term the main advance is likely to be far greater use of word processing systems with output in contracted braille. These systems are available from a number of firms, but as yet they have had relatively little impact on the availability of braille.

Further Reading

Clark L.L. (Ed) Developing Braille and Talking Book Services. Munich: Sauer. (In preparation)

Hampshire B. Establishing Braille Production Facilities in Developing Countries - A Handbook. Stockholm: Swedish Federation of the Visually Handicapped, 1980.

International Guide to Aids and Appliances for Blind and Visually Impaired Persons. New York: American Foundation for the Blind, 1977.

Acknowledgements

The authors are grateful for the advice of J.W. Berryman and W.M. Raeder.

Appendix Braille Equipment Suppliers

Computer controlled braille embossers are surveyed elsewhere in this issue of Braille Research Newsletter and paperless braille devices were covered in the last issue, so information on these devices is not repeated in this appendix.

American Thermoform Corporation, 8640 East Slauson Avenue, P.O. Box 125, Pico Rivera, California 90660, USA. Tel: (213) 723 9021. Vacuum forming machine for duplicating braille.

C.R.Clarke & Co, Carragamman Lane, Ammanford, Dyfed SA18 3EL, Wales. Tel: (0269) 2329. Vacuum forming machine for duplicating braille.

Deutsche Blindenstudienanstalt e.V., Postfach 1160, Am Schlag 8, D-3550 Marburg, German Federal Republic. Tel: (06421) 67053-59. Telex 4821106. Stereotypers, braille composition and correction units, rotary printing presses, printing boxes and braillewriters.

Howe Press of Perkins School for the Blind, 175 North Beacon Street, Watertown, Massachusetts 02172, USA. Tel: (617) 924 3434. Braillewriter.

Maryland Computer Services Inc, 2010 Rock Spring Road, Forest Hill, Maryland 21050, USA. Tel: (301) 879 3366. A word processor with the capability to produce documents in contracted American braille.

Matsushita Research Institute Tokyo Inc, 4896 Ikura, Tama, Kawasaki, Kanagawa, 214 Japan. Duplication system using an optical reader.

Ernest F. Moy Ltd, Unit 5, Brunswick Park Industrial Estate, New Southgate, London N11 1JF. Tel: 01-361 1211. Electric stereotyping machine.

RB Aids for the Blind Ltd, 6A New Street, Warwick CV34 4RX, England. The Braille and Ink-print Text-processing System (BITS) permits a typist to produce both print and contracted English braille.

Royal National Institute for the Blind, 224 Great Portland Street, London W1N 6AA. Tel: 01-388 1266. Stainsby braillewriter.

Tele-Ekonomi, Hardemogatan 1, S-124 44 Bandhagen, Sweden. Tel: 08-99 04 85. Telex 17098 GRAPRO S. Microprocessor-based system with input by a braillist.

Theil Industrie Elektronik, 6104 Seeheim-Jugenheim, German Federal Republic. Tel: 06257 2035. Telex 0468496. Production systems with input by a braillist.

Timson (Export & Sales) Ltd, Panton House, 25 Haymarket, London SW1Y 4EN. Tel: 01-839 4781. Telex 892316. Reel-fed braille press.

Triformation Systems Inc, 3132 S.E. Jay Street, Stuart, Florida 33494, USA. Tel: (305) 283 4817. Micro-based system that translates printed materials into contracted braille. Plate embosser.

Voltas Ltd, Kaybee Cell, 19 J.N.Heredia Marg, Bombay 400 038, India. Tel: 26 81 31. Telex 2239/3054. Braillewriter.

Two Devices with Braille Output

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Introduction

The National Research Council has operated a programme for the development of aids and devices for the blind since 1965. It is a small project involving only two persons and has been directed mainly towards the development of vocational aids. Some work has been done on recreational and mobility devices. No work has been done on major braille production equipment, although braille has been used as an output mode on certain measuring instruments for industrial use.

Two devices employing braille as their output are described here. The first is a communication aid for the deaf-blind giving access to the telephone system and to certain Teletype networks operated by the deaf. The second is an electronic calculator employing a unique combination of touch and sound to display answers to a blind user. The display requires no moving parts and results in a very inexpensive braille system.

Visual Ear

The deaf-blind are one of the most communications handicapped groups in society. Generally, information can be imparted only on a one to one basis by use of the manual alphabet or by braille. If a deaf-blind person chooses to live alone (and some do) they are very isolated indeed.

Recently a device has been developed in Canada for use by the deaf which has been called the 'Visual Ear'. The device consists of a normal typewriter keyboard, with the top row of keys missing; numbers are produced using a control key and the top letter row. A 23 character scrolling LED display shows either the information being entered on the keyboard or the data as received. The telephone handset fits into a modem. The device communicates in the serial BAUDOT code commonly used by Teletype service networks for the deaf. There is also a parallel ASCII ouput provided to operate a printer when required. In many cities the deaf operate Teletype networks which give them access not only to each other, but also to a central service bureau which then can make voice contact with other services as requested.

We felt that if the Visual Ear could be inexpensively equipped with a braille readout these services would become available to the deaf-blind as well. The preferred system would be a multicharacter braille display similar in capacity to the visual display used on devices like the VersaBraille. Unfortunately such displays tend to be very expensive, and people with this handicap cannot afford them. Thus we have selected a 64-character first-in-first-out (FIFO) which receives data from the printer output on the Visual Ear which feeds a single braille cell. The dots are formed by solenoid driven pins. A seventh dot to the left of the usual six dot matrix is used to indicate spaces, for word separation and to differentiate numbers from letters (instead of generating a braille number sign).

Since it has been found that steady dots under the same part of the finger seem to deaden the tactile sense and 'disappear', we have made the dots vibrate by supplying them with pulsating DC. A manual control is provided which clocks the rate at which new characters are displayed. The rate can be varied from one to ten per second.

The current braille display attachment is rather larger than necessary and is powered from the mains. Future units will be considerably smaller and battery powered, to make them compatible in portability with the Visual Ear itself.

Preliminary trials have been very encouraging. One unit is currently in use by a blind operator in a government office to enable him to accept Teletype calls from deaf clients.

Braille Calculator

A simple braille display has been developed. The method avoids the use of any moving parts, but employs a combination of touch and sound to display the requisite numbers. The system is being applied to a whole range of electronic instruments including calculators, frequency counters, radio receivers and transcievers, and others.

The seven segment information fed to the instrument's visual display is passed through a programmable read-only memory (PROM) which delivers the equivalent braille code. The four dots of the braille cell, required for numbers only, are printed in a square as insulated islands on a printed circuit board. These islands are surrounded by a copper field. A small hole is drilled in the center of each of these islands and a short piece of wire is passed through and solder built around it to form a dot. Dots are placed on 10 mm centres so that when touched by a finger it will not bridge two dots at a time. The copper field is connected to a source of supply voltage and the dots control CMOS and GATE inputs. The PROM drives the equivalent opposite inputs on these gates. The input impedance of the CMOS circuits is sufficiently high that when a dot is touched, skin resistance to the copper field will set that input to the ON condition. If the other input to that gate has been turned on by the PROM the gate will close. This in turn operates an audio oscillator and loudspeaker. If, however, there is no signal from the PROM equivalent to that dot, no sound will occur. Thus by running a finger around the four dots only those dots that produce a sound are noted as forming part of the number being read.

When the digital read-out system is multiplexed, it is necessary to use triple input gates; otherwise there is little complication.

A number of calculators using this system were subjected to a field trial conducted by personnel of the Canadian National Institute for the Blind's National Employment Service. Results were favourable. The system is also in use by a number of radio amateurs across Canada to read the frequency of transceivers and other instruments. We have also found that in most applications it is possible to substitute a binary coded decimal readout by printing the dots in a vertical row rather than a square, and letting the dots have the values 1,2,4,8 from top to bottom of the row.

The Baruch College Tactual Graphics Facility: A Progress Report

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Introduction

Long term readers will recall that when the Computer Center for the Visually Impaired was established at Baruch College in the Spring of 1977, an agenda of tasks and projects was outlined (see BRN No. 8). Among these was the creation of an adapted computer assisted tactual graphics system based on the pioneering work done by J.M. Gill at Warwick Research Unit for the Blind. Baruch College has been fortunate in securing funding from private and foundation sources for the development of such a system.

I shall say without overstressing the point that the venue of a business oriented college is not ideal for what is, after all, technological research and development and careful engineering. It is a tribute to the many friends of the Center with such expertise that in the Spring of 1982 we were finally able to announce we had achieved one important benchmark in the project: namely the replication of the quality of map that John Gill had established as a world standard in his laboratory.

Perhaps the most important lesson that we have learned is that it is attention to detail, and a passionate dedication to quality of execution of the epoxy master (from which copies of graphics are made) that make the difference between an "interesting" duplication of Gill's work and a replication of his work. Our realization of this indeed underscores his amazing achievement in his experimental prototype system, now dismantled.

The objective in this first phase of development of the Baruch adaptation has been to develop components of a system that can be duplicated by others; and to create software that could be targeted towards portability when its features and capabilities have been confirmed by adequate task performance. We are not now far from achieving that goal.

Producing Tactual Graphics

The process of turning a visual diagram into a tactual map or graph occurs in four steps. Visual information is entered into the computer. The image is edited to enhance its tactual clarity. The drawing in the computer memory is carved into a piece of Bakelite plastic. This negative image is transformed into a positive by molding it in silicone rubber. The positive image master is then Thermoformed to produce tactual maps and drawings.

The Program

The present system implementing these tasks has been written in interpreted Basic on a 24K microcomputer system. The program has four main menus: create/edit, disk, modify, and produce.

With the Create menu the operator can insert braille, draw lines, load symbols and duplicate part of the image. Information is entered first on a digitising graphic tablet. It acts like a sketch pad. There is a 12-inch by 12-inch tablet and an electronic stylus. The computer senses when a pen is touched to the surface of the pad; the X/Y position of the point touched is stored, simultaneously displaying a flashing dot in the appropriate place on the CRT screen. Braille is input by entering the starting and end points of the braille string on the digitiser. The present program will insert number signs; Grade II braille is entered manually on the keyboard.

Four predefined line modes are available: horizontal, vertical, curved or independently sloped. One line can be drawn independently of others, or connected to the end of a previous line. A square is made by entering correct mode, followed by codes for two horizontal and two vertical lines. This method reduces dependency on the steadiness of the operator's hand. Time is saved in creating graphics by storing commonly used patterns in the system memory. They are loaded on the current drawing and moved into position by using the editor. Within the edit mode symbols and groups of lines can be transformed, scaled, rotated, stretched and duplicated.

The disk menu is used to load and save whole drawings. Drawings can be also merged, erased or renamed.

The Modify menu is used to change parameters that are used in the engraving step later on. Each line is assigned a type and an engraved depth. Each line can be unbroken, or it can be segmented as required by the operator. Lines can also be changed to dashed, dotted or sawtooth form.

Problems to Date

The program is being rewritten at the moment to expand its capabilities. A zoom/window algorithm will be used to view small areas of the screen. A viewpoint will be selected by drawing a box on the screen. The computer will then fill the whole screen with the lines within the viewpoint. The digitiser coordinates will be enlarged so they will be proportional to the area of the screen. This method will enhance greatly the accuracy of the system.

Another algorithm is being written to use the digitiser pen as a locating device. To identify a line the user will draw a temporary slash through it. The computer will compare the equation of that line with every other line in the current window. By solving the simultaneous equations the intersection will be identified and the number of the line will be stored. This program can be used to cut away parts of a line selectively. Symbols and groups of interconnected lines will be identified not by numnber but by name. Then, the operator will be able to move the symbol representing a door by inputting, "translate door".

Mechanical problems have slowed down our developmental work. The engraving table, for example, is controlled by three stepper motors. Each moves one step for each digital pulse the computer sends it. The number of pulses are counted, thus keeping track of the X/Y/Z position. But motors cannot be accelerated from steady state to full speed without missing pulses. Those missing pulses are included in the final count since there is no feedback to inform the computer that the motor has not moved. This problem becomes serious in drawing many interconnected lines. The solution is an electromechanical feedback system: one monitors the Z axis with an electronic depth gauge with digital readout; this responds immediately to fluctuations in the Bakelite and keeps track of missed steps. Similar monitoring will be done for the X and Y axes.

The Future

At the moment we are reprogramming the software for the system to operate on a faster memory in a system with a larger memory. At present, many hours are required to complete the work necessary to create tactual graphics, even when there are no problems regarding the optimal representation of visual features in tactual form. (And of course there are always such problems.) But within the next several weeks, the lucubration of the system programmers will be rewarded by achievement of a system that we expect will be near production form. Already orders have come to us from universities, foundations, organisations for the blind and public service organisations for tactual graphics of several kinds. We aim to produce packages of software and recommendations for hardware that will allow the development of regional venues for the production of tactual graphics to uniform and excellent standards of perceptual clarity.

Braille to Print Translator

A computer program, to run on a microcomputer under CP/M, to convert contracted braille to print is being sold by RB Aids for the Blind. The system is designed for use with a VersaBraille, and incorporates word-processing facilities. Further information can be obtained from RB Aids for the Blind Ltd, 6A New Street, Warwick CV34 4RX, England.

Computer-Controlled Braille Embossers

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This survey is limited to commercially available devices which emboss braille directly on paper. Some machines have been developed for use by blind people who need access to computers, and others have been designed specifically for computer assisted braille production; the latter tend to be more robust.

These machines emboss conventional six dot braille cells on continuous heavyweight paper. The slower machines emboss one cell at a time, but the faster machines emboss a whole line at a time. The embossers normally produce the international braille page size of 11 by 11.5 inches; some machines can be adjusted for other page sizes. The paper is sprocket fed fanfold of 100 to 160 gsm. The surface finish of the paper is important since the dust caused by embossing can clog the mechanism.

Table 1 compares some of the main features of the available embossers. For ease of comparison the prices quoted are those which would have to be paid by a customer in England; these prices will vary with relevant exchange rates.

The information contained in this article has been provided by the manufacturers and the author has not verified the accuracy of their claims.

Table 1 Braille embossers

	Braillo 270	RS-14	REM 8BR	LED-15	LED-120
Max cells across page	42	40	40	40	40
Double-sided - simultaneous	*				
Double-sided - reverse paper			*		
Can produce 8 dot cells	*	*			extra
Alphanumeric keyboard	extra	extra	extra	extra	extra
Tactile signals/alarms	*	*	*	extra	extra
Max operating speed (cells per second)	270	160	15	15	120
RS 232C interface	*	*	*	*	*
Baud rates 110	*	*	*	*	*
150	*	*	*	*	
300	*	*			*
600	*	*			*
1200	*	*			*
2400	*	*			
4800	*	*			
9600	*	*			
Handshaking	extra	*	extra	*	*
Weight - Kg	200	40	28	114	114
Size - height mm	1050	750	235	940	940
- width mm	570	400	525	635	635
- depth mm	950	500	525	610	610
Instruction manual in English braille	*	*		*	*
UK price (incl. VAT) £	43125	10925	2875	6454	11500
Delivery £	extra	0	115	287	287
Delivery - weeks	12	8	12	12	12
Warranty - months	12	12	12	3	12
Year when launched	1980	1981	1976	1979	1974
No. currently in use - Europe	2	10	84	0	16
- North America	0	0	15	16	185
- Elsewhere	0	0	6	0	5

Braillo 270

Manufacturer: Braillo.Norway A.S., Ringshaugvn. 118, P.O. Box 647, N-3101 Tonsberg, Norway. Tel: 033-30977.

Description: Prints on both sides of the paper (interpoint) simultaneously at up to 270 characters per second with a line length of up to 42 characters. A fail-safe mechanism prevents damage to pins if hard objects accidentally should be placed in their way while the printer is running. The vertical spacing between lines is variable. The printer may be operated by a blind person; control buttons are marked in both print and braille.

A text positioning program directs the text to be printed from top to bottom on one page, then from bottom to top on the other. Accordingly, the lines are laid out in normal left to right fashion on one page, and in the reverse direction on the next page. Cutting three sides of the stack and binding the fourth is all that is necessary to have a bound book. No handling of individual pages is needed.

Specification: Transmission ASCII RS232C asynchronous with maximum rate of 9600 baud. Variable pagelength, variable line length with 42 characters maximum, line spacing variable in increments of 1/10 of a line. Text storage space 6K bytes, program storage space 3K bytes. Height 105 cm, width 57 cm, length 95 cm. Operator controls: printer start/stop, power on/off, page count (4 digits), paper stop, page length, line length, test print, paper feed, page shift, reset printer.

Price: 450,000 Norwegian Kroner; delivery and installation extra. The price includes 15,000 pages of paper, a tool kit, and training of the operating and maintenance staff.

RS-14

Manufacturer: Resus International, Wijnhaven 102B, 3011 WV Rotterdam, The Netherlands. Tel: 010-11.02.07/33.10.77. Telex 26321 RESUS NL.

Description: The mechanism involves 80 pins, suspended on springs, which can be locked by a cam controlled by a solenoid. On the opposite side of the paper is the printbar, with 80 holes, which is moved towards the paper so forming the dots. The construction of the machine is based on low maintenance principles. Paper dust has little effect on the transport mechanism.

The braille output can immediately be read. When, after completion of a line, the embosser receives no further information, the controller generates enough linefeed commands to advance the paper for reading the last line. Before starting the next print-cycle, the controller moves the paper back to its original position.

Specification: Interface 8 bit parallel TTL Facit SP I compatible or serial V24 RS232C 20 mA current loop. Input code 6 point MIT braillecode or ASCII converted. Printspeed 240 lines per minute, maximum 40 characters per line, line spacing 10 mm, line width 200 - 360 mm. Operator panel: push buttons for on/off, reset, run, halt, page, test, warning lights with audible signals for paper, print error, data error, end of text. Dimensions 750 x 400 x 500 mm; weight approx. 40 kg. Switch or software controlled: 8 point braille. Options: second processor with expandable ram memory for braille translation; special push button controls; modifications to use as a computer terminal; special input codes.

Price: 44,000 Dutch Florins FOB Rotterdam.

REM 8BR

Manufacturer: Societe d'Applications Generales d'Electricite et de Mecanique, Department Teletransmissions, 6 avenue d'Iena, 75783 Paris Cedex 16, France. Tel: 745.14.60. Telex 610762F.

Description: The braille embosser was developed from a matrix printer; each cell is embossed as two columns of three dots. The embosser is available with an alphanumeric keyboard (TEM 8BR). By turning the paper over, interdot braille can be produced.

Specification: 110 or 150 baud. 31 characters per line (optional 40 with 310 mm wide paper). Power supply 115, 127, 220 or 240 volt, 50 or 60 Hz. Height 235 mm, width 525 mm, depth 525 mm (640 mm for TEM 8BR). Weight 28 kg (34 kg for TEM 8BR).

Price: 23,646 French Francs for receive only; 28,727 Francs with alphanumeric keyboard; 2316.50 Francs extra for paper tape punch; 1541 Francs for paper tape reader; 4623 Francs for 6 key keyboard. These prices are ex-factory, Paris.

LED-15

Manufacturer: Triformation Systems Inc, 3132 S.E. Jay Street, Stuart, Florida 33494, USA. Tel: (305) 283 4817.

Description: Designed specifically for broadcast studios as a wire service news terminal, compatible with the normal wire services teletype. Low speed printer which embosses one braille cell at a time.

Specification: Maximum speed 100 words per minute with EIA RS232 B/C nonsynchronous or TTY interface. Input code ASCII, EBCDIC, BCD, Correspondence or Baudot. Size 25 x 24 x 37 inches; weight 250 pounds. Power input 115 VAC, 60 Hz (220 volt, 50 Hz extra).

Price: $8,125; $220 extra for alphanumeric keyboard; $110 extra for carrier detect tactile indicator; $165 extra for 220 VAC operation; $660 extra for control electronics; $72 extra for interface cable. Carriage extra.

LED-120

Manufacturer: Triformation Systems Inc, 3132 S.E. Jay Street, Stuart, Florida 33494, USA. Tel: (305) 283 4817.

Description: Line embosser which embosses three rows of up to 80 dots per line of braille.

Specification: ASCII communications code input at 110, 134.5, 300, 600 or 1200 baud, full or half duplex. 25, 27 and 31 lines per page spacing switch selectable. Paper out alarm. EIA RS232 B/C nonsynchronous interface. Size 25 x 24 x 37 inches; weight 250 pounds.

Price: $15,921; $220 extra for ASCII keyboard; $55 extra for dot 7 & 8 switch; $210 extra for 202C option; $110 extra for carrier detect tactile indicator; $110 extra for buffer overflow tactile; $110 extra for data present tactile indicator; $110 extra for automatic print option; $165 extra for 220 VAC operation; $110 end of line alarm. Delivery extra.

Touch Colour

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Touch colour is an invention that provides the conceptual framework and method of teaching the properties of colour, "flat-form", perspective and panorama to the blind, deaf-blind, colour-blind, and individuals with certain learning disabilities through the sense of touch. A study of touch colour may help develop an intellectual understanding of colour and an appreciation of colour in which the sighted are immersed. One may learn a vocabulary of colour, which improves on ability to converse it.

The primary and the secondary colours, black and brown are represented by standardised tactile patterns composed of raised lines and/or data. White is represented by the absence of any textured pattern. The raised lines and/or dot patterns can be varied by greater or lesser spacing between the lines and dots to indicate a lighter tint or a darker shade of the colour. The standardised tactile patterns of the primary colours consist of line arrangements of horizontal parallel lines; the secondary colours are represented by lines that run diagonally. Both yellow and red are represented by parallel lines, but the distance between the lines distinguishes between yellow and red. Blue is represented by alternate horizontal solid raised lines and broken lines; green, a secondary colour by solid raised lines which run from upper right to lower left; orange by solid raised lines which run from upper left to lower right; purple by solid raised lines from upper left to lower right intersected at a 90 degree angle by solid raised lines which run from upper right to lower left. On the touch colour wheel, brown is displayed in a small circle in the centre of the wheel and its standardised pattern is the same as the cross hatch pattern used for violet, with the addition of a single dot in the centre of each mesh. Black and white are the keys to the touch colour wheel; they are displayed in small squares on either side of the wheel and are used to help the student understand "density". The pattern for black consists of raised dots similar to those used in the braille code. The tactile patterns for brown and black can also be altered by varying the space between lines and dots to indicate lightness and darkness. For example, when dots are placed very close together they represent black. When widely spaced they indicate grey. The tactile patterns for the various colours represent colour only when used in reference to colour.

A tactile gauge indicating the width of the lines for yellow and/or red accompanies each picture. It is embossed with the standardised representation of the colours to lend clarity to the intention of the artist. The tactile gauge may help avoid confusion say, between dark yellow and light red or pink. An orientation dot indicates the top of each touch colour picture.

The property of "density" is communicated through the standardised tactile representation of colour. White (the least dense) is represented by the absence of embossing. Black (the greatest density) is represented by closely spaced dots. By spacing dots progressively the various shades of grey may be represented.

When a sighed person looks at a two dimensional picture, he observes various forms and colours. When a non-sighted person touches the flat surface, it feels devoid of form. "Flat form" is the term we use to describe those basic forms which a sighted person sees in a picture, photograph, or illustrations. By learning the assigned tactile patterns, the blind student can become aware not only of colour displayed on a surface, but also form or shape. Basic forms are combined to show complex shapes. The touch colour line representations of colours define forms and shapes for the blind reader in the same way as colour defines forms for the sighted, even though they may not be aware that colour defines form (circle, square, triangle, oval, rectangle, etc.) and shape. The touch colour system portrays "flat forms" and shapes in a prescribed "relief or three-dimensional" mode which can be perceived and interpreted through the modality of touch.

Heat is another property of colour. It is also represented in the touch colour wheel. Yellow is a "warm colour", red a "hot" colour; orange, between yellow and red on the colour wheel, is warmer than yellow but not as hot as red. Thus, a study of the colour wheel helps the blind user understand the allusion to "heat" by sighted persons as this relates to clothing, interior decorations, and the so-called psychology of colour.

Both perspective and panorama can be represented with touch colour. This differs from utilitarian use of nonstandard lines in graphics. Touch colour will allow blind persons to communicate about art with other blind persons. When touch colour pictures or graphics are overlayed with pigments or colours, they can be appreciated by both blind and sighted persons.

The uniqueness of touch colour from other types of tactual codes is its applicability to pictoral art and its utility in labeling and graphic representation as in interpretative maps and diagrams.

The conceptual framework and the method of instruction for blind students in using touch colour allows them to create pictures using a Sewell Raised Line Drawing Board overlaid with plastic paper; or alternatively, by using a Sensory Quill and plastic paper. Pictures, maps and illustrations may also be made with the use of a tracing wheel on braille transcribing paper placed over a rubberised pad or surface. The fact that blind persons who know the touch colour method can "read by touch" pictures, maps, illustrations and graphics are made by others and can also create them, provides for action between sighted and blind persons and among blind persons. Touch colour pictures and graphic materials may now be produced by computer assisted methods. This will make it possible to mass produce instructional and artistic materials which hitherto have been produced by hand in single copy.

Editor's Note: This paper represents an attempt to develop a coding scheme for colour, texture and perspective as represented in tactual graphics. Comment on the suggestions made by the authors are welcomed if (a) they relate to acceptance to consumer groups and (b) speak to the adequacy of coding for colour, texture and perspective. The paper is drawn from a forthcoming textbook by B. Elder (Arkansas Council of the Blind) and R. Tonelli, developer of the code system (independent researcher).

The Virginia Way - R.E.B.

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The traditional problems of producing and using braille instructional materials have only been compounded by recent increases in demand. To alleviate any of these many problems, we were led toward a pilot study of electronic braille systems. After a thorough investigation of prototype models of electronic braille devices, the VersaBraille (Telesensory Systems) was chosen.

The intent of the pilot program, Reading Electronic Braille (REB), was to determine the feasibility of cassette braille as a medium for providing textbooks to blind students through the elementary and secondary levels of education.

Digitally encoded braille can have a positive impact on the education of blind children. First, readability is superior to hard copy embossing. This can be attributed to the excellent and consistent tactile quality presented. Second, there is indication that reading speed can be expected to increase without sacrificing comprehension. Third, the nearly silent operation encourages students to record more braille notes during classroom sessions. Finally, by utilising search features of the equipment, he has ready access to large amounts of material.

The transcription process for electronic braille is definitely speedier. Correction of, deletion from, and addition to, reading materials in this medium becomes a transcriber's dream. The fatigue factor is also reduced, due to the ease of operating any electronic-type keyboard. The 400 pages of braille held on one C-60 cassette is actually more material than can be written on 400 pages of hard copy.

Duplication of cassette tape is accomplished rapidly and simply either by existing tape duplication equipment or by interfacing two VersaBrailles (Model P2).

Storage, handling and distribution of cassette braille is simpler and less costly than conventional braille materials. This type of data gathered during the preliminary study convinced us to seek means for establishing this new medium as a part of the statewide system. The procurement and distribution of appropriate instructional materials and tangible aids needed by the visually impaired students is our major responsibility.

Format and method for transcription has become a natural by-product of the REB Project. Guidelines for the transcription of educational materials have been formulated, revised and will be re-edited as future experiences dictate. Consistency of transcription format is a basic requirement. Before training transcribers to produce instructional materials, it was necessary to prepare procedures for such transcriptions. These guidelines have been formulated with the view that many revisions may be necessary.

It is unrealistic to simulate braille examples in print when they are to be applied on a line of 1,000 character length, a cassette braille version of the more complicated techniques for textbook production has been prepared. Such items as footnotes, numbered line prose and poetry, and indices are given on tape to accompany the printed guidelines.

Workshops to train transcribers and teachers in the use of the VersaBraille system are being conducted now. In our experience, an efficient method of conducting short term training sessions is to start with the readout functions. A cassette on which approximately 20 tape pages have been written is used. These pages exemplify uses of the book structure - title pages, transcriber's notes, contents and text are illustrated. After learning simple readout, search functions are mastered easily.

Writing functions are more "natural" when they follow editing procedures. A second cassette with many intentional transcription errors is provided each trainee. Cursor movement is thus mastered purposefully. A secondary benefit from the editing lesson is a test of proofreading, and a review of braille rules. Deficiences will surface during these workshops, and also the opportunity to upgrade inadequacies. These skills must be "sharp". Teachers of the visually impaired will be responsible for training students in the proper use of the VersaBraille system.

By September 1982, fifteen to eighteen blind students in grades 8 through 12 will begin using VersaBraille routinely. Instructional materials selected from the regular curriculum will be available in digital braille. Each student will have at least one such text on this medium. Transcriptions produced electronically will be listed with the Central Cataloging Service of the American Printing House for the Blind, Louisville, Kentucky. We plan to reproduce cassette braille upon request for any other student outside the State of Virginia. This follows current practice of providing Thermoformed braille from hard copy masters in our own repository.

We expect to provide hard copy reference volumes to accompany cassette braille. They will consist of tactile illustrations, such as maps and graphs, and any needed spatial representations. We expect, further, that use will be made of this system in many different classes when note-taking is required.

A New Braillewriter and Business Application System

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Introduction

An ad hoc research and development group, Braillite Associates (T.F. Doyle, C. Ronney, R.S. Everitt, with the assistance of K. Reinjtes), has been engaged for the past three years in the development of an improved electronic braillewriter and a business applications system using braille as a communications code. The group based its work on observations of the inadequacies of available braillewriters, judged by many users to be noisy, heavy, not portable and "dumb" to outside communications links. A new design to meet the criteria suggested by Clark (BRN No. 9) was made for a braillewriter which will be inexpensive, with a soft touch and quiet keyboard, light in weight and portable, microprocessor based and capable of linkage to outside devices. These criteria, if met, will overcome the objections by students that they cannot afford braillewriters after leaving school, and that normal braillewriters are objectionably noisy and heavy for use at work. Such a design would encourage use of braille for both personal and occupational applications, maintain braille skills and reduce fatigue.

Concomitant with the development of the braillewriter we began also to be concerned with employment of blind users. Hence we began work on a business applications system with wide implications.

Progress to date on the Braillewriter

A feasibility study has been completed, and work has begun on a prototype model. The keyboard design is 80 percent completed and the cost study 90 percent completed. The embosser design is 15 percent toward its goal, and the marketing study is 10 percent completed. We expect that the braillewriter prototype model will exist early in 1982.

We decided at a very early stage that the design of our braillewriter would be such that we could plan to use impaired and/or disabled persons in its manufacture. This decision has caused slight delays in design work, but we believe the time well spent. One consequence will be that the keyboard, embosser and the circuitry will be easy to repair and maintain. Our success in this effort will determine to a large extent whether we meet a low cost criterion.

Progress in Business Applications Systems

Our work in developing the braillewriter has brought us into contact with the range of problems facing persons with a visual impairment in finding employment. We believe that our technologies can help solve some of these problems. The goal is to allow a person to walk into my office and start to work right away. We aim to minimize any special conditions of adaptation, to avoid compromising existing office methods and allow normal procedures to be followed.

The design criteria for the BAS are:

(1) use of the braille code as an input (with easy adaptability to any revisions in the present braille code);

(2) although a knowledge of braille by the user is assumed, neither manual nor automatic transcription of input to braille is required of him or her;

(3) maximum use of interfaces from braille to other standard office machine and devices used today and in future.

We believe that the efficiency of the braille code makes possible superior performance of workers skilled in braille in the office environment if these conditions are met. Some modest experiments have been conducted to compare speed of text processing with braille compared with English ink print input. When six keys were used to braille on a normal keyboard input to stimulate the "soft touch" keyboard, and an operator typed the same material using braille input vs. ordinary ink print input, the simulated braille input speed was equal to or slightly faster on five 3-minute tests. We infer that use of braille as an input medium compares favourably, in principle, with the use of normal language input speeds.

Adaptation of standard high speed office machines is now under active exploration. We believe that a quarter of those now receiving braille training could operate in such adapted business environments; and of the remaining braille using population 20 percent could be marginally qualified to do so. Employment possibilities range from court stenography, simultaneous natural language translation, to Postal Service, steno pooling and record keeping of all kinds.

It will be no surprise to readers of this journal that communication among developers, users and funding sources must be encouraged to heighten the awareness of the potential impact of new technologies. Widespread understanding of the unique advantages the braille code will help make this possible. We continue to be motivated by the potential in the applications we envisage of the code to a wide variety of text stream applications.

A Note on the RNIB Standard for Giant Dot Braille

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Background

Recently an opportunity arose in the Royal National Institute for the Blind to review the dimensions of the British giant dot braille. We have only one giant dot item which is regularly ordered, and its plates had become too worn for use: they were prepared forty years ago, and meanwhile the stereotyper used to prepare them had been 'cannibalised' for other machines. A new one was therefore needed.

No information had been left about the design of the original. We had no dimensions to go on except those derived from samples of the braille. These appeared to be:

vertical spacing between dots within the cell	.125 inches
horizontal interdot spacing within the cell	.125 inches
horizontal character pitch (dot 1 to dot 1)	.385 inches

Testing Specifications

We felt the dimension of .385 was probably, in fact, .375, and generated (by hand) various samples to this specification. One point of interest was that the horizontal dots within a cell appeared closer to the touch than the vertical ones, giving a very high, elongated profile to the cell; the balance was restored when the paper was turned on its side. We attempted to overcome this with a horizontal interdot gap of .150 inches, while keeping the pitch at .375. Even this small adjustment caused reading problems among our braillists and, therefore, we reverted to our original specification.

Although our braillists were very experienced they had little or no contact with giant dot. Problems were most severe where one half of the cell was unoccupied; however, even where both sides of several adjacent cells were more or less occupied, horizontal disorientation occurred. For example, "QL" might be read as "L" followed by "ER" sign.

Ideally we would like to have tested newcomers to both braille and giant dot; but there were none around Braille House and we needed a decision quickly. In addition, such tests would need very careful handling and skills which I do not possess. Finally, the number of readers taking part in the test was small, and the sample only a few words; both were a reflection of the short time available to us.

Final Specification

The final specification is, therefore:

vertical interdot spacing within the cell	.125 inches
horizontal interdot spacing within the cell	.125 inches
horizontal character pitch (dot 1 to dot 1)	.375 inches
vertical line pitch (dot 1 to dot 1)	.750 inches
base diameter of dot	.093 inches
dot height (approximate mean)	.027 inches

We are not suggesting that this is ideal, but so far as we can ascertain this is the first time that specifications for giant dot have been published.

Meanwhile, we feel that there is a definite need for research in this area to establish the ideal dimensions not only for giant dot, but also for small character braille - not least because of their relevance to elderly blind people and blind children respectively. In fact a study to determine the ideal dimensions for normal braille would not be amiss.

Acknowledgment

I should like to acknowledge the part played in this work by Mr E. Scutt, who not only initiated the work, but carried out all the engineering concerned with it. Although the need to complete the stereotyper was urgent, he showed great patience and understanding in his keennes to get it right.

Recent Publications

Tactual Perception: A Sourcebook

Edited by W. Schiff and E. Foulke, Cambridge University Press, ISBN 0 521 24095 6, 1982, 465 pp.

This volume draws together the threads of many studies, both historical and recent, to present the first systematic overview of current knowledge about tactual-haptic perception. Tactual graphics, the perception of speech via the skin and the written word via braille, the production and perception of drawings by the blind, and the social significance of touch are among the topics addressed by the chapter authors.

A CAM System for Tactile Graphics for Visually Impaired

by P. Fries, Department of Highway Engineering, Chalmers University of Technology, Gothenburg, Sweden, 1982.

This report describes the development of a computer-assisted system for the production of tactile graphics for the visually impaired. The programs are written in Basic. The report is in Swedish with a summary in English.

Microcomputer-based Aids for the Disabled

by J.M. Schofield, Heyden & Son, ISBN 0 85501 700 7, 1981, 116 pp.

The material in this book was originally written as a PhD thesis at Hatfield Polytechnic. The book concentrates on MAVIS (Microprocessor-driven Audio/Visual Information System) developed at the National Physical Laboratory.