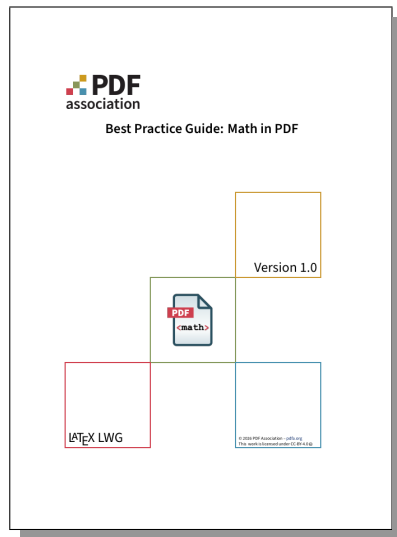


New Best Practice Guide for Mathematical Content in PDF

L^AT_EX Liaison Working Group
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PDF Association L^AT_EX Liaison Working Group

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$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0} \quad (1)$$

$$\nabla \cdot \mathbf{B} = 0 \quad (2)$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \quad (3)$$

$$\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right) \quad (4)$$

Accessible mathematics in PDF has historically been difficult for:

- Screen readers
- Reflow and adaptation
- Semantic extraction
- HTML conversion
- Accessibility conformance

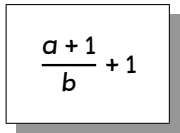
Legal mandates for accessible content are expanding worldwide.

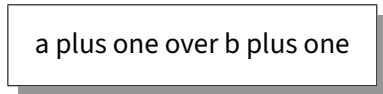
The (Poor) User Experience

Traditional approaches usually relied on:

- Images of equations
- Alt text descriptions
- Non-semantic tagging

Result: Poor experiences for STEM readers using assistive technologies.


$$\frac{a+1}{b} + 1$$



a plus one over b plus one

Traditional approach: “Describe the equation.”

Problems:

- Not navigable
- Loss of structure
- Cannot adapt to the users' needs
- Cannot generate concise braille
- Math-heavy documents would require huge amounts of alternative text
- Authors may not be experts at producing high-quality alternative text

Math accessibility is a subset of a larger topic of PDF accessibility, which relies on:

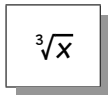
- **Tagged PDF** — the means of including semantic markup in PDF files.
- **WTPDF** — “Well Tagged PDF” defines the correct use of Tagged PDF for accessibility and reuse purposes.
- **PDF/UA-1** — the ISO standard for accessible PDF files based on PDF 1.7 (which does not support structured mathematical content).
- **PDF/UA-2** — the ISO standard for accessible PDF files, based on WTPDF (which supports MathML for mathematical content).
- **Associated files** — are files embedded in the PDF. For accessibility purposes, such files are linked to specific structure elements, enabling the associated file to represent page content.
- **MathML** — A markup language for mathematics. May be used in HTML and in PDF 2.0.

What Is MathML?

MathML, part of HTML, is a semantic vocabulary for mathematics.

Example: (the cube root of x)

```
<math>  
  <root>  
    <mi>x</mi>  
    <mn>3</mn>  
  </root>  
</math>
```



MathML enables:

- User-enabled speech rendering
- Synchronized highlighting
- Navigation within equations
- Mathematical (not text) braille
- Better derivation to HTML

The Core Problem

A mathematical expression is not just formatted text.

Assistive technology must understand:

- Structure
- Reading order
- Operators
- Superscripts/subscript
- Fractions
- Intent

Without semantics:

- Speech output becomes ambiguous
- Navigation fails
- Braille rendering suffers
- Copy/paste degrades
- Searchability decreases

Example:

$$\int_0^{\infty} e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$$

Encoding the Semantics of Mathematics

Semantic math approach: “Represent the actual mathematics.”

The Best Practice Guide notes the following example of notation where the semantics and required reading varies according to the context.

- $\overline{\overline{x + y}} = \overline{\overline{x + y}}$ “mean of x ”
- $\overline{\overline{x + y}} = \overline{\overline{x + y}}$ “complex conjugate of x ”

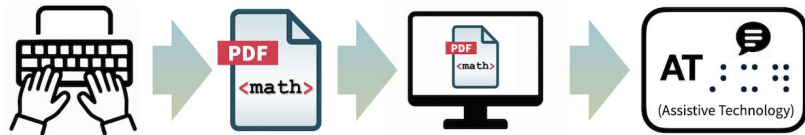
While the examples here are visually identical, they require different semantic markup which may be provided by embedding suitable MathML.

WTPDF and PDF/UA-2

The guide recommends conformance with WTPDF and/or PDF/UA-2.

Why? Because accessible math depends on:

- Correct tagging
- Semantic structure
- Proper namespaces
- Predictable processing behavior



Accessible mathematics requires the newer standards; at the same time these standards improve the overall document accessibility.

Best Practice Guide: Math in PDF

The publication is a result of practical implementation of these standards. It clarifies missing points and enables the complete workflow from creation to the AT support.

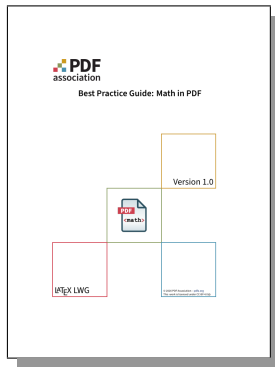
The new Best Practice Guide itself is:

- PDF 2.0
- WTPDF conforming
- PDF/UA-2 conforming
- PDF/A-4f conforming
- Vendor-neutral, published under CC BY 4.0

It also uses:

- Associated files / MathML structure elements
- CSS support for derived HTML rendering

This is significant, as the publication serves as an example implementation.



Publishers should accelerate transitioning toward:

- PDF 2.0 workflows
- Semantic math generation
- MathML-first pipelines
- WTPDF / PDF/UA-2 validation
- WTPDF practices

Potential impact areas:

- Academic publishing
- Scientific journals
- Education
- Government STEM content
- Technical documentation

**To reduce or even eliminate the cost of remediation,
accessibility must originate upstream in authoring workflows.**

Tool vendors should support:

- MathML embedding
- AF relationships
- PDF 2.0 namespaces
- Tagged math structures
- WTPDF / PDF/UA-2 validation
- Reliable AT interoperability

Likely ecosystem effects:

- Improved validators
- Better extraction tools
- Better HTML derivation
- Improved remediation tooling

Many tools are starting to implement a PDF 2.0 based workflow for STEM documents.

Authoring systems

- L^AT_EX
- Word, PowerPoint

PDF viewers

- Foxit
- Acrobat
- Firefox

Validators

- veraPDF
- show-pdf-tags
- octoPDF

Note:

At this time not all PDF validators correctly validate PDF 2.0 and PDF/UA-2, and not all PDF viewers support accessible math.

Key Takeaways

- The accessibility ecosystem is transitioning away from alt-text and towards structured approaches.
- A core aspect of the suggested workflow is providing the mathematical semantics in the authoring tools and automatically transforming that data to quality MathML instead of requiring manual post-processing/remediation
- Use PDF 2.0, because it enables MathML, which is foundational for modern math accessibility in PDF documents.
- WTPDF and PDF/UA-2 are key quality indicators, but require appropriate tools and care in authoring
- Accessibility is (increasingly) the law

Accessible STEM publishing is now possible — what remains is further adoption.

PDF Association

- [L^AT_EX Project Liaison Working Group](#)
- [Best Practice Guide: Math in PDF](#)
- [Well-Tagged PDF \(WTPDF\)](#)

ISO

- [PDF for Universal Accessibility \(PDF/UA-2\)](#)
- [Portable document format – Part 2: PDF 2.0](#)

L^AT_EX Project

- [Using L^AT_EX to produce accessible PDF](#)

Microsoft

- [Transforming math workflows in Microsoft 365](#)