The Evolution of Braille:

Can the Past Help Plan the Future?

A three-part article from the Braille Authority of North America

Part 1

Introduction

Braille itself has been instrumental in making possible the integration of blind people into society, and, in turn, this increased integration has driven developments in the use and production of braille. The more integrated that blind people have become, the greater are the demands placed on sources of literacy. Are the literacy tools keeping up?

The purpose of this article is to illuminate the changes in the way braille has been produced and used over the past 50 years and to discuss some of the reasons for and impact of these changes. Clearly there are a number of overarching and complex issues that influence the teaching, learning, and use of braille—teacher shortages, teacher competency, service delivery methods for braille learners, the role of braille in employment, and more. However, this article will focus on the evolution of the communication methods used by braille readers; it will also look at other evolutions that have occurred such as how blind children are educated, the range of available technologies, and the evolution of braille and print.

This article is divided into three parts. Part 1 traces the use of braille as a viable reading medium from the 1960s to the present and takes a close look at how print has changed over the same period. Part 2 discusses the more technical aspects of braille translation, challenges faced by current transcribers of current codes, the need for accurate forward and backward translation with the least amount of human intervention, and the impact of the use of refreshable braille displays. Part 3 discusses the future; it explores the options for change and examines Unified English Braille (UEB) and the Nemeth Uniform Braille System (NUBS) as examples of code unification.

The development of braille and of its use in the United States is a long and fascinating story. The history is well-documented, so it will not be repeated here. This article will begin with a look at the evolution of braille in the United States beginning in the 1960s. First, however, it may be helpful to provide an answer to a frequently asked question: "Print does not change; numbers are numbers, parentheses stay the same, a dollar sign means dollars. So why all this tinkering with our braille?" Let's take a quick tour of the relevant changes that have occurred in print during the last 50 years.

Print Changes

In the early 1960s, print was, believe it or not, quite a different thing from what it is today—not only in terms of its methods of production and distribution, but also in the way it looked. For starters, individuals could produce print either by handwriting or with a mechanical or electric typewriter. Print produced on a typewriter was very symmetrical with rows and columns of characters. The primary tool available for showing emphasis was underlining. In 1961, the first IBM Selectric typewriters had a rotating typeball that could be changed in mid-document, allowing, for the first time, different fonts in the same document. This meant that individuals could produce a document with bold or italicized text, and they began to do so with abandon. Still, symbols that could be represented by typing were limited. If one wanted to place an accent mark over a letter, such as in the word resumé, it had to be done by backspacing over the final e and using an extra keystroke. Multiple copies could only be made using carbon paper or mimeograph machines, and, if a print document could not be hand delivered to its intended recipient, it had to be sent in the mail.

Color and graphics could only be produced by professional printers or publishers using expensive and complex methods, and they were not used in the same way we see today. Classroom textbooks were generally full of text, which was usually meant to be read straight across a column or page.

Beginning in the 1980s, people began to have computers and printers in their homes. At first, the printers created text much as typewriters did—columns and rows. In fact, a common kind of printer at this time was the "daisy wheel" printer, with technology not much ahead of the Selectric typewriter. The daisy wheel had a spinning sunburst of petals, each with a character on its end, and only characters available on that wheel could be printed. Copy machines improved and fax machines became common, so it was easier to reproduce and distribute print documents. Still, although floppy disks for computers could be hand delivered or mailed, paper was key in the distribution of print. Print began to show variations of font and style. Creativity abounded, and people were continually looking for ways to make the print appear “more attractive” to readers.

By the 1990s, the world of print was evolving at a tremendous rate. With laser printers, personal computer users were able to print complex text with multiple character sizes and various fonts and styles on a page. It was even possible for a person to create an entirely new print character if the current range of characters did not happen to include what was needed. People liked what they saw, and the vast varieties of possible print continued to expand. Color print was at first quite expensive for individuals to produce, but became more economical with the introduction of the inkjet printer.

As the possibilities have expanded, the nature of print on a page has become more and more non-linear and with an extensive use of graphics. Today, both K-12 and higher-education textbooks are full of photographs, diagrams, charts, graphs, boxes, and sidebars presented for visual appeal, and the content necessary to convey the meaning is displayed in a variety of layouts and arrangements on a page. Because technology is so much a part of the daily life of people of all walks of life, the boundaries between what is "technical material" and what is purely literary are increasingly blurred—web addresses, symbols that stand for letters, and even mathematical equations can frequently be found in everyday books and magazines.

Often, written documents never even make it to paper; rather, they are presented and read using computer screens, cell phones, or other electronic devices specifically meant for on-screen reading. For example, in 2008, the Colorado Community College system announced that students could access all their textbooks online for a flat fee. Online textbooks have the advantage of including hyperlinks, definitions, links to additional information, interactive graphics, and much more. Classroom settings in general are much, much more computer-based. Gone are the days of a teacher writing on a chalk board—the teaching demonstrations, the assignments, even the tests are increasingly conducted in an online forum.

Print conventions have changed. For example, there are now many styles of enclosure symbols like parentheses—brackets, curly braces, and angle brackets. Bulleted lists are ubiquitous. Changing technology has made it easier to change font, color, and print size—even within the same sentence—and brought new words into our language, spelled in new ways with capital letters and periods in the middle of words. Plus signs, dollar signs, trademark and copyright symbols, @ signs standing for letters, question marks with spaces on either side run rampant, not just through text messages, but all through everyday magazines and newspapers.

Braille Changes

Before the 1960s, blind children were usually educated in completely separate settings from sighted children, mostly in residential schools for the blind. The main source of leisure reading materials in braille was the Library of Congress. Educational materials were brailled mostly by a few braille publishing houses, using human braille transcribers who wrote each and every word of the material into braille; the number of titles that needed to be transcribed was limited by the fact that blind children attended only a relatively few schools. Most of the teachers who worked with blind students knew how to read braille, and, therefore, could comfortably create braille materials and did not need to rely on a print copy to read the students' materials. Print page numbers were not generally shown in braille books. Outside of the braille publishing houses or schools for the blind with access to braille presses, transcribers could only produce braille by hand, either using a Perkins braillewriter or a slate and stylus. Multiple copies of a document could be produced only using a thermoform machine, which was an expensive and laborious process.

The literary and the mathematics braille codes had generally been developed and then evolved with an eye toward saving space; for example, in order to use fewer cells, the percent sign and units of measurement such as "cup" were always brailled before the number, regardless of the order in print. Part of the role of the braille transcriber was to make the judgment calls that were sometimes needed to decide how to transcribe a given symbol. To save space and use less paper, it was common practice to divide words between lines when there was room for part of a word at the end of a line. This practice required time-consuming consultation of a dictionary to ensure that proper division occurred, and saving space and paper was more valued than saving time. The code for rendering mathematics in braille changed several times during the first half of the twentieth century, and, by 1972, the *Nemeth Code for Science and Mathematics Notation* was the standard.

If a blind person needed to produce something in print, the person either used a manual typewriter, often having written the material in braille first, or dictated the material to a sighted individual to handwrite or type. Reading braille always meant reading from hard copy—primarily paper but also on thermoform plastic.

Many factors in the blindness field began to change in the 1970s. In the educational arena, Public Law 94-142 provided that blind children should be educated in the “least restrictive environment.” An increasing number of blind children had already begun to be educated in the public schools rather than in specialized schools for the blind, and the law accelerated the trend. This shift required many more titles to be transcribed because not every school used the same textbooks, even within the same state, and this led to an increased need for braille transcribers.

The organization responsible for developing the braille code had changed in composition and in name numerous times over the preceding century. In 1976 this group became known as the Braille Authority of North America (BANA), and it included national consumer organizations, braille producers, the Library of Congress, transcribing organizations, and others. While continuing to fine-tune the literary braille code, in the late ‘70s, BANA developed a system that included print page numbers in braille books so that mainstreamed blind students could follow along with the rest of their print-reading class. The system included additional symbols and formats not covered in the literary code, but needed for the meaningful transcription of textbooks used in mainstreamed classroom settings.

To some extent the braille code moved away from specialized practices, such as inserting apostrophes in braille where none existed in print, and more toward giving the reader an accurate representation of print. Library books, magazines, and the like were still transcribed using the literary code. The textbook code was substantially updated in 1997 and is now known as *Braille Formats: Guidelines for Print to Braille Transcription* and numerous conflicts between the literary braille code and braille formats still exist today.

Literary braille provides only one way to indicate a change in font showing emphasis. The one indicator, the italic sign, has to represent italic, boldface, underlined, or colored type. The *Formats* guidelines allow for italic, boldface, and various colors. These are needed when a textbook gives an instruction such as: “Copy the new vocabulary words (shown in italic type) into your notebook and study the review words (shown in boldface type).”

The literary braille code instructs the transcriber to substitute a word for symbols such as + (the plus sign), - (the minus sign), and < (greater than) that are shown in print. *Braille Formats* has braille characters to use for many such print symbols. For example, in a sentence such as "John + Mary = True Love," *Braille Formats* would use symbols similar to but not exactly like those in the Nemeth Code. If literary braille is followed, words "plus" and "equals" would be used for the print symbols. (Part two of this article will discuss the conflicts that can arise when symbols from different BANA codes are considered for adoption into literary braille.)

Print textbooks make use of a variety of enclosure symbols, including parentheses, square brackets, curly brackets (also referred to as braces), angle brackets, and enlarged versions of all of these symbols. The literary code only provides for parentheses and square brackets. *Braille Formats* adds curly braces and angle brackets. In some texts, it is critical for students to know what enclosure symbol is shown in print. Mainstreamed students and employed blind people are expected to be able to produce print similar to that of fellow students or colleagues at work. Their textbooks need to help them prepare for this.

Additionally, to try to ensure greater clarity in the representation of computer-related material that was becoming more prevalent, BANA developed a specific computer braille code. While this made computer programming easier for braille readers, it added a new set of symbols. For even the most casual braille reader of general literary material, symbols from this code abound today in e-mail addresses, web sites, and even the name of common companies such as Amazon.com.

In the 1970s, braille translation software, although still in its infancy, started to become more common, and by the early 1980s, braille embossers were being used by larger organizations. Transcribers could either use six keys on a regular computer to enter the braille by hand or they could insert special codes into a print document to produce the proper formatting. Embossers provided an easier way to make multiple copies, but still, reading braille meant reading hard copy. Electronic braille displays had started to arrive, but they were mostly incorporated into stand-alone products that did not interface with mainstream devices, and most people did not have access to them.

In the late 1970s and the 1980s, the typewriter and the dictation method were still the primary methods for a blind person to produce print. However, in the K-12 education setting, the braille-reading students could often write out their assignments in braille, and then the special education teacher or transcriber would "interline" the braille, i.e., write print above the braille so that the classroom teacher could read it. Most blind students who grew up during this era never had the experience of being able to read directly-written communication from their classmates (no passing messages, no copying class notes), because most of their classmates were print users who did not know braille.

In the late 1980s, speech output became possible on personal computers, but was far from commonplace. Blind people with access to this technology could check and edit their own typing and could share their work by printing it out onto paper. There was still no way to fill out forms or pay bills without using a human reader, and no way to share documents without printing them first.

Beginning in the 1990s, the further proliferation of the personal computer and the rise of the Internet began changing the nature of the interaction of print and braille and drastically increasing blind people's access to written information. Today, all kinds of print-origin documents are more directly available to braille readers. Now, with various combinations of Internet media, speech output, braille displays, scanning and OCR, braille translation software, and braille embossers, blind people can read, in a matter of moments, virtually anything created by anyone—a pop quiz from a classroom teacher, a popular new book that just came out in stores yesterday, a web page created by someone two minutes ago in France. Job applications, registration forms, order forms, and the like are readily available online, and bill statements are available electronically to everyone. Blind people are accessing the exact same material, in the exact same format as their sighted peers. Braille readers utilize technology to render these materials accessible, not a sighted reader or transcriber. Of course, human readers are still the most efficient means of accessing some information, but the need for them is not as great as in times past. Some online material is inaccessible, but it is now easier than ever for blind people to have direct access.

Refreshable braille displays have become more adaptable to mainstream computers, and note-takers with braille displays are common. These devices allow blind people to read directly what was produced in print by others without the need to emboss onto paper or have someone transcribe it. The very same files or messages that sighted peers access by looking at the screen on their computer or device can be accessed by viewing through a braille display—no other intervention required. Although these displays are quite expensive now, they are in the hands of more and more braille readers, and there is no doubt that cheaper production methods will become available. With braille displays, any number of daily newspapers can be read in braille, no waiting required and no elimination of articles because of limited space in a braille publication. When surfing the web with a braille display, blind people can click on a braille cell using a device, and soon there is another page of braille. Hence, an unprecedented level of access to books of all types in braille is now available. The Gutenberg Library, Web-Braille, and Bookshare have made tens of thousands of titles available electronically, and it is now possible to read these books in braille using the technology available. Additionally, as optical character recognition technology has improved and the price of scanners has fallen, an electronic version of any print book is within the braille reader's grasp even if it is four o’clock in the morning, and there is no print reader for miles!

The Future is Now

Today, blind people can communicate in writing with classmates and co-workers with the greatest of ease via e-mail, text message, social media sites, or by simply passing files back and forth using a host of methods. The method of writing is not nearly as tied to the method of reading as it was in the past. For instance, someone can type an e-mail using a device with a refreshable braille display, and the recipient can read it in print on his or her cell phone screen, print it onto paper, etc. Likewise, someone can use a cell phone keypad to enter a text message, and, with the right technology, the recipient can read it in braille. This, of course, means that blind students can now produce assignments for their teachers more independently than ever. They can receive the handouts via e-mail or web page, access them directly in braille, and submit the assignments directly, again via e-mail or web page.

Braille translation software interfaces well with more and more mainstream applications. Braille embossers, now more widely available, can produce reams of paper braille. Because the existing technology makes it possible to produce braille more easily, it is often used in cash-strapped education settings by people who are not necessarily knowledgeable about braille itself. On the other hand, the work of knowledgeable transcribers, still extremely important, can be far more efficient with the use of this technology. Translation software and braille embossers, combined with the ability to scan documents and the availability of electronic source files from publishers, has created the potential to greatly speed the transcription of braille books. Transcribers are now able to invest less time in entering text and more time in preparing the proper structure and format books that will be translated. Greater ease of braille production correlates positively with a greater availability of braille textbooks, even in higher education. Thus, the stage is set for quicker, cheaper braille.

Increased technology has aided braille readers in their methods of braille production as well. Besides using a slate and stylus or a braille typewriter, blind people, too, can use braille translation software with a PC to create braille for embossing. Refreshable display devices allow users to type either in six-key Perkins Brailler style or use a QWERTY keyboard to get either uncontracted or contracted braille.

Rather than being paper-based, braille for work and communication is now mostly electronic-based—original documents can be copied infinitely, manipulated, and customized. The same file, with a few keystrokes, can render a document in uncontracted, contracted, or partially contracted braille; with print page numbers or without them; on narrow or wide paper; and on paper or on a refreshable braille display.

BANA has continued to make minor changes to the braille codes from time to time, most moving braille toward greater similarity with print. For example, the placement of the percent sign and items of measurement was changed to follow print, and symbols such as the copyright and trademark symbol were added. These changes are intended to give the braille reader more accurate information about what is shown in print, and to give the transcriber greater freedom to focus more on issues of formatting the material rather than assuring that each and every word is rendered correctly. Since a human transcriber is not always part of the equation, it becomes increasingly important for our translation software to at least be able to render the words and symbols correctly. That need factors strongly into the code changes as well and will become an increasingly pressing necessity as print continues to evolve.

Since its invention in the early nineteenth century, braille has remained vital to the literacy of people who are blind, and it continues to thrive despite the predictions of some to the contrary. As we have seen, however, until the last 30 years, people who use braille had relatively little direct interaction with print, and read braille that was delivered in a fairly standard way. Now, braille users generally interact directly with print-origin material on a routine basis, and the boundaries between what is in print and what is in braille are becoming virtually nonexistent. In addition, while print has undergone tremendous changes in appearance, delivery, and conventions, the braille code itself has changed relatively little.

We have painted a bit of a rosy picture here about what is possible in theory today with so much access to braille. However, we should make no mistake about it. There are great challenges as well. In the next installment of this article, we will discuss in more detail the workings of BANA; some of the challenges in today's braille production via braille display, translation software, and human transcriber; and the reasons why maintaining the status quo in braille code development in this country will not be a viable option for much longer if braille is to keep up with our changing written language and remain the primary tool for nonvisual literacy.

Part 2

Part one of this article gave an overview of the vast changes that have occurred in both print and braille in the last few decades. This installment provides background on the Braille Authority of North America as well as a glimpse into its deliberations. The article also offers perspectives on the challenges of producing braille today given current codes and current production methods.

The Workings of the Braille Authority of North America

The mission of the Braille Authority of North America (BANA) is to assure literacy for tactile readers through standardization of braille and/or tactile graphics. BANA's purpose is to promote and facilitate the use, teaching, and production of braille. It publishes rules, interprets those rules, and renders opinions pertaining to braille in all existing and future codes. It deals with codes now in existence or to be developed in the future, in collaboration with other countries using English braille. In exercising its function and authority, BANA considers the effects of its decisions on other existing braille codes and formats, the ease of production by various methods, and acceptability to readers.

The board of BANA and all of its committees are made up of educators, transcribers, braille producers, and braille readers. More than 100 people are involved in BANA's work.

As language changes, the need for new ways to represent things in braille continues to raise the need for new symbols and new uses of current symbols. Braille readers need access to the same information as do their print-reading counterparts in this age in which the norms for printed material are evolving rapidly.

Despite the need to respond to the changes in language, making changes in braille is not easy. BANA must deliberate very carefully before making even small changes to braille. It is essential that BANA consider the impact of any changes on readability, "writeability" (that is, how easy it is to write the code using various tools), computability (which refers to how accurately it can be translated and represented electronically), space considerations, familiarity to current braille readers, and so on. There are many goals to balance, and not all of them can be achieved effectively all of the time. The benefits of making any change must be shown to outweigh the drawbacks. For example, when the term and icon for the euro were adopted in Europe in 1995, a braille symbol had to be invented to represent that new print symbol. In 2007, BANA adopted new symbols for copyright and trademark; before that, the practice had been to spell out the word, even though a print symbol was used in the original text. BANA cannot ignore the changing conventions of print without putting braille readers at a significant disadvantage. The current process of "keeping up" has been to add new symbols as they come up, but with each new symbol and each new rule change, more ambiguity and more conflict are being created in braille. An example of this is given later in this article.

The following case provides a look into the workings of one of the BANA technical committees and the process through which decisions are weighed and made. Each technical committee of BANA works on various "charges" regarding changes and clarifications to a particular braille code. The committees work via e-mail and teleconferences, and provide written reports of their progress to the BANA Board for each of its semi-annual meetings. The Literary Braille Technical Committee was working on the seemingly simple task of deciding how to show partial emphasis of a word. Partially emphasized words—that is, using indicators to identify bold or colored print or other font changes—are appearing with increasing frequency in elementary school textbooks, as well as in other materials that include challenging text such as product brand names, mentioned later in this article. The committee's report to the Board in the fall of 2006 included the following informal narrative as an illustration of the process by which the committee members approached this task. Read along and follow their thinking as they attempt to solve this issue:

- First: We decide, following our principles, not to add a hyphen to signal the transition between regular print and italic or fully capitalized print, giving the braille reader more accurate information about the print text. Of course, we all want to do that.

- Second: We decide to use the termination indicator as necessary to end italics or all caps. That looks good. All is going well. This is going to be easy!

- Third: Someone points out that, following these rules, an italic indicator could come before an e, n, s, d, or t, causing confusion between the italicized letter and a contraction.

- Fourth: We then consider the letter sign to fix the problem; no, that won't work. It's not clear to the reader.

- Fifth: OK, we'll require uncontracted braille in partially emphasized words. That's consistent with the current *Braille Formats* guidelines.

- Sixth: That would solve the problem, but how is the reader going to know that this is uncontracted braille? Sometimes a contraction not used early in the word will be a tip-off. Maybe the problem contraction will be the only one. Then the reader may have to stop to think a minute, but, if reasonably well educated, will probably be able to figure it out. It will be even easier if the reader happens to know the rule about use of uncontracted braille in this instance. How often will one find the word "uses" with the final s in italics? I guess, even then, the reader could probably tell whether "uses" or "useless" were intended. Sigh . . . Not a perfect fix—especially in textbooks for children in elementary grades.

- What number are we on now? Well, maybe those hyphens weren't so bad after all. Now, why was it we wanted to get rid of them? Oh, that's right, to give the braille reader accurate information about the print. How about making a symbol meaning "uncontracted braille coming?" That would solve the problem completely! Wow! Let's do it!

- Now what symbol should we use: a. Double letter sign? We could, but then we'd have to change the non-Latin passage indicator. b. Three letter signs? Too long—it will never fly. c. Letter sign followed by dots 2-3? That's kind of nice, but we'll have to be sure we don't want to use the letter sign for out-of-place punctuation. That will take a long time.

- Are we having fun yet? We thought this would be so easy to solve!

Code building is a more challenging task than it first appears; even simple "fixes" become complicated given the complexities of our current codes. The literary braille code was not designed to be "extensible" – that is, there are no clear and specific rules for building and changing symbols in a logical fashion. Right now, every proposed change to the braille code has to be considered individually in an ad hoc fashion.

Current Challenges in Transcription, Translation, and Backtranslation of Braille

As discussed in the first part of this article, braille transcribers often use braille translation software to make their work more efficient. Braille translation software converts the text in an electronic document into characters that can be embossed in braille onto paper or that can be shown on a refreshable braille display. The software is written so that, as much as possible, it follows the rules for correct usage and placement of braille contractions and symbols. While this software can often do a very good job of converting print characters into braille symbols, there are still some situations in which a transcriber must intervene in order to produce accurate and comprehensible braille. Charts and tables, descriptions of pictures, and transcription of spatial arithmetic are some obvious examples. However, there are other instances that may be less obvious. Currently, human intervention is often required for such details as ensuring correct use of single and double quotation marks, proper displaying of acronyms and web addresses, handling of long passages written in all uppercase letters, removing excessive emphasis indication, correct use of dashes and hyphens, to name only a few. The intervention is largely required because the way these items are handled in print can vary greatly from document to document, and the rules for their use are far more restrictive in braille than they are in print. Transcribers may need to follow additional steps to change an electronic file into correct braille in other situations as well, such as changing decorative letters into text because the software does not recognize these images as letters.

A transcriber can produce braille that can be read either on paper or on a refreshable braille display. However, as braille readers gain greater access to refreshable braille displays, the more common scenario is that they are using the displays to read directly from the screens of computers and mobile devices, and no transcriber is involved. Using this "on-the-fly" translation without transcriber intervention, the texts are often displayed incorrectly. Here are three examples:

> Example 1. According to current codes, e-mail addresses should be brailled in Computer Braille Code so that each character in the address is clear to the reader. Yet, when reading in contracted refreshable braille from a computer screen, an e-mail address will display in contracted literary braille, making the characters ambiguous. The user can take steps to view the address with no translation applied, but then the surrounding text is also displayed in uncoded characters.
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> Special symbols often display incorrectly. For example, both the tilde and the caret display as dots 4-5. The underline character displays as dots 4-6, no matter where it is, creating confusion with the print "dot" that appears in virtually every electronic address. These ambiguities can make for garbled translations and incorrect information to the reader.
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> Example 2. There is often a great deal of confusion among single quotation marks, apostrophes, and accent marks. Because of the various ways these symbols are used in print, sometimes inner quotation marks display in refreshable braille as apostrophes (dot 3), and sometimes a mark that is intended as an apostrophe or accent mark is shown as an opening inner quotation mark (dots 6, 2-3-6).
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> Example 3. When the sentence "H_2O = water" is displayed in refreshable braille, the fact that the 2 is subscripted is usually ignored, and the equals sign may display as a full cell. If, as in this example, it is spaced away from the formula, the sentence reads instead as "H2O for water." What's more, the way these situations are handled varies depending upon the screen reader or translation program being used; for instance, some programs simply display the = sign as the word "equals" instead of the symbol. Therefore the braille reader is not getting the same information as the print reader of this text.

Changing print conventions further complicate the job of accurate braille translation. There are situations in which it is unclear how to braille something correctly at all according to the current BANA codes. For example, a dollar sign most often comes at the beginning of a string of numbers, and the braille symbol for the dollar sign in the literary code (dots 2-5-6 when placed before a number sign) seems to have been chosen with the assumption that this would always be the case. Unlike the print dollar sign, the braille symbol is dependent upon its placement for its meaning; in other contexts, dots 2-5-6 has numerous possible meanings. How, then, should we handle the name of the pop music sensation that is pronounced "Kesha," but who uses a dollar sign instead of an *S* in the middle of her name?

According to the literary braille code, an out-of-place dollar sign should be brailled as dot-4, 2-5-6, that is, dot-4 dollar sign. This seems to work when the dollar sign is by itself or when it follows a number or is in a context that refers to currency. Since the dot 4 also can stand for some kind of accent or letter modification and is also used as a “print symbol indicator,” the braille reader might be quite puzzled to have dot 4, dots 2-5-6 turn up in the middle of a person’s name.

For clarity, should the name Ke$ha simply be brailled with an *s* instead of a dollar sign? That solution might work as far as "readability," but it does not provide the braille reader the same information that the print reader has. A transcriber encountering this name may spell it Kesha, but include a transcriber's note indicating that the *s* is shown as a dollar sign in print. Of course, this solution is clear, but it requires the involvement of a transcriber rather than the name automatically and correctly displaying on a braille device.

"But there is an easy fix," the astute braille reader may say. "There is a perfectly good symbol for the dollar sign in the math code—BANA should just use that in the literary code, too!" The dot-4 *s* may work because it is unambiguous, and is associated with the shape of the print dollar sign. However, a change of the literary dollar sign to the one used in the Nemeth Code would require use of different rules from those that apply in the Nemeth code. In the literary code, a number sign is required after the currency symbol if it precedes numbers and the numbers are in the top of the cell. However, in Nemeth code, there would be no number sign following the dollar sign and the numbers are brailled in the lower part of the cell. Even with this approach, consistency still has not been established.

The example above of the out-of-place dollar sign is not an isolated instance. There are countless other examples of words written in ways that make it difficult to apply some of the context-based braille rules developed many decades ago. For example, brand and company names, such as the sports store *FanNation* and the online service *Bookshare.org* use creative punctuation and capitalization to make their names stand out, but also make an exact representation in braille more complex. If a company uses nonstandard symbols in its name and a blind person misspells the company name on a cover letter for a job application because she did not get accurate information from the braille, what are the chances that person will get the job? Should she have to check the spelling using audio or relying on a sighted person to tell her how it is spelled or should braille, the primary literacy tool for people who are blind, be capable of giving the most accurate information?

Aside from the difficulties in literary contexts, it is becoming increasingly problematic that a completely different code is used for mathematical and technical materials. These materials currently do not translate correctly with the use of software that does not include transcriber intervention. The need for a solution to this issue is ever more urgent as mathematical and computer code expressions increasingly appear in everyday contexts.

To be clear, at this moment there is no known solution that would completely eliminate the need for a trained transcriber to intervene in order to verify that the format of an embossed braille document is clear and conveys enough information about the layout of a print page or document. This is especially true in educational materials. Transcribers will likely always be needed for creating tactile graphics, complex mathematics and science materials, and other complicated written matter. It would be much more productive, however, if, their work could be focused on these difficult materials rather than on ensuring that each and every dot in the text is correct. The more frequently that human intervention and judgment calls must be made, the more likely that braille production is delayed, that costs are increased, and that the braille is less accurate.

Another area of concern is backtranslation, which is the process by which software converts contracted braille materials into print. Backtranslation is most often used when a person creates a document in braille on a computer or other electronic device and then either prints the document, e-mails it, or simply saves it into a mainstream file type. This process can be especially useful for braille-using students who need to write in braille to support their developing braille literacy, but who also need for their work to be readable by their non-braille-reading teachers and by fellow students with whom they may collaborate on projects. In the workplace, braille readers can also benefit from the ability to type text using the computer keyboard as a sort of “electronic brailler” by using six keys or by attaching other braille devices, thus producing text readable as print by someone who does not read braille. The software and hardware exist for this need to be met in a seamless way, but there are sometimes problems that occur during the process of backtranslation—even when the person who typed in braille followed the rules of the code perfectly. Many of the examples given in this article are also problematic when dealing with backtranslation.

When a braille reader reads a document that has been translated from a print original, reading itself is a form of back translation. The braille document gives the braille reader information about the print original. Ideally, that information is both complete and accurate. The more print changes, the greater is the inability of the current braille codes to do that job.

Conclusion to Part 2

It is, without question, desirable for users to have independent access to braille materials. The proliferation of braille translation software, of braille embossers, and of refreshable braille displays has given braille readers more access to braille from more sources than ever before. With this greater access has come the need to consider multiple factors in the development of new rules and symbols for braille. In order to meet the needs of today, which are different from past decades, braille needs some systematic changes that will allow for the following:

- room within the code to add new symbols in a systematic way so that a braille reader has access to the same information as a print reader
- consistency of symbols so that correct braille will be shown when reading a computer or mobile device screen using braille
- ability for backtranslation to work more reliably
- ability to get better "on-the-fly" braille for mathematical/technical material, which is increasingly appearing in everyday contexts

It is clear that BANA cannot continue to adjust the codes on a symbol by symbol basis. Our community needs a flexible code that can grow with the English language and the changing ways it is represented in print. Braille needs to translate into and from print with complete accuracy. To keep up with growing demands, braille needs to be produced more quickly and with less human intervention than is currently required. BANA is considering solutions that will permit this. The third installment of this three-part article will outline these potential solutions.

Part 3

The Challenges Ahead

Previous installments of this article traced the changes in braille and print production methods over the past decades and discussed some of the challenges caused by the interaction of current codes with current production methods. This final section discusses the history of efforts to resolve these issues and briefly outlines possible solutions.

With the proliferation of better and more efficient technology, the relevance of braille as a reading and writing medium is frequently questioned. Technology has made it easier than ever for people who are blind to access a wide variety of texts, to create print documents, and to be more productive at work and home. Some people report that they can read faster with speech than with braille—and they probably can. But are those same people continuing to use braille? Have the ways braille readers use braille in their daily lives changed so dramatically that it should impact the development of braille codes?

The answer to both questions is a resounding yes. While the ways people are using braille have changed over the years, braille remains a viable and crucially important medium for communication. Speech access allows for quick skimming of information, but braille gives access to text in a manner that allows the reader to read independently and to see the spelling of words, the format of documents, and the symbols used. For these reasons, it's imperative that the codes are kept up to date so braille users can read and write accurately.

For many years, BANA has continued to make small changes to the braille code where absolutely necessary. Out of consideration for the impact on braille readers, teachers, and transcribers, BANA has acted conservatively in making changes. However, the "small fixes" made over the years have, in some cases, increased the complexity and ambiguity of the braille code. An example of how an effort to make a seemingly simple change to the code led to bigger complications was illustrated in the second installment of this article. To resolve many of the shortcomings of the current braille code outlined in the previous installments, serious efforts at code restructuring have taken place in the past two decades. A more comprehensive approach was needed to create flexible solutions for the changing needs of braille users.

Unified English Braille

The first of these efforts was the Unified English Braille (UEB) code project, which was initiated in 1992 by the Braille Authority of North America (BANA). The impetus for this effort was a memorandum sent to the BANA Board in January, 1991, by Abraham Nemeth and Tim Cranmer. In this memo, Drs. Nemeth and Cranmer expressed their concern over the "proliferation of braille codes" with different symbols for common characters. They stated: "For a long time now, the blindness community has been experiencing a steady erosion in braille usage, both among children and adults. This trend shows no sign of abatement, so that there is now a clear and present danger that braille will become a secondary means of written communication among the blind, or that it will become obsolete altogether." Later in their memo, they cited “the complexity and disarray" of the braille codes then in use, and they asked BANA to give the braille code a major overhaul to improve its usability and flexibility. They stated clearly: “It is time to modernize the braille system.” Based on the recommendations in this memo, BANA established a committee to explore the development of a unified code.

The original intent of the unified code project was to explore the possibility of bringing together three of the official braille codes that are used for various purposes: English Braille, American Edition (literary material), Nemeth Code (mathematics and scientific notation), and Computer Braille Code (computer notation). In 1993, the project was adopted by the full International Council on English Braille (ICEB). The project was expanded in scope to explore the possible unification of the braille codes that are used for those purposes in all seven ICEB member countries: Australia, Canada, New Zealand, Nigeria, South Africa, United Kingdom, and the United States. Work to develop a unified code was conducted primarily by braille readers in those countries with input from transcribers and educators.

At the time the project began, the braille codes used for English literary purposes were similar, though not identical, in most English-speaking countries. Because of this, substantial preservation of that code was one of the basic goals in the development of UEB. However, the codes used for technical purposes in the other ICEB countries were very different from those used in the BANA countries, so that UEB can be regarded as bringing together the braille codes used in different countries as well as those used for different kinds of notation. The only notation specifically exempted from consideration under the UEB project was the music braille code, which was already and still is a well-accepted international code.

In the initial stages of UEB development, one of the most pressing issues to be decided was the placement of numbers. In the U.S., numbers in the literary code were written using the four dots in the upper portion of the cell while in math and science, numbers were written in the lower portion of the cell. For a consistent code, one method for writing numbers had to be chosen, using either the upper or lower part of the cell.

In addition to these two possibilities, a third way of writing numbers was considered. Called "dot 6" or "Antoine" numbers, this system forms numbers by using the same dots as upper-cell numbers with dot 6 added. In this system, 1 is dots 1-6, 2 is dots 1-2-6, and so on. The zero departs from this pattern. Dot 6 numbers are still widely used in France, Germany, and other European countries.

To decide which system of numbers should be used, the committees, both in the U.S. and internationally, looked at the ramifications of using upper numbers, lower numbers, or the dot 6 numbers. Using lower numbers would mean changing all of the punctuation signs or having a special mode for numbers. The number sign would still have been needed in most cases because numbers standing alone could easily be misread. Use of Antoine numbers would mean losing ten frequently-used contractions, and many people reported that they were slower to read. Upper numbers had the advantage of being familiar to everyone and not conflicting with punctuation. In an analysis conducted using literature that contained frequent numbers, such as math and economics textbooks, numbers were found to come in contact more frequently with punctuation than with letters. After intense debate, the familiarity of the standard upper number system with its advantage of keeping current punctuation was judged to be more important and suitable, especially for the general reader. Based on this rationale, the upper number system was selected for all purposes within UEB.

A full discussion of all characteristics of any code would be beyond the scope of this article. However, the primary changes in UEB from the current literary code used in the U.S. are:

1. Spacing: Words that are currently written together such as "and the" must have a space between them as they do in print.

2. Less ambiguity: Nine contractions are eliminated: "ally," "ation," "ble," "by," "com," "dd," "into," "o'clock," and "to" because of translation difficulties and confusion with other symbols.

3. Punctuation: A few punctuation marks are different (for example, parentheses are two-cell sequences of dots 5, 1-2-6 and 5, 3-4-5). This change follows a new systematic pattern developed for creating symbols in UEB. In addition, symbols are included for different types of brackets, quotation marks, dashes, and others to show the braille reader exactly which symbol is used in the original text.

4. Indicators: Bold, underline, and italics each have their own indicators. There is a method using three capital signs to show a long passage of uppercase text.

5. Math symbols: Numbers are shown in the upper portion of the cell as they are now in literary braille; operational symbols such as plus and equals, which do not exist in current literary code, have been added and are different from those in the Nemeth code.

In 2004, the international community voted that UEB was sufficiently complete to be considered an international standard and for braille authorities of individual countries to vote on its adoption for their respective use. To date, UEB has been adopted in six of the seven ICEB countries, including Canada. The United Kingdom voted in favor of UEB adoption in October 2011.

Nemeth Uniform Braille System

The decision to write numbers in the upper portion of the braille cell had a major impact on the technical aspects of the development of UEB.

Dr. Abraham Nemeth, the developer of the Nemeth Code for Mathematics and Science Notation, recently completed development of a code that uses lower numbers throughout called the Nemeth Uniform Braille System (NUBS). Like UEB, it is also designed to represent literary, math, and computer information--combining all three codes into one unified system. While this system proposes changes to some parts of all three codes, it makes no changes to current literary braille contractions.

The primary changes from the present literary braille code would be:

1. Numerals: Numbers in all contexts occupy the lower part of the cell; these are referred to as "dropped numbers."

2. Use of modes: There are two modes—*narrative*, for normal literary material, and *notational*, for numeric and technical material. Notational mode is invoked with the number sign (dots 3-4-5-6) or by the "begin notational mode indicator" (dots 5-6). Notational mode is terminated by a dash or a space when the space is not within a string of numbers or a mathematical expression. Notational mode can also be terminated by a hyphen or a slash, and when these characters are not followed by a space, they are preceded by a dot 5. Contractions are not allowed in notational mode.

3. Punctuation: Proposed changes in punctuation include new symbols for parentheses, brackets, quotation marks, and the dash. Because the NUBS symbols for parentheses (dots 1-2-3-5-6 and dots 2-3-4-5-6) could be confused with the words "of" and "with," a punctuation indicator (dots 4-5-6) must precede each parenthesis when used in narrative mode. The semicolon, exclamation point, and question mark remain unchanged, but require a punctuation indicator in notational mode to distinguish them from digits. The period, the comma, and the colon are completely different in the two modes.

4. Type indicators: There are some changes in the technique for capitalization and for implementing italics and other types of emphasis.

Similarities of the Codes

Both proposed codes employ the use of "modes." It should be noted that even the current literary code uses modes, although they are not often referred to in this way. For example, when the word "dance" is written in contracted braille, it uses three cells (d, dots 4-6, e). When a number sign is placed before these three cells, their meaning is completely different; that is, it becomes the number 4.5. It can be said that the number sign has invoked a "numbers mode." Similarly, the use of a letter sign before a "c" changes the "mode" so that "c" means "c" instead of "can."

Although modes are not a feature requiring much notice in current literary code, the concept is inherent in the code. Modes do not create conflict within a code if their application is systematic. Part of the problem with current codes, however, is that the concept is not applied systematically, and creates conflict and ambiguity. Both UEB and NUBS were designed to be systematic in their application of modes and symbol construction.

At a Crossroads

As clearly indicated in the previous parts of this three-part article, braille in the United States must change to keep up with current trends in publishing and technology. It must also be more flexible and responsive to changing conventions of text. Two new braille codes have been developed, one of which has been adopted internationally. Both codes were developed with an effort toward retaining as much of the current literary braille code as possible; both codes have the reduction of ambiguity as a guiding principle to facilitate ease of learning and production. Easier facilitation of forward and backward translation would make it simpler for the user to create print documents and would also make the “on-the-fly” translation required for accessing the screens of computers and mobile devices much more accurate and reliable. It could also significantly reduce the cost of producing paper braille, which could have the effect of making much more braille material available for readers.

BANA will soon be at a critical juncture. It appears we have several choices as to how to proceed:

1. We can continue to tinker with the current codes we have, potentially making them less easy to use and more ambiguous;

2. We can adopt UEB, as have all of the other ICEB countries;

3. We can adopt NUBS;

4. We can do nothing at all to change braille, realizing this might cause braille to become obsolete.

The BANA Board recognizes that to preserve the viability of braille, changes must be made. The BANA Literary Technical Committee believes that continuing to make small changes to the current code will place braille readers and transcribers in an ever-worsening spiral of ever more complicated braille codes. The committee recommends that BANA adopt a system such as UEB or NUBS that was designed to be extendible, flexible, and consistent.

BANA is conducting an impact analysis that will look at the costs and benefits of making changes to the current system of codes as well as the costs inherent in *not* changing. The impact on transcribing and embossing various materials, training of new teachers and transcribers, the retraining of current braille teachers and transcribers, costs for creating e-texts, and other critical factors are being considered.

Any major change in braille would necessitate careful planning and implementation. New code books would be needed, as well as training sessions for transcribers and teachers. A phase-in period would be necessary with diligent attention to the needs of all braille readers—from the very youngest who are just learning to read and write to the reader who has known and loved braille for many years. The most important consideration of all is to keep braille as practical, usable, and flexible as possible in the future as it has been for the past 150 years.

As BANA examines the past and considers options for the future of braille, we encourage you to share your ideas, concerns, and suggestions with BANA Board members. Please visit www.brailleauthority.org and share your thoughts with us.

References

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