A Myriad of Uses for MathML

By Robert Miner, Vice President, Research & Development, Design Science, Inc.

All kinds of enterprises are putting XML to work to better organize and reuse valuable data and to streamline their editorial and publishing workflows. While the benefits are substantial, they do require thinking beyond a text-only approach. For example, mathematical notation has historically been arduous to set in type, and thus a mindset developed of math being problematic. The reality is a new generation of XML standards, tools and techniques are transforming the accessibility, application and reuse of mathematical notation across diverse industries.

The key to working with math in XML documents is MathML, a World Wide Web Consortium standard for encoding mathematics in XML. MathML is one of the first widely adopted domain-specific XML vocabularies, and is quite mature with support in a wide variety of software tools.

The following are just some of the innovative ways organizations have utilized MathML in their workflows.

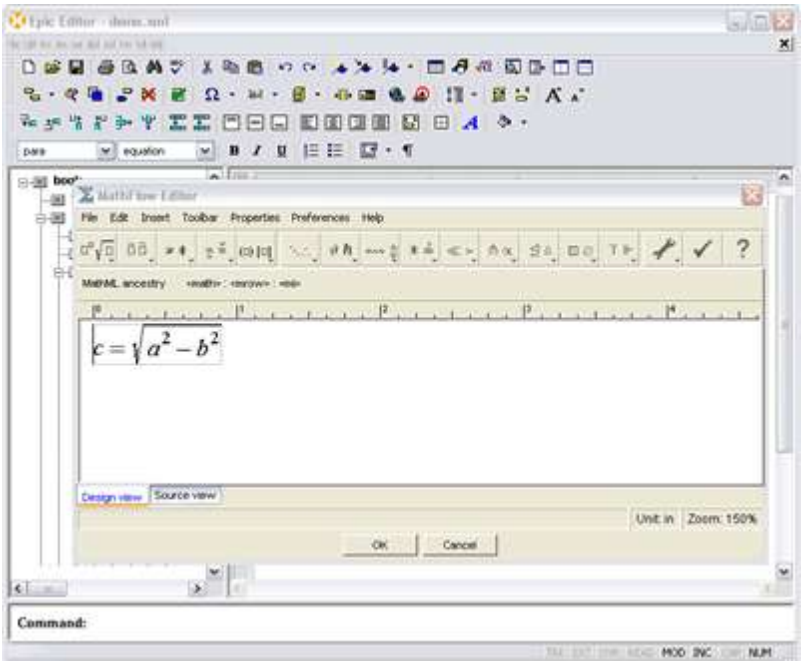
Science, Technical and Medical (STM) Publishing

Background: Mathematical notation is an integral part of almost all the disciplines encompassing scientific, technical and medical content, and thus STM publishers were among the first to confront the issue of dealing with math in XML.

Problem: Publishers of STM books, textbooks, journals and databases deal with high volumes of articles, each containing many hundreds of equations. Consequently, the ability to edit, validate and process mathematical notation along with other document content with a uniform set of tools and workflows was critical and of strategic importance.

Solution: By using MathML to represent mathematics inline with other document data, publishers were better able to:

- Improve quality and uniformity, and simplify downstream processing by validating mathematical content
- Enhance the speed and accuracy of copy editing through the use of integrated graphical editing tools—such as the MathFlow Editor with Epic Editor
- Gain better control over the composition process by uniformly styling and processing both math and text using standard techniques such as XSL transforms



The MathFlow Editor integrated with Epic

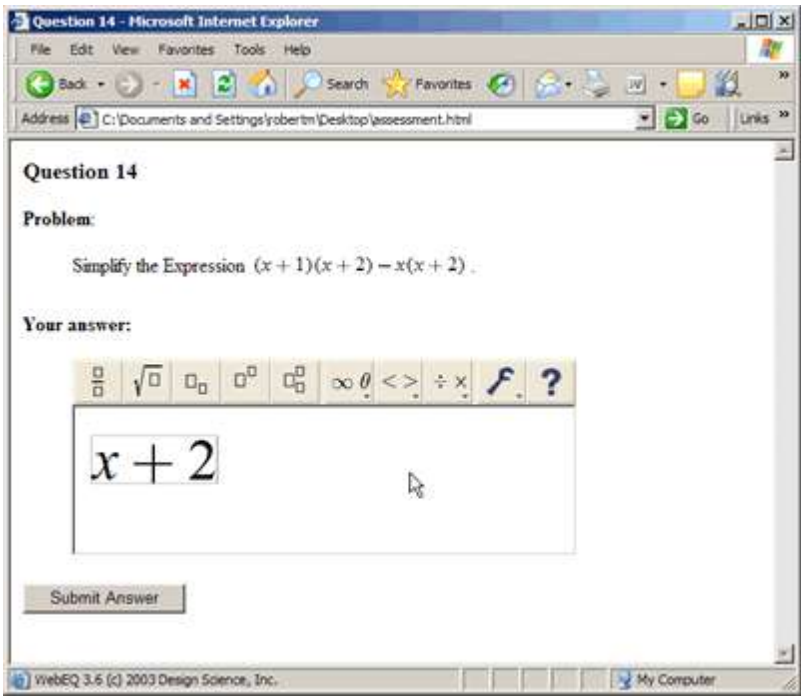
Educational Assessments

Background: The US government's *No Child Left Behind* program mandates standardized testing of all school children at several grade levels. As a result, educational publishers suddenly faced new demands both for the creation and deployment of assessment tools on a very large scale.

Problem: While federal law requires testing, curriculum is controlled at the state and local level. This created substantial logistical challenges for educational publishers reliant on large scale preparation of test questions tied to local standards. At the same time, administering and scoring tests in a timely manner also presented challenges in terms of accuracy and cost. Moreover, since math is a core competency area for school children, both authoring and deployment systems had to handle math content well.

Solution: By leveraging existing web-based XML authoring tools, assessment vendors were able to quickly deploy distributed authoring systems, thereby:

- Ensuring that curriculum experts across the country could create test questions
- Publishers could validate content and maintain consistency across authoring tools
- Teachers could utilize existing technologies for the input and display of MathML in browsers, with some even automating the scoring of math, or provide hints to students taking practice tests



Browser extensions for math displays and input facilitate web-based testing.

Technical Manuals and Documentation

Background: Many industries, such as aerospace, defense and pharmaceutical must produce a high volume of technical manuals and other documentation on an ongoing basis. These manuals and documents are essential to customers, engineers, designers and numerous other parties. Therefore, the timeliness and accuracy of the mathematics and text in technical documentation is paramount.

Problem: The content for many manuals is typically drawn from disparate independently versioned sources. It is imperative that the final output be up-to-date, and the versions of constituent pieces be compatible. At the same time, due to volume and time constraints, the publication process must be highly automated.

Solution: By encoding content in XML and storing it in a content management system, many manufacturers are able to easily assemble manuals from smaller units across a variety of sources. Encoding mathematical content as MathML inline with other content affords technical writing departments the ability to:

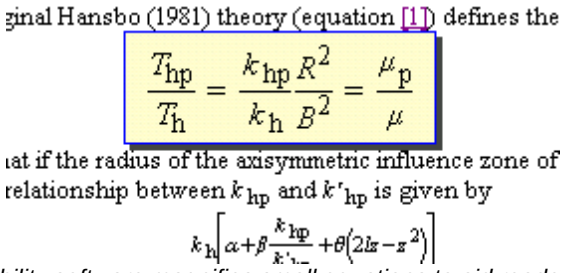
- Create uniform methods of versioning content and maintain consistency among documents
- Store mathematics for reuse and simplified repository management
- Employ XML search and discovery techniques that apply to mathematical notation, in contrast to standard search methods that leave math invisible

Accessible Educational Materials

Background: A variety of state and federal laws mandate that schools or publishers, or both, provide individuals with visual disabilities accessibility-enhanced educational materials. For example, educators utilize materials ranging from Braille texts to electronic texts suitable for use with screen readers or in the form of large print editions.

Problem: While workable software solutions for accessible text content have existed for some time, only recently have there been economical solutions for math content. In most cases, math accessibility has been handled by manually preparing text descriptions. However, translating math into text doesn't meet the needs of the visually disabled, since it doesn't permit convenient navigation, which is key to comprehension of all but the simplest mathematical formulas, nor does it permit the use of large fonts and synchronized highlighted aural rendering for individuals with low vision or learning disabilities.

Solution: Since MathML encodes mathematical meaning in a very structured way, it is facilitating the development of a new generation of economical math accessibility tools that do a much better job of meeting the needs of those with visual disabilities. In particular, there are now MathML speech engines that seamlessly interface with text-based screen readers, and permit navigation within expressions, as well as user customization of speech generation rules. MathML rendering engines are also starting to provide highlighting synchronized with speech generation, Braille output, and automated line breaking which is helpful when very large fonts are being used.


ginal Hansbo (1981) theory (equation [1]) defines the

$$\frac{T_{hp}}{T_h} = \frac{k_{hp}}{k_h}\frac{R^2}{B^2} = \frac{\mu_p}{\mu}$$

at if the radius of the axisymmetric influence zone of
relationship between k_{hp} and k'_{hp} is given by

$$k_h\left[\alpha+\beta\frac{k_{hp}}{k'_{hp}}+\theta\left(2lz-z^2\right)\right]$$

MathML accessibility software magnifies small equations to aid readers with low vision

The "New Math" Really is Better

By thinking creatively and leveraging the tools and solutions that have coalesced around the MathML standard, innovators in a wide range of contexts have been able to make the shift from math as difficult typesetting to math as an opportunity for enhancing content. So whether your math publishing requirements are large or small, take heart. This time the "new math" really is better and easier than the way we used to do it.

About Design Science

Design Science develops software used by educators, scientists and publishing professionals, including MathType, Equation Editor in Microsoft Office, WebEQ, MathFlow, MathPlayer and TeXaide, to communicate on the web and in print. For more information please visit www.dessci.com.