Mathematical Texts as Illuminated Manuscripts: Augmenting Hand Lettering with Calligraphic Fonts in LaTeX

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Abstract

I outline a process for creating illuminated manuscripts from mathematical texts by combining hand-calligraphed, illuminated pages with printed pages typeset in LaTeX using fonts created from one's own calligraphy or writing. The vision is that a solo calligrapher can produce a complete book fairly quickly, making entire exhibits containing several books attainable within a reasonable time frame. There is an abundance of mathematical writing already typeset in LaTeX. The tools exist to easily generate fonts from one's own script, then to utilize these fonts within a LaTeX document in a fairly straightforward manner. Here I present a brief overview of my process creating pages for a small book from my own logic notes. I took inspiration for the manuscript style from a medieval book of hours.

Introduction: Illuminating Mathematical Texts

Historically, teams of scribes breathed life into the text of an illuminated manuscript with calligraphy, gilding, decorative elements, and illustrations, then bound the pages into a book by hand. These historical treasures inspired the modern-day illuminated St. John's Bible, completed in 2011 by the combined efforts of 23 individuals variously working as scribes, illuminators and artists for over 11 years [2]. Inspired by the beauty of mathematics, but lacking a team of scribes, how can one calligrapher generate a collection of illuminated mathematical manuscripts, especially when some mathematical proofs run into the hundreds of pages? Fortunately, the prolific use of LaTeX [8] by mathematicians, Unicode TeX engines (such as XeTeX [11] and LuaTeX [7]), along with font generation software (such as FontForge [4]), provide the means to gain digital assistance towards the completion of such a project. The idea is to create a small selection of hand-calligraphed and illuminated pages and bind them together with printed pages, typeset in LaTeX using fonts generated from hand-written letterforms and symbols. This paper gives a brief overview of the process, following a small example project. Many technical details must be deferred to the documentation of the software in use here.

Project Overview and Hand-Created Elements

I started with some of my logic notes typeset in LaTeX, modified the page format to create a small book, created fonts from my calligraphy, typeset the text with the calligraphic fonts, and created one page by hand with decorative elements and gilding. The final product will be a hand-bound book containing the hand-made page and the printed pages that were typeset in LaTeX with the calligraphic fonts.

The production time for one illuminated manuscript created as a hybrid of hand-made and printed pages is such that exhibit-sized collections of manuscripts might be created in a reasonable time frame by one calligrapher, where hand-illuminated folios are displayed open in otherwise complete, printed books. Further, by hand-illuminating at least two folios per book in several of the books, a combinatorial selection of display options for the exhibit could be produced with a minimum of laborious hand-calligraphy and illumination, in stark contrast to the time and labor that went into the fully hand-calligraphed and illuminated manuscripts of the past, or the modern-day St. John's Bible. Inspiration comes from the many historical illuminated manuscripts that have been digitized and made available online. I take inspiration for the work described here from folio 172v of the Doffinnes Hours, a medieval book of hours in the Walters Art Museum collection [3] (Figure 1).
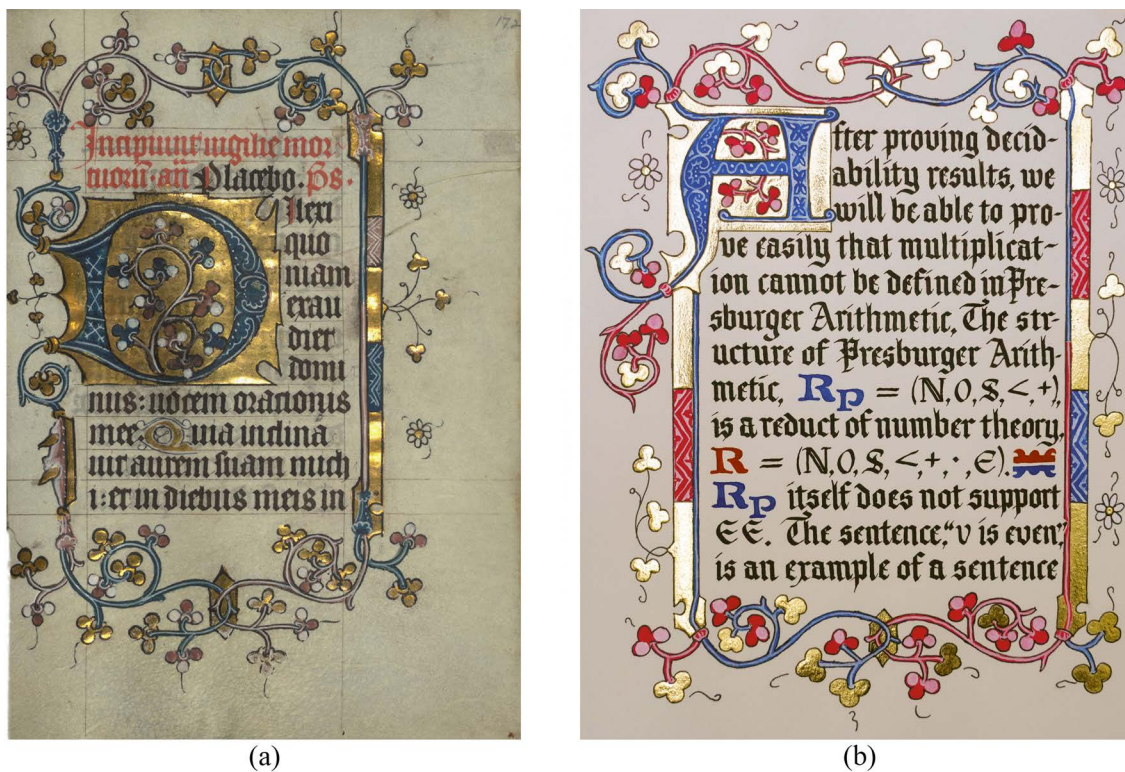
(a) (b)

Figure 1: *(a) The inspiration page from the Doffinnes Hours manuscript, folio 172v, at the Walters Library [3]. (b) The hand-calligraphed and illuminated page created by the author for this project.*

Creating Fonts from Hand-Written Scripts

For mathematical writing typeset in LaTeX, font families are needed for the main text, along with more fonts and symbols for the math typesetting environment. The font family for the main text will usually include a straight letterform, an italic letterform, and a bold letterform, at minimum. Bold italic, and various weights of text might also be included in a main text font family, along with sans serif and typewriter fonts. Equations and mathematical text need another Unicode font that must include at least the mathematical symbols needed for the given project. It would be daunting, and is not necessary, to create every symbol in the comprehensive LaTeX symbol list [9], but this list can serve as a reference. In this project, I chose to create several styles of blackletter script frequently seen in medieval manuscripts to substitute for the upright, italic, and bold text fonts and the math italic fonts. I created capital letters in the versal style as accents, and finished out the set of symbols and greek letters in styles compatible with the rest of the lettering.

Font creation began by writing out pages of letters in the various desired forms with broad nib pen and ink, until I had an acceptable representative for each character or symbol (Figure 2a). I then scanned the pages of letters and image traced them in either Adobe Illustrator or Inkscape to make each letter into a vector graphic . I organized vectorized alphabets into exemplars (Figure 2b) and saved each letter individually as an SVG file, with dimensions compatible with FontForge (1000 x 1000 pixel as a standard.) I imported the SVG letter files into the appropriate positions in the FontForge table for each font (Figure 2c.) I centered the letters to start with, then adjusted left and right spaces until the letter spacing was fairly good. Kerning, the adjustment of spacing between specific letter pairs, is usually needed for the best result. This was done in FontForge, then the font was generated and installed on the operating system. I chose to use OpenType fonts for this project. FontForge allows one to address many details of the typeface to make sure the fonts function correctly in all possible contexts, but it was not necessary here. This allowed for the use of my spontaneous,

Figure 2: *(a) Detail from a page of hand-calligraphed letters with the broad nib pen used. (b) A gothicized italic script exemplar created by scanning, vectorizing and organizing the page in (a). (c) A set of capitals and lowercase gothicized italic letters in fontforge created from my calligraphy.*

hand-created letterforms that better mimic hand-calligraphy when printed. Further details on font creation can be learned in the FontForge documentation [4].

Calligraphic perfection is not required for a project such as this. Any hand-created letterforms could be used, including one's own handwriting. The final manuscript could be anything from historically inspired to modern and abstract. Artistically, the most impactful part of the the process described here is to take some care in the letter spacing and kerning (done here in FontForge,) along with page layout, line and word spacing.

Typesetting with Unicode Fonts in LaTeX

To change all the fonts within a mathematical text, I used the `fontspec` [5] and the `unicode-math` [10] packages. Use of these packages requires the use of the Unicode engines XeTeX [11] or LuaTeX [7]. I used XeTeX in this work. Central to mathematical typesetting in LaTeX are the `amsmath` and related packages [1], whose documentation can serve as a guide for deciding how to create lettering for equations and mathematical content within the manuscript.

The assumption at this stage is that one already has a mathematical text written in LaTeX and typeset for publication as a journal article, a book, or a set of notes to share. What remains is to add commands for page layout and inclusion of altered text or decorative elements. Page dimensions, margins, line spacing, paragraph spacing, and strictness of adherence to a left- and right- justified page format are some of the page layout options. Here, I used the more flexible `memoir` document class. In particular, the unusual and larger font sizes it allows are more amenable to creating a text that is styled as an illuminated manuscript.

Various LaTeX packages can help with the inclusion of elements found in illuminated manuscripts. The `lettrine` package [6] allows for the incorporation of a large initial capital letter, spanning a specified number of lines. Special letterforms with fluorishes or alternate forms can be included with the swash or boldswash styles made possible with the `fontspec` package. Modifications continue with insertion of special characters, use of color, and addition of decorative elements in the form of symbols within the supplied fonts. XeTeX, a TeX typesetting engine, meets the challenges of typesetting the Unicode calligraphic fonts and illuminated letters described here to produce output such as that shown in Figure 3.
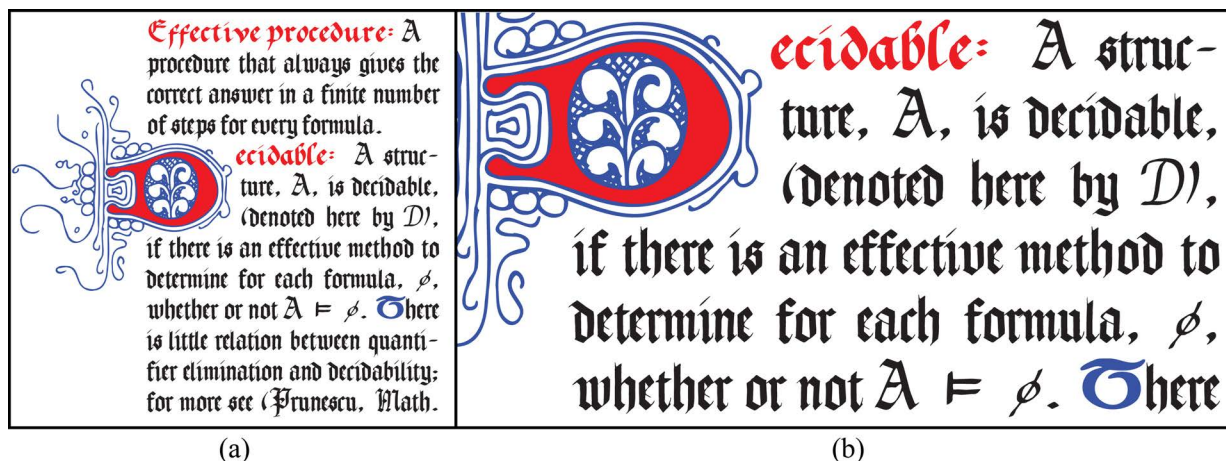
Figure 3: *(a) Example page typeset with callgraphic fonts in LaTeX. (b) Detail of the typeset page showing the use of different calligraphic fonts, color, a drop capital letter 'D' and a swash letter 'T' to selectively add calligraphic details and variety.*

Summary and Conclusions

I have outlined a process for creating illuminated mathematical manuscripts with a hybrid approach including hand-created pages and scripts together with printed pages typeset in LaTeX, the typesetting system commonly used by mathematicians for writing mathematical papers. I developed calligraphic Unicode OpenType fonts that could be typeset in LaTeX by using the XeTeX extension of the TeX engine. This work creates a pathway for artistic expression of written mathematics by uniting it with the creative world of calligraphy to produce mathematical illuminated manuscripts. After producing the printed text and some hand-illuminated folios, the pages created here can be hand bound in a book. Combinatorial options for the display of the hand-produced pages in books produced this way could be generated by including two or more hand-calligraphed, illuminated folios per book, bound with the printed pages.

References

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