Structured Math On The Web

First 10 Years Of MathML

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Google Research
Outline

- MathML — Turning the clock back to 1995
- XML, MathML and Extensibility
- State of mathematics on the Web in 2006
- Future of online mathematics
The Web In 1995
Web In Early 90’s

- Invented by technologists for technologists
- Online math was our obvious next step
- Web made of static HTML
- Goal: display Math in a Web browser

Started as the Math ERB
MathML Design Goals

*Design a markup language that could*

- Capture semantics for computation
- Capture richness needed by publications
- Enable aural presentations and other views

*MathML: First XML Web vocabulary*
Web In 1995

- Commercial Web came to the forefront
- Shopping carts overtook Math equations
- Mainstream browsers ignored online math
- Web browsers had a primitive layout model
- Math typesetting is hard

Impedance mismatch between Web and online Math
Consequences

- MathML relegated to browser plugins
- Retarded ubiquitous deployment
- Authoring \((\LaTeX)\) still easier than XML

*Fixed tagset and extensible math do not mix well*
Consequences Of XML

- XML is extensible; XML dialects are not.
- Fixed tagsets *always* lose semantics.
- Author-level extensibility important for Math.

*Compare with \((\text{La})\TeX\).*
XML, MathML And Extensibility
XML Benefits

- Well-understood document semantics
- Mixed vocabulary documents
- Internationalizable
- Extensible framework

*MathML rode the XML wave.*
Thoughts of a disillusioned XML hacker

- XML failed to deliver simple S-expressions
- XML dialects are not extensible
- Fixed tagsets make new notation difficult.
An \((L^A)\TeX\) View Of Extensibility

 Authors need to invent new notation

- Math notation cannot be frozen in time
- Authors invent new notation
- New notation requires new markup

Lack of extensibility leads to presentational markup.
An (L^{\text{A}})\TeX Example

\newcommand\infer[2]{\frac{#1}{#2}}

\infer
\frac{a}{b}
\infer
\frac{b}{a}

Tag set extended incrementally
Example From ASTER

ASTER — semantic markup → rich aural renderings

(def-object :macro-name "infer"
  :args 2 :object-name infer
  :processing-function infer-expand
  :precedence arrow-operator
  :supers (binary-operator)
  :children-are-called
  '("premise" "conclusion")

Declarative markup → semantic representation.
Rendering rule for semantic representation:

(def-rule speak (infer)
  (afl:new-block
   (speak (arg 1 infer ))
   (speak " implies ")
   (speak (arg 2 infer))))
(LATEX) Advantages

- Authors invent notation and markup
- Semantics captured at authoring time
- Declarative markup separates processing
- While allowing author control over processing

*This is still difficult to do in browsers*
Firefox equivalent would require:

- Creating a custom markup element,
- Binding it to MathML via XBL,
- Style it for presentation using CSS,
- Add behavior via Javascript,
- Package pieces into a coherent component.

Overhead precludes extensions by authors
HTML Extreme

**Just do it with two elements.**

```html
<div class="infer">
  <span class="premise">a</span><b class="conclusion">b</b>=a
  <span class="conclusion">b</span>=a
</div>
```

- **Style with CSS**
- Use CSS selectors to attach behavior

**This solution cannot scale over time.**
Publishing And The Web

- Print publishing provides reusable styles
- Contrast with Web publishing
- Interaction behaviors alien to publishing

*Online Math victim of this impedance mismatch.*
Math On The Web In 2006
Available Technologies

- Mixed namespace documents
- Plugin development is easier
- Augment declarative markup with behaviors
  - CSS for styling,
  - XPath, XSLT for rearranging content,
  - JavaScript for interactivity,
  - XBL for creating components
What Can We Build?

- Math Wikis?
- Wikipedia uses \( \text{\LaTeX} \) for alt text
- Enable authors write simple math as \( \text{\LaTeX} \)
- Map \( \text{\LaTeX} \) to MathML DOM
- Enable blogging community author Math

*Bring Math on the Web to the mainstream*
Incremental Deployment

High-end math rendering will remain a hard problem.

- Package MathML as script libraries,
- Leverage SVG for final-form rendering,
- Enable online interaction via scripting,

Online Math need no longer be static.
On-ramp For Ubiquitous Math

- Use incremental deployment to make MathML essential
- Browser integration needs user demand
- Retain advantage of being an extension
What Can We Add To The Web
Evolving The Web

Demands of Math typesetting gave us \( \LaTeX \)

- Highly interactive online math
- Exploratory UI for interactive proofs
- Computing on online Math

Where do these requirements lead the Web?
Consequences For Mainstream

- Math more complex than plain text
- Fulfilling these impacts online education
- Potential for pioneering work

*Create next hypertext revolution*
Watch The Math Web Take-Off!