**LIFE CYCLE OF A DAISY BOOK WITH MATH: FROM AUTHORING TO PLAYERS**

This panel session covers all aspects of creating a DAISY book that contains math. Topics covered include authoring, using OCR, and MathML-aware DAISY players.

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**Introduction**

Last year, the DAISY Consortium approved an extension to their 2005 NISO standard[1, 15] for Digital Talking Books (DTB) that allows authors to include mathematics so that the math is accessible[17]. Standards based on the DAISY standard, such as NIMAS[3], can point to this extension as their method for inclusion of accessible math. They can also be used by technical journals, as is being done in a pilot project to publish the American Physical Society’s Physical Review as a DTB.

This panel session will provide an overview of the DAISY Standard and its various components, and describe how the Mathematics Modular extension fits into DAISY. Panel members will discuss some production environments and demonstrate MathML authoring of original text and using OCR to generate MathML from existing texts. Panel members will also demonstrate basic and advanced DAISY players reading mathematical content.

**The DAISY Standard and Extensions**

The DAISY specification is a comprehensive multimedia approach to accessing information. A DAISY book is made up of several files:

* the Navigation Center (NCX)
* textual content document (DTBook—XML) which includes mathematical content
* synchronization file for audio, text, math, images (SMIL[2])
* annotation and bookmark file
* resource files for customized presentation of elements

The DAISY Consortium has a mechanism for enabling the creation of extensions for content that is not addressed in the core standard[14]. The first such extension is the mathematics module[17]. This module makes use of the existing MathML[16] standard. This means that existing tools that can author, manipulate, and display MathML can be leveraged to reduce the time and cost of adoption of the extension.

The use of existing standards (where they exist) is one of the requirements for extensions to DAISY. Other requirements for the development of a modular extension include:

* open development of the extension with multiple companies and organizations
* ensure that production tools exist to deliver content
* demonstrate reading system support for the extension
* create training and sample materials
* extend the validation tools to support the standard

**Math Extension**

Math is embedded in the DTBook using MathML[16] islands. These islands exist in a different namespace to avoid collision with any DAISY element names. The MathML that is used can occur either inline or in a block/display context.

The top-level element of MathML is the <math> element. In DAISY, this element lives in a separate namespace. It must include the two attributes:

* altimg—a URL pointing to an equivalent image
* alttext—a textual description of the MathML that can be used for speech

These two attributes are provided so that basic DAISY players that are not MathML-aware can still render a static math presentation.

The MathML extension envisions three classes of DAISY players:

* Audio-only players that are MathML-unaware. These players, which currently comprise the majority of DAISY players sold, use the SMIL[2] file and not the DTBook file for playback and will play the textual description of the math that is derived from the alttext attribute.
* Visual players that are MathML-aware but do not support MathML. This category of players will either extract the image and audio from the “altimage” and “alttext” attributes or apply a supplied XSLT file to transform the MathML into a DTBook that uses image groups (<imggroup>).
* Players that are MathML-aware and support MathML. MathML-aware players can provide a richer user experience because they can:
  + magnify the image or change its colors
  + tailor the speech to an individual's needs
  + provide local navigation and exploration of the mathematical structure
  + synchronize highlighting with the speech
  + translate the MathML to a Braille math code for use with a refreshable Braille display

While MathML-aware players are likely to be visual players, audio-only players that are MathML-aware can provide added value by tailoring the speech to an individual’s needs along with providing enhanced navigation support.

**Authoring MathML**

The W3C MathML website[19] lists over 20 applications that can be used to author or edit MathML. Some of these applications are standalone editors and some are part of a complete authoring system. Solutions include Java-based editors, .NET components, and plug-ins to Word and other ActiveX containers. All of these solutions provide a WYSIWYG interface so that users never need to worry about the details of MathML.

The most popular math editor is Design Science’s MathType[7]. MathType is the professional upgrade to the equation editor that comes with Microsoft Office. With a single click, a Word document with math can be converted by MathType into a web page containing MathML and from there it can be converted into a DTBook using several different production tools.

For those who use an XML environment, Design Science’s WebEQ[8] and MathFlow[5] products integrate with a number of XML editors and gives fine control over the MathML generated if that is desired. Like many of the products listed at the W3C site[19], MathType and WebEQ can be used as standalone products that allow copy/paste of the MathML into other documents.

The tools above work well for authoring math, but sometimes people wish to convert pre-existing documents. The InftyProject[18] addresses this need with a set of tools that work together to allow users to scan documents that include math. The InftyReader achieves a relatively high recognition rate that is over 96% for math[13]; work continues on improving those rates. Because OCR is not perfect, the tool set includes InftyEditor[12] and a self-voicing accessible extension of it called ChattyInfty[10].

Text in ChattyInfty is displayed on screen normally and math is displayed in standard two-dimensional notation. Input is loosely based on TeX commands. Using the arrow keys, users can navigate around the document to hear both text and math in the document. A screen shot of ChattyInfty is shown below. The displayed content is equivalent to what is shown in the WinTriangle example above.

ChattyInfty can import LaTeX and InftyReader (see below) formats. It can export a variety of formats including LaTeX and XHTML+MathML. The later form can serve as input to the DAISY pipeline.

**Putting the Pieces Together**

A variety of production tools are listed in the tools area of the DAISY Web site[4]. These commercial and open source products create a final “DTB” for distribution. To support the MathML Modular Extension, the production tools need to be extended to generate the necessary SMIL and metadata described in the specification. Design Science has developed a utility to automatically generate the altimg and the alttext from the presentation MathML in a DTBook.

ViewPlus Technologies uses some of these tools to create a DTB of the American Physical Society’s (APS) Physical Review Letters. APS has an XML workflow that includes MathML for the representation of math. Using the DAISY pipeline with the Design Science utility mentioned above, ViewPlus also converts the figures to SVG using their IVEO Creator product[11]. The resulting DTBook file can be converted to XHTML+MathML+SVG for display with IE+MathPlayer or Firefox.

**DAISY Players**

DAISY books and players provide a superior accessible reading experience over other book formats. Using the DAISY format, DAISY books provide:

* navigation by page, section, and sentence
* book content presented in several formats: audibly, visually, tactilely
* features for readers such as bookmarks and annotations
* choice of portable, mobile players or full-featured software players

Schools and other learning environments have started to use DAISY books. With adoption of the NIMAS, use of the DAISY standard will certainly expand rapidly. Because mathematics is taught every day in every school, support of mathematics in DAISY players is essential to make math and science books accessible. As mentioned above, the MathML extension to DAISY envisions three types of players. The panel will demonstrate an existing audio-only player that works with MathML. This will then be compared to the gh Player[9] that is a visual MathML-aware player. The gh Player is an intelligent reading system that unlocks the power of MathML in DAISY. The gh player supports:

* fine grain navigation of math
* selection of visual magnification and color
* translation to Braille for refreshable displays

The MathML extension to DAISY is new, and hence support for mathematics in DAISY players is still in its infancy. In the future, it is likely that MathML-aware players will expand upon the capabilities listed above and will allow for a more “dynamic” presentation of math. These capabilities might include:

* summaries of the entire expression or parts of the expression
* navigation by mathematically meaningful units such as by term, by numerator/denominator, by parts of integral, etc.
* speech customized to the subject, age group, or individual preference of the teacher or student

**Other Players**

DAISY content can be converted to many other formats including PDF and HTML/XHTML by a number of the tools listed on the DAISY Web site[4]. The accessibility of these other formats varies, but they may be useful for some readers. For example, if the content is converted to XHTML as is done for APS’ Physical Review Letters by ViewPlus, a screen reader can read the content in a browser.

If the content contains MathML, then MathML-aware tools can be used to make the math accessible in that format. For example if a conversion produced XHTML, then IE together with Design Science’s MathPlayer[6] plug-in can be used to view the math expression. When MathPlayer is used in conjunction with a screen reader or other assistive technology, the math is spoken. MathPlayer can also enlarge math expressions in a Web page, match colors to the text color, and synchronously highlight the math with the words that are spoken.

**Summary**

Mathematics is a part of every student’s day from first grade through high school. To date, their textbooks and work assignments have typically had limited accessibility. With the inclusion of MathML into DAISY, authors and publishers can now create accessible multimedia books that include mathematics. The use of MathML leverages the existing tools that can create MathML and helps to speed the creation of such books. Furthermore, at least one player already exists that can provide a better reading experience than would be supplied by a static picture combined with “alttext”.

**References**

[1]

ANSI/NISO Z39.86-2005. Specifications for the Digital Talking Book, NISO Press, 2005, <http://www.niso.org/standards/resources/Z39-86-2005.html>.

[2]

Ayars, J., Bulterman, D., Cohen, A., Day, K., Hodge, E., Hoschka, P., Hyche, E., Jourdan, M., Kim, M., Kubota, K., Lanphier, R., Layaida, N., Michel, T., Newman, D., van Ossenbruggen, J., Rutledge, L., Saccocio, B., Schmitz, P. and ten Kate, W. Synchronized Multimedia Integration Language (SMIL 2.0) - [Second Edition], 2005, <http://www.w3.org/TR/2005/REC-SMIL2-20050107/>.

[3]

CAST. NIMAS Technical Specification, 2005, <http://nimas.cast.org/about/proposal/spec-v1_1.html>.

[4]

DAISY Consortium. DAISY Tools, <http://www.daisy.org/tools/>.

[5]

Design Science. MathFlow, <http://www.dessci.com/mathflow/>.

[6]

Design Science. MathPlayer, 2004, <http://www.dessci.com>.

[7]

Design Science. MathType, <http://www.dessci.com/mathtype>.

[8]

Design Science. WebEQ, <http://www.dessci.com/webeq/>.

[9]

gh. gh PLAYER, <http://www.gh-accessibility.com/ghplayer.html>.

[10]

InftyProject. About ChattyInfty, 2005, <http://www.inftyproject.org/download/AboutChattyInftyE.txt>.

[11]

John Gardner, V.B., Holly Stowell, The ViewPlus IVEO Technology for Universally Usable Graphical Information. in International Conference on Technology and Persons with Disabilities, (2005), <http://www.csun.edu/cod/conf/2005/proceedings/2349.htm>.

[12]

Kanahori, T., Fujimoto, M. and Suzuki, M., Authoring Tool for Mathematical Documents - Infty -. in 3rd International Conference MKM2004, (Bialowieja, Poland, 2004), <http://www.inftyproject.org/articles/2004_MKM_Kanahori.pdf>.

[13]

KANAHORI, T. and SUZUKI, M., Refinement of digitized documents through recognition of mathematical formulae. in Proceedings of the Second International Conference on Document Image Analysis for Libraries (DIAL'06), (2006), IEEE Computer Society, 297-302, <http://ieeexplore.ieee.org/search/wrapper.jsp?arnumber=1612971>.

[14]

Kerscher, G. Guidelines, 2005, <http://www.daisy.org/z3986/modular/modular.html>.

[15]

Kerscher, G. Theory Behind the DTBook DTD, 2001, <http://www.daisy.org/publications/docs/theory_dtbook/theory_dtbook.html>.

[16]

Ron Ausbrooks, S.B., David Carlisle, Stéphane Dalmas, Stan Devitt, Angel Diaz, Max Froumentin, Roger Hunter, Patrick Ion, Michael Kohlhase, Robert Miner, Nico Poppelier, Bruce Smith, Neil Soiffer, Robert Sutor, Stephen Watt. Mathematical Markup Language (MathML) Version 2.0 (Second Edition), 2003, <http://www.w3.org/TR/2003/REC-MathML2-20031021/>.

[17]

Soiffer, N. and Kahl, K. Specification for a Digital Talking Book Modular Extension for Mathematics, DAISY Consortium, 2007, [www.daisy.org/projects/mathml/mathml-in-daisy-spec.html](http://www.daisy.org/projects/mathml/mathml-in-daisy-spec.html).

[18]

Suzuki, M., Tamari, F., Fukuda, R., Uchida, S. and Kanahori, T., INFTY: an integrated OCR system for mathematical documents. in Proceedings of the 2003 ACM symposium on Document engineering, (Grenoble, France, 2003), ACM Press, 95-104, <http://www.inftyproject.org/articles/2003_DocEng_Suzuki.zip>.

[19]

W3C. MathML Software, <http://www.w3.org/Math/implementations.html>.

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