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edited by

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Editorial

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A Rite of Passage

Readers of this Newsletter may well have noted that the tone of editorial statements has varied in past issues between the personal and the disinterested. I beg leave in this statement to return to the former mode, not least because I introduce, rather immodestly, an issue comprised largely of my own text. In addition, I am offered as well an opportunity to note something of a shift (no direction defined!) in my professional career and professional identification, which may also be of interest to some. In any case, I shall have to leave the appropriate trail so that readers of this issue can identify a venue for attack on the ideas expressed!

At the end of 1978 my long association with the American Foundation for the Blind was ended. I decided to accept a position as Director of Communications of the National Council for Homemaker-Home Health Aides Services, Inc., 67 Irving Place, New York, New York 10003 (212 674 4900). My specific interest in the area of blindness impairment will be continued through my academic appointment at the Department of Statistics (Educational Computer Center-Computer Center for the Visually Impaired) at Baruch College, 17 Lexington Avenue, New York, New York.

The principal content of this issue is devoted to a systematic analysis of braille, in its use, in training for its use, its deployment, and its role into the future. I was brought to write it by the realisation that unless current trends in its utilisation were somehow checked, if not reversed, its importance would gradually decline and fade. Such surely will be the case if the benign, if not studied, neglect of the medium continues at its present rate.

Oxford University has acquired over the centuries the sobriquet of "The Home of Lost Causes". Such need not be the fate of the braille houses and the publics they serve. Indeed, there are several indicators that encourage us to think that now, uniquely in the history of braille usage, there is knowledge accumulating that will allow particularly effective expansion of its use. Among these indicators I can mention the following:

The existence of this Newsletter is based on the burgeoning, and focussed, interest of technologists, braille specialists, educators, and organisational management in transferring the benefits of research to braille deployment and use;

The work of psychologists, educators, editors, and engineers in exploring the possibilities for simplification of the rules of braille will make it easier to learn and easier to write, while maintaining the potency of braille as a primary mode of literacy for the congenitally blind;

The proliferation of translating languages, and the availability of relatively error-free tapes from photocompositors, implies a tremendous potential for incrementing the access by the blind braille reader to the same kinds and variety of published material that the sighted enjoy;

The proliferation of small, portable, and decreasingly expensive braille recorders and reproducers, including refreshable braille displays, and based on digitally encoded material, implies the increasing potential for the use of braille in school and work environments;

> The forthcoming development of cheaper methods of making large-scale braille press runs will defuse current concerns over the escalating cost of press production and release braille material to meet the crest of forthcoming demand in an economically viable way. As our French colleagues put it, "Appetite comes with the eating".

The current issue is published in the hope that the dialogue on these matters, so far confined to a few managers and knowledgeable users, can be opened up to a much wider and inventive audience - in effect, to escalate the concern with the issues raised on both the national and international level. Braille has had a certain sacrosanct quality about it in years gone by; and although one may express a certain regret for the loss of innocence that comes with the realisation of knowledge about the creation of an icon, it is perhaps healthy in the long run for both users and administrators to realise that what happens to braille is really a vital and personal concern; and that the expression of their interest can make a difference in its future. Stated differently, it is to be hoped that the impertinence of the issues raised in this discussion of braille may arouse others to discuss them; to disagree even violently with the analysis made of them; and thereby refine the discussion of issues related to braille in new and more sophisticated ways.

Toward this end, we solicit discussion from readers of this issue. Comment will be published in forthcoming Newsletters from readers. Hopefully, when enough comment has been made, some author will be charged with the revision of the analysis presented here, so that it represents not only a concensus on the present state of braille, but the ways in which it can be enhanced in the future.

In taking my leave of the Newsletter, I wish to thank my co-editor for his patience and intelligent concern over his colleague's forgetfulness of deadlines. I should also like to thank our authors, who have laboured hard and well to make this publication a vehicle for the latest and best thinking in the application of research to meeting real human needs. I have had rewards well beyond my own investment of time and effort in my association with this enterprise; and I have no doubt that the future will mark this publication as one of the positive forces for useful change in the field.

The Future of Braille

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For more than a century, the significance of braille has been reinforced and emphasised by every organisation serving the blind. Its importance as a primary medium of achieving literacy and its capacity to provide random access to reference information were established early. This was strongly reinforced by the two major causes of blindness - congenital blindness and industrial accidents - which at the turn of the century established the twin foci of the blindness rehabilitation community: the educable young and the employable adult.

Today the situation has altered. Talking books and synthetic speech systems are becoming primary sources of information. Furthermore, the proportion of blind and visually impaired has changed: there are more persons with low vision who do not require braille, more elderly who do not seem to want it, and more adults who do not use it. These changes have been accelerated by radical increases in the cost of producing and deploying braille. In an ever more cost-conscious society, the federal government is searching for ways to limit expenditures for materials of uncertain usefulness and effectiveness, and volunteer producers are looking for even more extensive methods of subsidising product at a price that state agencies are willing and able to pay.

A variety of traditional approaches have been engaged to find solutions to the complicated problems of providing braille material. (1) For the past 15 or 20 years, the primary emphasis has been technological innovation, and the pace of technological development increases steadily.

The primary challenges to braille are the talking book and, potentially, synthetic speech. But the talking book is basically a passive medium; it does not require the

learner's active participation in the same way that braille or ink print does.

Synthetic speech offers attractive possibilities for generating easily understood output from machine-readable sources, and its rate of presentation, like that of natural speech, is more than double the rate achieved by the average braille reader. Yet the periods of enjoyable listening it provides may be limited because of the relatively monotonous quality of the output. Furthermore, the current design of equipment for converting ink print to synthetic speech (e.g. the Kurzweil Reading Machine) requires manipulations that result in net reading speeds that are only slightly higher than those achieved with braille. (Average rates for both mediums range between 80 and 100 words per minute.) Finally, the current price of this equipment is prohibitive: for instance, the Kurzweil machine costs $20,000, and even its proposed cost of $5,000 will probably preclude its mass adoption as a personal mode of reading unless major federal subsidies are forthcoming. (2)

Recent research indicates that long-term use of synthetic speech may cause additional difficulties. (3) Because normal speech contains much redundancy of the information-carrying elements of the speech signal, it is extremely resistant to interference. The classic illustration of this is the so-called "cocktail party effect", in which one can concentrate on a single voice in a hubbub of voices and understand what the individual is saying. Because the amount of redundancy in synthetic speech is inherently low, the listener must pay greater attention to the speech signal. Moreover, the lack of redundancy places a greater burden on short-term memory. Thus errors in comprehension accumulate in short-term memory, and the intelligibility of the speech stream may decline after a person listens for long periods.

For these and other reasons, braille remains an important medium of communication and is a primary medium through

which the blind achieve literacy. As a method of random access, it is unequalled for reference material and for rapid recall of previously read material. Yet, the use of braille has been declining. The main reason for this decline has not been technical but one that is best characterised as benign neglect. One possible end result of this neglect - gradual deterioration of the braille production and deployment system for the small hard core of some 30,000 to 60,000 users - is viewed in this article as an unsatisfactory outcome.

Much of the discussion that follows implies that if more braille materials were available, the use of braille would increase. Similarly, if braille was easier to learn, was taught better, and was supported by technological innovation, it would penetrate the everyday world of work and leisure and its use would increase. Are these assumptions valid? Little evidence exists to confirm or disconfirm them. By analogy, one might inquire whether the sighted have been reading more since speed reading techniques were introduced.

Decline in Readership

Among the congenitally blind, the percentage who use braille may be as high as 90 percent. For example, braille remains an important medium of instruction for the 25,000 blind students in the United States. But among the 1.7 million Americans of all ages who cannot see well enough to read ordinary ink print, this is not the case. A nationwide survey of severely visually impaired persons conducted by the American Foundation for the Blind (AFB), under contract to the Library of Congress, found that only 3 or 4 percent of those who learned braille at some time on their lives continued to use it. (4) There is also evidence that adventitiously blinded adults who learned braille in rehabilitation centres (where braille is routinely taught) seldom use it: indeed, many use it only for making brief notes, labelling tin cans, or identifying clothing rather than for vocational or recreational reading. (5)

Over the past five years, the number of individuals who use the Library of Congress braille book program has increased by about 20 percent (or an average of 4 percent each year). But the number of persons who use talking books and other audio materials has grown by about 20 percent each year over the same period. (6) The number of young braille readers registered with the American Printing House for the Blind, which produces textbooks and other educational materials in braille, has also declined slightly each year. (7) At best, one can say that the number of braille readers has reached a plateau. In view of the increased population of blind and visually impaired and individuals who use talking books, however, braille readership has declined.

There are two main reasons for this decline: one is concrete; the other, abstract. First, because of radical increases in the cost of paper, labour, and distribution, the cost of producing braille has risen sharply, and the main purchaser of braille, the federal government, is becoming more and more cost conscious. Second, a combination of factors has culminated in the view that braille is a dying cause. As a result, actions that would enhance the availability of braille, ensure the competence of both teachers and learners, and increase the value of braille for personal and vocational use are delayed.

Uncertain Market and Lack of Availability

Several problems related to the availability of braille may stem from ignorance of the real and potential market for braille. For example, there is no assurance, beyond the acceptance of materials now available, that what the braille production system is delivering is in fact what readers want. What they probably want is a mix of press and short-run braille, of changing as well as reference information, of textbooks and books read for pleasure, of material they are willing to pay for and material they cannot afford (as in the case of some on-the-job manuals).

The current braille production system cannot keep up with the ink print publications issued each year. Although estimates vary, only 300 to 400 titles among the 40,000 or so published each year in English are issued in braille. If titles issued in talking-book form are added, the total is about 1,200 to 1,300 titles. Access to ink print literature is increased by a small, unknown amount with aids such as the Optacon reading aid (Telesensory Systems, Inc.) and the Kurzweil Reading Machine. But the contribution to the blind person's access to ink print with all these aids is minor and is likely to remain so until additional technical breakthroughs occur in optical character reading and in microcomputers. (As mentioned earlier, the so-called reading machines may create a different set of problems; consequently they deserve careful and detailed examination.)

The unavailability of timely information in braille probably reduces the motivation of the blind to master braille to a significant degree. The primary gaps in braille materials are usually discussed in terms of non-job-related ink print publications found on sale at newsstands or bookstores. But the problem is also critical in relation to the specialised needs of blind professionals. For example, the lawyer must have ready access to briefs and court decisions. The computer analyst or computer scientist must have access to new code manuals and user manuals. The blind psychologist must keep abreast of experiments and programs in his special area of interest. The electrical engineer must keep up with the latest circuit designs and components. Unable to locate this information in the mass of published materials, these professionals are forced to depend on sighted persons as readers and scanners, and unlike sighted professionals, they cannot rely on abstract services.

Pilot projects mounted in England to supply monthly abstracts in engineering, computer science, and other professions have been greeted with enthusiasm. (8) Each user submits a profile of his interests, which is then used to identify and print out abstracts each month that match those interests. Print-outs in braille are obtained by

feeding the digital tapes used to produce ink print output into a braille translator and a high speed embosser. These print-outs contain minor departures from braille standards and have been supplied free during the trial phase. So far, the number of users has been small - about 20 in the United States and 20 in the United Kingdom. Although the market for this service is not well defined, there may be 1,000 to 3,000 persons for whom braille abstract services would be relevant.

In the case of blind computer programmers and systems analysts, the availability of translation programs and embossing devices has made job advancement possible. Furthermore, the availability of embossers that can be linked to computer outputs for hard copy have made it feasible for the blind to obtain jobs such as tax information officer with the Internal Revenue Service.

The ordinary citizen fares no better than do most professionals. Although his bank statements may be written in braille, he is unlikely to receive his bills in braille. Occasionally, he may find a restaurant that prints its menus in braille, but rarely will he find information about cultural events, transit systems, public services, and government buildings and services written in braille. Remedies for this situation are not easy to come by because the market is small.

Finally, among the most tragic victims of the unavailability of braille is the student who must wait for textbooks for months or even years after his sighted classmates receive their ink print versions. If textbooks in braille were provided simultaneously with ink print versions, blind students might perform as well as their sighted classmates. The evidence, however, is argumentative. (9)

Uneven Quality of Instruction

Research in education, the psychology of learning, and the art of communication have indicated overwhelmingly

that individuals can learn symbol systems such as foreign languages, typing, stenography, and Morse code with relatively little difficulty - if they are motivated. Most of these systems are probably as difficult to learn as braille, or even more difficult to learn. It is also true that a broad relationship exists between skill and intelligence. But supportive measures, such as review texts and programmed learning techniques for learning languages and codes are more highly developed. Finally, when perfected, these symbol systems often yield salable skills. From the viewpoint of sheer learning, however, self-fulfilling prophesies are intimately involved: i.e., if people expect a skill to be difficult to learn, the skill will be difficult to learn.

Over the past few years, the place of braille instruction in the blind child's curriculum has been de-emphasised. This has occurred as residential schools - which, until recently, were attended by most blind children who had no additional impairments, declined in importance. Now taught in sighted classes, the blind child is immersed in an environment where most teachers, classmates, and other significant persons do not share his need for information in braille and thus may devalue it. This learning environment demands increasingly greater use of the spoken word, including sighted readers, special tape recordings, and talking books. Although first and second graders receive instruction in braille for about an hour each day, five days a week, older students usually are not given regular instruction during the school day. Instead, itinerant teachers instruct them in school resource rooms, generally for about two to four hours a week, and maintain and support the reading skill achieved in the first two grades (when reading speed is approximately 30 to 40 words per minute). In subsequent grades, increases in speed accrue from the same processes of practice and overlearning that are involved in learning to read ink print. According to most authorities, the average reading rate among blind ninth graders is 90 to 100 words per minute. (10)

Students are provided with approximately five to ten textbooks in braille each year. The majority come from volunteer sources. Exceptions are the basic reading texts and textbooks supplied by the American Printing House for the Blind, which remain unchanged from year to year. Talking books, normally containing recreational material, do not figure significantly in the normal school environment. For high school, college, and graduate students, books on cassette tapes or flexible discs are available through Recording for the Blind, Inc.

According to anecdotal evidence obtained from skilled teachers of braille, the relatively poor performance in braille of today's blind students - which reduces their motivation to use braille during and after school hours - results either from poor teaching methods or from inadequate time spent on instruction. Poor methods of teaching may be compounded by ineffectual organisation of the teaching of braille. In fact, organisational issues may be more important than are technical concerns, such as the best way to teach specific skills. Even the best methods will fail when staff and administration are not oriented toward common goals.

Similar problems occur in the teaching of the adventitiously blinded adult. Indeed, few adults who receive instruction in braille probably learn it well enough to use it for anything but note-taking and labelling. Anecdotal evidence tends to confirm this suspicion. Granted, the blinded adult's motivation to learn braille is critical. When braille will help restore or reconstruct their work and family life, blinded adults will learn it. In the meantime, however, pressure increases to curtail training in braille among adult rehabilitants.

There are 40 comprehensive rehabilitation centres, all of which teach braille. (Not every state operates a comprehensive training centre program.) All these centres have at least one teacher on staff: the largest have two or more; Arkansas Enterprises for the Blind, one of the largest,

has six. There are perhaps 60 teachers in these rehabilitation centres in total. Many small programs, such as the day programs in Florida, also provide instruction in braille. This brings the total number of braille teachers to about 200. Instruction is provided by these centres for periods varying between six and nine months. Most use the "Standard Braille Series", Books I, II, and III, but there seems to be widespread dissatisfaction with this text. Alternative methods of teaching braille have been developed by Stocker in Kansas and Bankovics in Minnesota, among others. (11) Some methods emphasise the recognition of braille dot by dot; the majority concentrate on recognition of characters and words. None focus on pattern recognition - the meaning of units such as phrases or sentences.

Apparently no universal standards exist, either for teacher competency or for the competency of students. Yet 40 or more clients are often taught at one time in the largest rehabilitation centres. Because most centres are funded locally within states, the wide variation in standards is not surprising. (Excellent instruction is provided in some large centres and in regional centres of the Veterans Administration.)

Generally speaking, the rehabilitation and special education teachers now emerging from universities and other training institutions seem ill-prepared to teach braille. The result is a lack of motivation among students to learn it. Compounding this lack of standards are the low financial rewards for teachers learning braille and the secondary role it is assigned in special education and in rehabilitation. In contrast to teachers of sign language, who are regarded as skilled specialists, teachers of braille apparently do not involve themselves in transcribing or reading braille. Instead, they view themselves as carriers of a strange code for reading and writing that has little relevance to the spoken language.

Little has been done to develop methods of teaching braille that complement mainstreaming or rehabilitation effectively. For example, segmented teaching, or the breaking down of teaching units so that braille skills are acquired step by step in reading and writing to motivate students is rarely used. Nor has programmed instruction ever had much impact on the teaching of braille. Because, other things being equal, skill in braille seems closely linked to intelligence, more effort should be devoted to matching rote learning, programmed methods, and expectation of success to the capacities of students and adults.

One final problem: A recent estimate from the Bureau for the Education of the Visually Handicapped, U.S. Office of Education, holds that 300 teachers of braille are needed immediately and that several thousand more will be needed in the next several years. What will they teach?

According to conventional wisdom, individual needs and capabilities are so varied that teachers must craft an individualised method for each student, drawing a mix from the available repertory. Sensitive and creative teachers, who surely ought to be rewarded by success in matching a student's capabilities with the desired outcome of making reading interesting, easy, and pleasant will probably spend much of their energy trying to decide which method is most effective. Yet no one method seems better than the others, nor is there any combination of current methods that seems best. One reason is that each new method of teaching which has appeared over the past few decades has been the object of claims for increased speed and accuracy in reading braille. In reality, however, these claims are supported only by exceptional students who seem to achieve no matter what method of instruction is employed. This phenomenon is illustrated best by the recent enthusiasm for teaching speed-reading in braille, using techniques adapted from teaching speed reading to the sighted. As Spungin recently pointed out, the main reason for large increases in reading speed may be that many blind individuals who participate in these programs may have had, for the first time,

information on specific braille reading techniques, and an actual step-by-step method to follow. (12) In other words, their reading speed was likely to increase, regardless of the method used. The clear inference is that increases are a function of good teaching.

Therefore, good teaching will depend on knowledge of the processes and conditions under which optimal instruction occurs. Olsen has outlined a method of instruction that incorporates past and present research. (13) Her conceptual framework calls for the following: (1) changing students' attitudes toward reading, (2) improving the coordination of their hand movements, (3) optimising return sweeps and page turning, (4) increasing the sensitivity of their fingers, (5) expanding their tactual-perceptual window, (6) reducing their lip movements and subvocalisations, (7) eliminating their regressive hand movements, (8) increasing their concentration and comprehension by using contextual and structural cues, (9) helping them develop flexibility in reading rate and (10) establishing rate and comprehension goals to increase their reading speed.

Although it may appear that a disproportionate amount of attention has been devoted here to the teaching of braille, this attention is merited by the fact that the potential user's attitudes toward the medium are shaped by the teacher. Consequently, creating an environment in which ease of learning and enjoyment of skill can occur sets the stage for interest in making currently available braille materials more accessible and in establishing a demand for increased production and availability in the future. The current teaching environment for braille, especially in the mainstreaming situation, relies heavily on the notion that there are similarities in ink print and braille reading. Yet the differences, stemming from the special characteristics of the braille medium (dual spelling of words; use of symbols in multiple ways; confusion arising from lower-cell, one-cell, and two-cell signs and contractions; positioning of cells within a phrase or sentence; and the nonphonetic nature of the code) may

frustrate nonspecialists' attempts to use braille. New knowledge will minimise the effect of these differences, make instruction more efficient, increase the motivation of both teachers and students to achieve competence, and, it is hoped, alter public attitudes about the medium.

Mismatch Between Production and Markets

Textbooks represent approximately 80 percent of the braille materials produced in the United States; the majority of these are still produced manually using braille writers and vacuum-forming duplication systems. Preparation of stereograph plates is almost entirely manual, and most long-run materials are produced on ancient rotary and flatbed presses. Even the small percentage of computer-assisted systems require relatively large amounts of human intervention to assure a product that conforms closely to the rules of braille transcription and format. Add to this the fact that the cost of paper has increased fourfold over the past few years and it is not surprising that placing orders for large press runs has become more and more difficult.

The relative absence of computer-assisted production systems is in part related to the slow diffusion of technological information since the 1960s. Most braille presses, however, are ill-prepared to use computer technology to an optimal degree. Typical of computer applications in general, lack of standardisation is the rule rather than the exception among the few presses that now use computer-assisted production methods. The computer programs used for translation, the input media, and methods of editing and proofreading braille are different from those used to produce ink print material. Although advances in stereotype plate-making from digital tapes or punched paper tapes have been made in the United States and West Germany, the high cost of this equipment and uncertainty concerning the flow, magnitude, and continuity of production orders have hampered dissemination of this technology.

It is encouraging to note that the physical plant for braille production is not necessarily inadequate. Together, the five or six major braille producers and a few dozen minor houses have about 50 presses. The age of a press is not necessarily a drawback since studies indicate that the tolerance for these machines, adapted from container folding systems, are far greater than those for which they were originally designed. (14) They are also mechanically simple. The major difficulty is that braille production is labour intensive - from capturing keystrokes on a stereotyper, loading the plates on the press, and pulling the embossed copy from the press, to stacking the copy for stapling, stapling and binding it, and shipping it out. These operations consume a tremendous amount of time. As mentioned earlier, in comparison to the flood of ink print, the number of titles published in braille is small. A more serious consequence, however, is the chronic delay of textbooks, especially for blind students who attend regular schools. In addition, production costs remain high because the economies made possible by automation are compromised.

Thus a system that must strain to meet the needs of its primary audience, school children, has neither the resources nor the time to consider special groups such as diabetics and the aged, whose tactual sensitivity is typically less than normal and who might benefit from "jumbo braille", in which the size of characters is larger than in standard braille. The system is also unable to meet the immediate need of professionals for short runs of material essential to their work or the need of the blind citizen for access to timely information about cultural events, his financial status, and so forth.

Unlike most books that are used in public schools and are available in libraries and bookstores, braille materials are usually paid for by federal and state governments or by church-related groups. Therefore, an examination of the policies and priorities of these bodies in relation to braille is critical to understanding and interpreting the trends. Larger per-copy allowances or increased

subsidies to major producers seems necessary.

Based on informal analyses, Schoof, Maure, and others have concluded that, without subsidies, the cost of producing one volume in braille is about $100 (four braille volumes are equivalent to one 250-page ink print book). (15) When produced by volunteers, each volume costs about $50, including overhead and materials. But the cost of production is inescapably entwined with the decision whether to provide braille in the quantity, variety, and depth that is wanted or needed. Assuming that the results of surveys indicate that most braille materials currently produced, which are oriented toward recreational reading, are what readers want, it is possible to infer that to enhance braille usage, much non-recreational material is called for.

Complexity of the Braille Code

Because braille reading is linearly related to intelligence and few users fully master braille, simplifying its grammar might increase the number of skilled readers. But until fairly recently, changing the rules of braille would have been impossible, except for minor modifications in the code manuals that would allow for difficulties in special areas of knowledge such as mathematics or music. Only within the last decade have any major international efforts been devoted to making braille less complicated.

Any effort to modify the grammar of braille must be understood in the context of the medium's history. In the English-speaking community, agreement about the need for compatible codes was reached in the 1920s, but only after an intense and bitter struggle among competing systems, each having articulate, competent champions among users. Surely this is one reason for the atmosphere of custodianship and protective management of change that characterised the activities of the "authorities" on braille in all countries. It also may explain the lack

of interest in the impact of technology on the deployment of braille over the past two decades.

At present, braille authorities apparently believe that the reader community's need for protection from capricious changes in braille is appreciated and that it is time to discuss changes that will make learning easier; make production faster, cheaper, and adequate in amount; and increase reading speed.

In some instances in some countries, the portal for change may have opened too wide too soon: changes have been made in the braille code that are suited to the needs of the computer but do not ease the task of the reader. Regrets are now being voiced about the lack of technical understanding and lack of control over the use of technology that have resulted in radical revisions in the rules.

The English-speaking community has tried to profit from the experiences of these countries as well as from countries such as the United States, which have not moved quickly enough. Efforts have also been made to bring about some accommodation - between those who seek changes in the code and those who seek to produce it automatically with computer-assisted transcription - concerning the flexibility of a living medium and the consistency of the computer program. Meetings in this atmosphere have been held since 1962 under the auspices of the major presses and universities to discuss the implications of computer-assisted production. Special committees within the Association for Computing Machinery, the World Council for the Welfare of the Blind, the Braille Authority of North America, and several publications are also devoting attention to the problem.

In June 1976, AFB and the Association for Computing Machinery sponsored a meeting that proved to be a milestone in the interaction between braille authorities and the technological community. The proceedings of that meeting demonstrate the open and interested attitude toward meaningfully managed change that marks the 1970s. (16)

Because of growing dissatisfaction with the difficulties of braille, general concern for improving reading efficiency through special techniques such as speed reading, and the growing attention that technologists are paying to the handicapped, Douce and Tobin proposed a comprehensive study of the grammatical rules of braille that would include the following:

1. An analysis of a comprehensive body of textual material in machine-readable form for optimal allocation of symbol codes in braille.

2. The use of a wide range of users and experts in evaluating proposed changes based on this analysis.

3. Statistical studies to assess effects of reduction in the number of rules and of space saving.

4. Careful evaluations of how proposed changes would affect learning time, reading speed, and general acceptability.

5. Iterative use of feedback from these studies to improve proposals and refine experiments and to obtain definitive results that would support or deny the case for modifying the rules of braille. (17)

This effort has received an initial push from the Department of Health and Social Security. But the problem of expanding the scope of inquiry and extending its benefits to more users remains.

Solutions

The following sections describe research and demonstration projects that will aid in solving the problems just described. In addition to an estimate of the funds required to carry out each project, each is ranked according

to its relative priority: 1 = highest priority, 2 = medium priority, 3 = lowest priority. Although all the studies are viewed as important, they are listed, in most instances, according to their priority to indicate the sequence in which they should be conducted.

Change Public Attitudes

Foremost among the methods of changing public attitudes toward braille would be a well-publicised international conference on braille touching on the problems discussed earlier. Many of the studies described throughout the remainder of this article need not, and probably should not be delayed until the conference is held. Indeed, the information generated by these studies would contribute materially to the value of the conference. A second method would involve the publication of a series of articles about the problems of deploying braille. A third would be to involve both producers and consumers of braille in writing federal funding proposals.

1. Hold an international conference on braille (priority 1; cost, $50,000; one-time effort). The entire thrust of this two- or three-day conference would be to produce an intensive working summary containing firm recommendations for action in all areas affecting the future of braille. Whether the conference would result in solutions would, of course, depend on whether the studies described in the remaining pages had been undertaken. Because AFB has sponsored many conferences oriented towards both research and practice, it should be able to organise a successful meeting.

To accomplish the goal of attracting the public's attentions, the conference would include the presentation of commissioned papers on major issues; demonstrations of current practice, proposed practice, and technological innovations; and reviews of evaluative and market studies already underway. In addition, workshops would be conducted on current and future practice, and films and other

graphic exhibits would be presented, and terminal facilities would be available for demonstrating on-line, computer-assisted translation and embossing techniques. During luncheon breaks, those developing new methods and innovative practice methods would have an opportunity to describe their work. Presenters and discussants would represent purchasers, administrators, researchers, producers, consumers, and consumer advocates.

2. Publish a series of articles on braille (priority, 2; cost, $10,000; duration, two years). Several articles about the problems associated with braille have already been published in specialised publications such as the Journal of Visual Impairment and Blindness and the Braille Research Newsletter. To carry this information to a larger public, a series of six to 12 articles, costing about $1,000 each, should be commissioned for publication in more widely read magazines and journals such as Scientific American, Science, the Harvard Educational Review, and Today's Education.

Because these articles could bring the problems to the attention of specialists in education, engineering, and administration, they should not only confront the problems and evaluate proposed solutions but confront difficult questions such as the following: Is braille truly useful? Why?

These articles would not replace studies of the kind described later; they would be based on already-existing literature or on data derived from fresh research. Furthermore, they would be relatively free of jargon and written for nonspecialists in braille.

3. Involve consumers and producers in federal contracts for necessary studies and demonstration projects (priority, 3; cost, $120,000; duration, two years). Solutions to the problems of production and deployment through the mechanism of federal contracts, such as research funding proposals, could be solicited from two groups: producers of braille

and users of braille. For example, producers might be asked to design a new braillewriter that is inexpensive, silent, and portable. In this case, the contract would be let in two stages: first, competition would be encouraged among designers to develop the best model of this device; second, the winning design would be translated into a production engineering and marketing plan.

Another example would be to encourage designers to develop competitive schemes for capturing photocomposition tapes used to produce books and magazines and make the tapes available quickly for short runs of automatically produced braille, synthetic speech, and large print that would attract the interest of special publics within the blind population. This effort could in turn be divided into two stages; a study on the feasibility of using photocomposition tapes from one large publisher and a national plan for the timely capture of the national output of these tapes.

The research funding proposal, or a similar mechanism, could be used to elicit plans from consumers for evaluating braille devices, new methods of production, or alternatives to the standard braille product. One could even consider asking user groups to write the proposals, evaluate the acceptability of changes in the rules and format of braille, hire their own researcher to help them evaluate their findings, and contract for braille material in nonstandard codes.

Define the Market and Enhance Availability

Five studies are proposed here. Because little is known about the market for braille, the first study focuses on defining this market. An initial effort has already been initiated by AFB and Baruch College, City University of New York. But two additional steps are required to obtain more comprehensive data. The focus of the other studies is to enhance the availability of braille by supplying

publishers of textbooks with tapes for conversion to braille, making abstract services available to professionals, providing short-run services in schools, and supporting short-run production by regional centres.

1. Undertake studies of demand (priority, 1; cost, $50,000 - $100,000; duration, 1½ years). Fundamental to understanding the use of braille and to planning for the future are the size and characteristics of the market for braille as well as the market for the allied media of large print and synthetic speech. A joint undertaking by AFB and Baruch College represents a beginning and should result in comprehensive information about the characteristics of readers, their reading behaviour, comparative use of braille and large print, and the areas in which the unavailability of braille is most severe. Telephone interviews will be conducted with 500 or more braille readers drawn from a pool of 12,000 recipients of AFB's braille catalogue, Aids and Appliances for the Blind and Visually Impaired, plus a sample of school-age blind children. The data obtained from this survey will be supplimented by interviews with 500 persons who receive a popular mass-circulation magazine in large print. The costs associated with this study, including direct expenditures and matching volunteered time of academic staff and survey specialists, are being borne by both organisations. (It should be noted that the major federal purchasers of braille have not established ongoing market research programs.)

Because the sample used in the AFB/Baruch study is limited, it may not represent users of braille and large print nationwide. Thus this effort should be supplemented in some way. For example, lists of braille users might be gathered from the Library of Congress, volunteer braillists, braille press houses, and service and consumer groups. Ideally, additional samples of user populations would be taken until the aggregate responses to questions included in the AFB/Baruch survey remained constant as the size of the sample is increased. Here again, interviews could be conducted by telephone (or in person, which might be

preferable but is more expensive).

This effort could be mounted in two steps: (1) interview an additional 500 respondents over 12 months at a cost of between $25,000 and $50,000 and (2) interview another 500 respondents over 18 months at a cost of roughly $50,000 to $100,000. After step 1 was completed, it would be necessary to decide whether the additional information obtained altered the conclusions based on the results of the AFB/ Baruch study and step 1.

2. Let contracts to textbook publishers to prepare tapes for conversion to braille (priority, 1; cost, $20,000; duration, one year). Since most textbooks are prepared from automatic typesetters, contracts could be let to major textbook publishers for preparation of tapes for conversion to braille. For example, with a contract of $20,000, the Houston Educational Computer Centre could purchase duplicate tapes of texts in ink print for one year and convert these tapes to ones capable of driving braille embossers. This experiment could yield data that might justify a continuing program of tape duplication as well as test the premise that braille textbooks can be produced at costs little higher than those of ink print versions.

3. Supply abstract services to professionals (priority, 1; cost $50,000; duration, three years). This study would identify persons with a strong "need to know", subsidise the production of braille abstracts, and seek evaluations from users. When the study was completed, braille versions of abstracts could be produced at cost by contracting with distributors of abstracts for the major data bases involved.

4. Evaluate the effectiveness of providing short-run services in schools (priority, 2; cost, $100,000 - $150,000; two-year trial). Since short-runs (duplication runs of two to 25 copies) of braille copy are produced locally; the local solutions must be sought. The availability of inexpensive computer-translation packages, such as DOTSYS III and COBOL-compatible computer facilities in school systems

as well as relatively inexpensive braille embossers, costing $4,000 to $14,000, depending on speed, make it possible to set up an experimental program for testing the usefulness of local production. (18) Specifically, a pilot project could be set up in six to 12 schools to evaluate the effectiveness of almost simultaneous provision of braille materials for two years in mainstreamed classes. This effort could yield valuable data on how well blind students, perform when they are not deprived of information that is accessible to their sighted classmates.

5. Support short-run production by regional centres (priority, 2; cost, $60,000; one-time grant). Pending development of small local terminals capable of translating ink print to braille, greater dependence must be placed on regional facilities to produce braille versions of ink print material. Regional centres that undertook contracts with transit systems, federal agencies, restaurant chains, banks, and utility companies to provide subway maps, menus, bank statements, and the like in braille could become self-supporting within a few years. Start-up funds to support regional facilities such as the Baruch College Center in New York City would encourage their proliferation. One-time grants of $10,000 to six regional centres would provide an opportunity to test the hypothesis that the need is sufficient to continue these services.

Standardise Criteria for Teacher Competence and Conduct Management Audit

Because most individuals who are capable of reading braille seldom use it and an extremely active minority enthusiastically accept it, it seems prudent to obtain as much information as possible about current teaching practices before making policy decisions that involve funding and are therefore difficult to reverse.

To provide the backdrop for technical studies of teaching methods, two organisational/management audit studies are suggested: one on the school system; the other on the rehabilitation centre system. Data about what is taught, who is teaching, and how effective the instruction is should give a realistic picture of current teaching practices. A second set of studies would focus on the cost structure of teaching braille. A third would focus on process and method (e.g., diagnostic methods, the potential of programmed learned and techniques for increasing speed and comprehension) and the impact of effect of age on the ability to learn braille.

1. Conduct two organisational studies on current teaching practices (priority, 1; cost, $150,000; duration, two years). Two management-audit type studies are needed immediately to survey the syllabi, curriculum and methods of training teachers; determine the degree of their commitment to teaching braille; and measure the competence and skill of teachers placed in schools and rehabilitation centres. In addition, the organisational arrangements for teaching, the number of teachers, and the number of hours of instruction provided would be defined. Both studies would also seek to clarify the administrative context in which teachers teach: i.e., the role of braille in the curriculum and the standards of skill expected from both children and adults.

These studies are needed to establish what is versus what could be if innovative practice was introduced into the teaching of braille - information that is clearly lacking at present. For example, if the degree of skill acquired by adults in rehabilitation centre training programs in braille were established, this information could be used as a benchmark for testing the efficacy of methods of self-instruction such as cassettes- and hard-copy kits, which are now in use in the United Kingdom. (19)

The first study could be conducted at a university, but by faculty who are not involved in training of teachers

in braille, or by a consulting firm with expertise in conducting organisational studies. Its purpose would be to gather information about the student population, currently and over the next few decades; discover and identify the levels of competence that teachers attain during training; determine the optimal number of teachers in relation to pupils; and help define the nature of a core curriculum based on the goal of enhancing competence in braille skills and the creative use of available technologies. This study would cost about $75,000.

The second study would attack the serious issue of whether current training of adventitiously blinded adults in braille is helpful, useful, and cost effective. It would not only focus on the level of competence of teachers and the nature of teaching methods but attempt to evaluate the match between what is taught and what is needed or desired by the majority of blinded adults. Because current practice seems to be relatively ineffective, it will be important to determine whether the current allocation of funds for braille instruction in rehabilitation centres would be better spent on contract services for the few adults who would benefit.

2. Determine the economic structure of braille teaching (priority, 1; cost $25,000; duration, one year). This study might well be subsumed under the organisational/management-audit studies earlier. Its focus would be the economics of different organisational arrangements for teaching braille and the specific levels of competence achieved by students. For example, little is currently known about the cost effectiveness of braille instruction in rehabilitation centres with respect to the level of skill acquired. Furthermore, until more is known about optimal strategies for instructing children, little will be known about the costs of braille instruction in the regular schools.

3. Examine the techniques for optimising the teaching of braille (priority, 2; cost, $150,000; duration, two

years). An investigation of process and method would support and enhance trends toward competence of teachers and students and reduce the variability of performance. First, because detecting and solving problems in reading as they occur reduces learning time and reinforces achievement, good diagnostic tests are critically important. Those incorporated in a series of stepped readers recently published by the American Printing House for the Blind and the Neale Analysis of Reading Ability, recently published in the United Kingdom, offer considerable promise for diagnostic and evaluative use, testing achievement, and identifying problems that impede achievement. (20)

Second, although the potential of machine-assisted, individually paced learning of braille has been documented by several investigators, the lack of suitable, inexpensive equipment until recently has impeded the use of this approach. (21) Thus the forthcoming availability of braille reading machines using digitally encoded braille on cassette tapes provides an important avenue for exploration.

It has long been observed that those who read braille rapidly and with good comprehension use both hands rather than two fingers to scan and follow text. Furthermore, a number of investigators claim that reading speeds can increase up to 1,000 per cent when several braille cells rather than individual cells are used as the basic unit of meaning. (22)

A separate study would concentrate on the influence of age on the ability to learn braille and thus illuminate the factors that affect teaching in rehabilitation centres and clarify the potential market for braille among the "advancing army of the aged" confronting rehabilitation centres.

Introduce Innovative Methods of Production

The uses of recent technological advances to enhance production of braille are limited only by one's imagination. As mentioned earlier, a multistep approach is needed to ameliorate the problems of production and deployment. Such an approach would mean (1) infusing technological advances into existing braille publishing houses, (2) altering the current braille code so that it approximates a "fully programmable" grammar, (3) using machine-readable input to braille translation systems, (4) developing efficient transcription programs that satisfy the standards of the code, and (5) using computer output to generate or set press plates automatically for driving a press braille system, creating digital braille tapes for read-only devices, and providing master tapes used in local multicopy production.

Four of the six studies proposed here deal with methods that hold promise of increasing production at a cost which is comparable to that of the existing system. These studies deal with the use of photocomposition tapes, a microprocessor-based ink print-to-braille translator, mini- and microcomputer-based packages, and the upgrading of flatbed presses.

Because little is known about the comparative costs associated with alternative methods of production and deployment, studies 3 and 4 focus on the impact of several existing and projected technologies. Both are based on alternative assumptions about the market for braille.

1. Investigate the use of photocompositor's tapes (priority, 1; cost, $30,000; duration, one year). This project would involve upgrading a braille press to accept a variety of relatively error-free photocomposition tapes as direct input to a translation program. As a source of already-captured printed materials, compositor's tapes are a valuable means of increasing the range, depth, and variety of braille. In error-free form, these tapes are

now commonly used by book publishers such as Cambridge University Press, and most magazines use them in relatively error-free form. At least one American newspaper is now produced using advanced laser technology, which reduces the ink-printed page to a digitally encoded form while the page mock-up is made in the editorial room. This method, too, is error free and directly applicable to braille production systems as machine-readable input.

Most funds allocated for this project would be spent on developing a set of preprocessor programs to input photocomposition tapes. The remainder would be reserved for equivalent machine-readable input (e.g., on floppy discs) capable of producing test material for replication in other press houses. A press already fitted with a computer-assisted translator, such as the one at National Braille Press, would be a good choice for this project.

The output of braille equivalent can also be used to test the acceptability and pricing of new silk-screen processes (see study 6), which may produce a product that is superior in quality to embossed copy and lower in cost. In addition, the output of braille equivalent can also be recorded in a form usable by current and forthcoming reading machines that accept digitally encoded cassettes of braille text. This approach will help determine the optimal design of these devices based on human factors, length of display, and the like.

2. Develop a microprocessor-based braille production system (priority, 2; cost, $100,000; duration, two years). Microprocessor-based terminals offer great potential for local production of short-run braille in hard copy or refreshable (line or page-at-a-time) displays. This project would be divided into two phases. Phase 1 would focus on developing a "compiler-compiler"-based approach to the translation of braille that is independent of natural language, consequently, an individual who is unfamiliar with the details of the translation program could modify the rules of translation from ink print to braille. When

he identified a contraction error, for example, he could key in the correct translation and the program would automatically modify its translation software.

In phase 2, a complete microprocessor-based "package" would be designed for braille and a limited variety of tactual graphic materials. Holman has suggested an integrated package consisting of a graphic microcomputer - a general-purpose interface buss based on data cartridges or floppy discs and programmed in BASIC. (23) As demonstrated during experimental production of braille and tactual pictures, this system can function in the braille universe and has been used to train teachers in the rudiments of braille. A feasibility study, using blind consumers and Comprehensive Training Employment Act (CETA) programmers, could result in a desktop system capable of producing Grade 1 braille and tactual graphics, with clear specification of the requirements for transient braille displays, for driving hard-copy embossers, for generating synthetic speech, and so on.

The costs of memory in microprocessors will undoubtedly continue to drop. For example, a two-kilobit core plus analog-to-digital converter and an eight-bit (64-word) register are currently available on one ten-dollar chip. With machine-readable versions of ink print as input, it should be possible to develop a video terminal fitted with a microprocessor-based translator for, at most, $500 more than the cost of the terminal alone.

3. Investigate the impact of existing technologies under different conditions (priority, 2; cost, $50,000; duration, one year). This exercise would begin with the current market and might predict a gradual, asymptotic decline in the demand for braille to a size representing the deaf-blind population only. Or it might assume that no changes will occur in current levels of production accuracy defined by the braille code. Or it might assume a modest mix of press runs and short-run document services, with and without changes in the braille code. At one extreme, it might

consider as completely automated a system as possible for a small number of markets.

If contracted for with a prominent marketing research consultant, this study would help guide decisions by pricing alternative strategies of deploying needed braille materials. It would include methods and associated costs of equipment, labour, and amortisation for the range of current methods of producing and distributing braille. It would begin with the use of manual slate and stylus and the Perkins braille-writer master/Thermoform copy system, progress to intermediate machine-assisted systems such as the PCBS (Triformations, Inc.), and end with the computer-assisted systems now in existence (e.g. APH, Duxbury, ARTS, DOTSYS III, and suitable input/output and CPU support systems).

In addition to fixing present costs predicated in all cases on producing a specific number of titles (e.g., 400) in braille, this investigation could provide information that would be useful to potential producers of all braille material, nonrecreational as well as recreational, with regard to time periods for production, the amount of capital investment required, the amount and extent of human labour, and the degree of human intervention in the production process in unsubsidised form.

4. Investigate the impact of innovative technologies (priority, 3; cost, $50,000; duration, one year). This study, a companion to the preceding one, would examine in a similarly structured way the impact of forthcoming technologies on the production of braille, both for press-run and short-run markets. Here, the focus would be projected systems such as laser scanning, multifont optical readers, automatic scanning, and recognition of previously brailled material. It would investigate the potential usefulness of translators such as the one proposed by Portier et al. - a syntax.based linguistic model capable of translating at extremely high speeds at low cost per page but requiring a large general-purpose computer and, for languages other than English, a compiler-compiler

microprocessor system. (23) The study would also examine the effect of the wide availability of microprocessor and integrated-circuit braille-reading and writing devices such as the ELINFA Digi-Cassette, the West German Braillocord and Braillex systems, the "paperless braille" device under development at Telesensory Systems, Inc., and the braille-reading machine produced by Triformations, Inc. Finally, it would assess the cost effectiveness of methods such as the optical-recognition-to-braille-conversion scheme under development at Kurzweil Computer Products. Engineering would be emphasised more heavily in this study than in the preceding one.

5. Examine the usefulness of automatic-press braille systems (priority, 3; cost, $100,000; duration, one year). One attractive alternative to labour-intensive flatbed presses would be the use of resettable computer-controlled stereotype plates that allow pages to be printed in sequence and automatically folded and cut into book form. Stapling could be incorporated into the paper flow system so that the press output would consist of books ready for shipment. With this method, labour costs are radically reduced, and speed of production is comparable to standard methods. According to a feasibility study conducted by Maure in 1976, this system might be cost effective once development was amortised.

6. Evaluate the cost effectiveness and acceptability of silk-screen-based production systems (priority, 3; cost, $100,000; duration, one year). Silk-screen-based production systems, which use methods shared in large measure with standard ink print processes, have been studied for years concerning their adaptability to braille production. Techniques recently developed in the United States, West Germany, and Japan insure high-quality braille, with fixed dots, that is acceptable to readers because of its "feel" and durability. Cost studies conducted by AFB indicate that these processes may be competitive with press runs of all but the largest publications in braille. This study would explore the cost of production and the acceptability

of the product.

Revise the Braille Code

This final proposal involves a collaborative study among representatives of the English-speaking communities to revise the braille code (priority, 2; cost, $150,000; duration, three years). The purpose of the study would be twofold: (1) to simplify the rules and grammar of braille, while retaining the advantages of compactness and speed, so that a larger population could learn the code and (2) to approach the ideal of a fully programmable set of rules and thus make possible faster and cheaper transcription by computer. It would be necessary to conduct this work in stages approximating those outlined by Douce and Tobin.

During stage 1, large bodies of text would be examined in machine-readable form to discover how symbol codes could be allocated to save space. Buckley has suggested using the so-called Brown Corpus, a data base of more than one million words drawn from a variety of sources, and the American Heritage Corpus, a data base of more than five million words drawn from the literature written for 3- to 9-year-olds. To these could be added Weber's and Markson's comprehensive data base covering modern English literature from 1600 to the present.

The emphasis of the stage 2 would be to standardise the signs, formats and contextual rules of braille. Because of their expertise in contriving these original analyses and their sensitivity to the need for consistency, psycholinguists such as Francis and Giannutsos could provide important aid during this stage.

Stage 3, involving the examination of statistical data to assess the effects of number of rules and space saving devices, can be conducted simultaneously with stages 1 and 2.

Steps 4 and 5 would concern proposed changes in the rules of grammar and syntax and evaluation of the effect of these changes on learning time, reading, and writing speed, and acceptability requires a carefully designed detailed experimental design and sensitive interpretation of the results. Among those who have long been interested in the readability of braille are a number of excellent investigators. (24)

Conclusion

The expectations of Americans for equal treatment are among the highest found in any country and in fact have been reinforced by recent changes in public law. An important segment of the reading public (potentially as many as 65,000) are readers of braille. Yet the basic premise of this article is that the use of braille has gradually declined - primarily because of benign neglect.

This article has identified several problems that explain this neglect. Some of these can be solved by generating new knowledge; others may yield to innovative applications of what is already known. But these remedies require a commitment to the current braille-reading public and to a view of braille as an important alternative method of communicating with and among the blind.

The money required to carry out all the activities proposed would be approximately $1.4 million, spread over a three-year period. This represents an investment of about $24 per user, which seems extremely modest since it would not only enrich the leisure of braille users but would most likely open up new job opportunities for them. In other words, the investment is cost-effective to the nation.

What is essential now is some national consideration of how to reverse the current trend - consideration at high levels, with a clear focus on developing a concensus about desirable directions. This author shares the conviction of many of his

colleagues that there is a large, untapped sentiment for a commitment to solving the problems. The article represents one earnest expression of that commitment.

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