

Accessible Math

Meeting the Demands of Users and the Law

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Outline

- I. Needs of Users with Print Disabilities
- II. Section 508
- III. Accessibility of Math using Bitmaps
- IV. The Promise of MathML

Disabilities and Impairments

- 60% of working age adults have mild or severe "impairments"
- 25% of the impairments are vision-related
- 12% of computer users use accessibility features such as large fonts, high contrast, and special keyboards
- Print disabilities — blindness, poor vision, learning disabilities

Blind Users' Needs

- Audio renderings (screen readers)
- Navigation of the math (rehear parts of the expression to understand it)
- Braille output to refreshable braille displays, embossers



History of Braille

- Early tactile systems used raised letters (slow to read and write)
- 1813: Louis Braille blinds himself at age 3 with a sharp tool while playing in his father's shop — infection spreads to other eye
- 1819: Charles Barbier, a French army artillery officer uses raised dots based on sounds, not letters, for messages to/from artillery batteries
- 1825: At the age of 15, Louis Braille invents a letter-based 6 dot (3x2) system that fits under a finger, followed by 12 years of improvements before fully elaborated in 1837
- 1932: Officially adopted in Great Britain and the US (improvements in 1957)
- Grade 1 (alphabet and punctuation) and grade 2 contracted braille (189 letters, words and parts of words)
- www.brailleur.com/braillehx.htm: excellent history starting with the crusades

Braille Codes Example: Grades 1 & 2

(example from www.tug.org)

May you live in an interesting time.

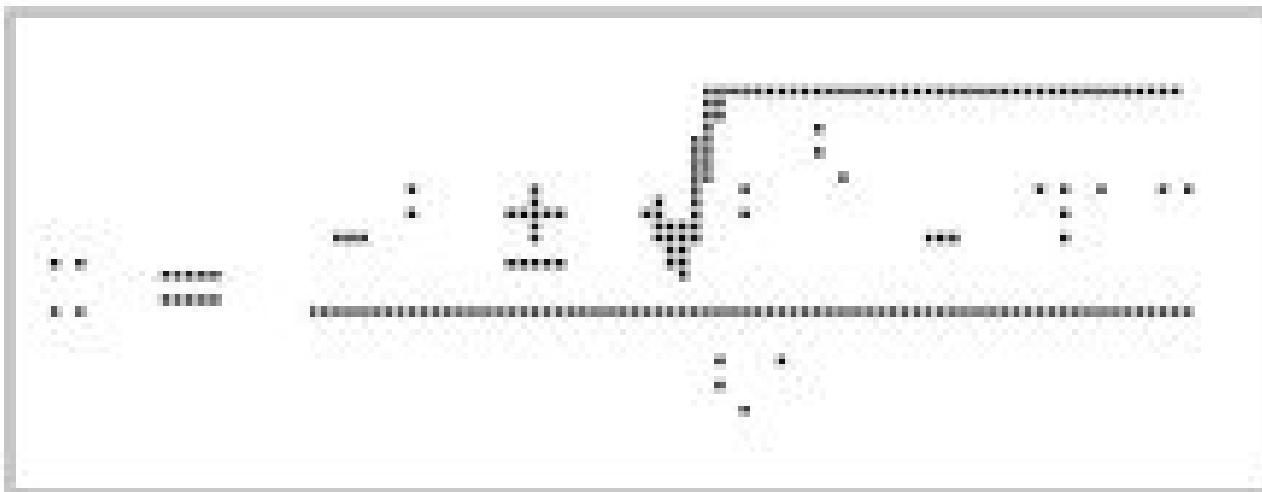
⠠⠑⠁⠿ ⠠⠽⠗⠑ ⠠⠇⠊⠑ ⠠⠊⠗⠊⠑⠗⠊⠑⠗ ⠠⠲⠊⠑⠗⠑.

May {you} live {in} an {in}t{er}e{st}{ing} {time}.

⠠⠑⠁⠿ ⠠⠽⠗⠑ ⠠⠇⠊⠑ ⠠⠊⠗⠊⠑⠗⠊⠑⠗ ⠠⠲⠊⠑⠗⠑.

Braille Math

- Many standards for braille math, even within a single country
All of the standards linearize math.
- In the US, Canada, and New Zealand, Nemeth code is the most common
- Other English speaking countries use a considerably different code
- Only 1/3 to 1/2 of math students and teachers learn Nemeth code
Almost no math teachers outside of blind schools know it
- "dots-plus" is an experimental 2D alternative



Users with Poor/Low Vision

- A wide range of users: nearly blind to less than 20/20 vision, color problems
- Much larger group than blind users
- Need larger screens, fonts, software or hardware magnifiers



- Larger fonts mean less math fits on a line
breaking expressions across lines is important

Users with Learning Disabilities

- People who benefit from audio feedback when reading (eg, dyslexia)
- Synchronization of highlighting with speech

Summary of User Needs

- Audio description
- Navigation of expression
- Braille math translation
- Line-wrapping of expressions
- Synchronization of highlighting with speech

The Law: "Section 508"

- 1990: Americans with Disabilities Act (ADA)
- 1998: Rehabilitation Act Amendments, Section 508
- Majority of states have similar laws mandating accessibility of content for organizations that receive state funding (Section 508 or W3C WAI guidelines)
- Majority of states require that textbook publishers provide versions of their textbooks for the blind

Section 508 Requirements

- Requires federal agencies ensure that electronic and information technology that is developed, procured, maintained, or used by the agency is accessible to those with disabilities unless doing so poses an "undue burden".

Regulations for what this means were issued at the end of 2000.

- Generic requirements examples
 - a well-defined on-screen indication of the focus must be provided and be programmatically exposed for AT
 - applications shall not interfere with accessibility features (eg, by overriding color or contrast selections)
- Web requirements examples
 - text equivalent to images/animations ("alt" or "longdesc")
 - information conveyed with color available is available w/o color
 - row and column headers for data tables

Website Checkers

- www.w3.org/WAI/ER/existingtools.html
- www.cynthiasays.com
- bobby.watchfire.com
- www.usablenet.com

Accessibility of Math Images

- Currently Static Bitmaps (GIF, PNG, JPEG, ...)

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- Standard problems of alignment, sizing, color
- Accessibility via ALT tags (not prompted for by most software)
- Audio output, but...
 - No navigation of math
 - No braille math output
 - No help for people with vision problems (enlarging, color, contrast)
 - No way to sync speech with display
- Using alt tags meets legal requirements, but not user needs

The Promise of MathML

- MathML contains enough structure for translation into many formats, including speech *Example:*

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

- Rendering software, not author, chooses words
- Can be expert about best practices
- Can allow user to set different verbosity levels
- Can use locale info to determine language for speech
- Braille math format can be chosen by reader (from supported formats)
- MathML changes size with document text size changes
- Can interact with screen readers or other assistive technologies to provide synchronized feedback.

Summary

- Users with print-disabilities are increasingly large group with diverse needs:
 - Audio description
 - Navigation of expression
 - Braille math translation
 - Linewrapping of expressions
 - Synchronization of highlighting with speech
- Section 508 and many states have laws mandating accessibility of web-sites
- Images with alt tags probably satisfy currently legal requirements, but not user needs
- MathML has the promise to meet the legal requirements of the various laws, and the needs of all of your users

Slides will be available at www.dessci.com/handouts

Braille Display



Braille Embosser Output



