A Suite of Typesetting Tools for the Web-Enhanced Classroom

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ABSTRACT

In ever increasing numbers, schools and businesses are turning to open source solutions in their quest for stable computing environments and technology tools requiring minimal maintenance and cost. Technical typesetting, needed for producing attractive and accurate documents containing mathematical formulas, requires powerful formatting tools. In addition, classroom presentations and web-based materials can be enhanced with graphics. For online publishing, it is preferable to produce generic solutions which are not restricted to a single platform. We present an array of tools which work in conjunction with LaTeX and provide the ability to do screen capture, create drawings, import graphics, produce presentation slides, and PDF or HTML documents. URLs where the software can be downloaded are included.

Keywords: learning objects, Linux, LaTeX, open-source, typesetting, web-based education

INTRODUCTION

A couple of the hottest learning technology buzzwords these days are *learning objects*, which may be defined broadly as "reusable digital resources" [1]. As educators know, producing digital resources requires a large investment of time and energy. The adjective "reusable" becomes increasingly important as the number of learning objects we produce and utilize soars. It is becoming critical that we find generic ways to encapsulate and distribute to our students and colleagues information about the content of our courses and research.

As a recent industry report by A. T. Kearney [2] notes, "the potential benefits of using network publishing tools and technology are enormous." In the educational arena, for example, lectures can be enhanced with the use of screen-based presentations, especially when they contain colorful graphics. Distribution of these presentations in note form is increasingly popular, both with faculty and students. Any material we can place online, such as slides, notes, manuals with hyperlinks, and lab files gives students instant access, whether they are on campus or half a world away. With standard file formats PDF and HTML, these files become platform-independent.

The push to utilize technology in our classrooms continues to grow. Along with such initiatives comes the challenge to find inexpensive solutions to web-based and classroom instructional needs. Open source operating systems and applications are quickly becoming a popular choice as an alternative to proprietary software, not only in academia, but even for entire governments [3, 4]. There is a wide variety of excellent software available for download at the click of a mouse. However, this variety can be a double-edged sword: although there are many solutions from which to choose, each has its own strengths and weaknesses. As a result, it can be difficult to determine which applications will provide the best tools for your specific needs.

To enhance our own classroom efforts and professional presentations, we sought a system that would integrate with the LaTeX software. We also needed to be able to put material online easily and quickly, preferring standard file formats. Whatever we chose had to be capable of producing some "special effects," 1-up, and n-up formats for our lecture slides, PDF and HTML files, and mathematical and specialized notation. After much searching, trial and error, and debate, we decided to adopt the applications listed in Table 1, all of which are available online at no charge.

Table 1. A Suite of Typesetting Tools

Package	Application and Web Site
TeX Live	Comprehensive TeX system `www.tug.org/tex-live.html`
pdfLaTeX	Create PDF files `ftp.muni.cz/pub/tex/local/cstug/thanh/pdftex/`
foilTeX	Create slides `www.ctan.org`
Ppower4	Add color and animation to slides `www-sp.iti.informatik.tu-darmstadt.de/software/ppower4`
hyperref	Create hyperlinks `www.ctan.org`
TeX4ht	Create HTML files `www.tug.org/applications/tex4ht/mn2.html`
gimp	Image manipulation and screen capture `www.gimp.org`
Xfig	Draw figures in various graphics formats `www.xfig.org`
emacs	Text editor `www.emacs.org`
aucTeX	TeX customizations for emacs `mirrors.sunsite.dk/auctex/www/auctex`

In the following sections we discuss the requirements and rationale behind our decisions, present various applications, and provide examples.

REQUIREMENTS

As with many educational institutions, our budget is limited, so we sought inexpensive solutions for our publishing needs. We have been using Linux as our primary operating system and LaTeX as our typesetting software for several years. LaTeX provides fine control of typesetting, has many strengths in mathematical typography, and supports a wide variety of special symbols. We had over 200 pages of existing LaTeX documents already in place. All this made made LaTeX an obvious choice; our interest was focused on non-proprietary solutions which would integrate well with it. Our goals were then to:

1. utilize existing LaTeX documents
2. create new documents with hyperlinks (clickable links to information internal or external to the document)
3. create screen-based slide presentations
4. package C++ source code for online distribution to our students
5. be able to create and include drawings and screen snapshots in all our documents, including slide presentations

RATIONALE

As the Kearney report [2] states (p. 24), "PDF (Portable Document Format): Allows for accurate and graphically rich layouts to be shared efficiently." We chose PDF and HTML formats since they also provide platform independence and viewers for these formats are commonplace. These characteristics were important since our campus has a wide variety of computing platforms, and few student-owned computers have Linux installed.

In his article about the MIT OpenCourseWare initiative [5], Philip Long asserts "Faculty members cannot be expected to create content twice, once for teaching and again for presentation to the broader academic public." This, too, supports our premise that the learning objects we create in the course of instruction should be generic enough to be reusable. Inherent in that viewpoint is the need for generic delivery systems which can utilize these learning objects.

Last year our university elected to adopt WebCT, a popular course management system. As we attempted to utilize it over a period of several months, we found it easiest to merely link from WebCT to our already existing course home pages, rather than try to port our documents to the WebCT system. Upon reflection, it seemed that the majority of our problems stemmed from both the proprietary nature of the software and the poor performance of the campus network. It became increasingly obvious that the time invested and the increased levels of frustration were not worth the minor benefits. Along with MIT and many others, we believe that faculty time and energy are better spent on non-proprietary solutions, regardless of monetary issues.

TOOL OVERVIEW

TeX provides the foundation for the tools we chose. There is a wealth of information and related software for this remarkable tool as its users continue to make contributions which extend its usefulness. For up-to-date information, CTAN—the comprehensive TeX archive network—is the primary clearinghouse [6]. TUG—the TeX Users Group—is another source of information about TeX and typesetting issues [7]. There are also many good reference books in print as well (for examples, see [8, 9]).

Since at this time HTML does not support mathematical notation except in limited ways, we chose to use the PDF format for our documents. The pdfTeX package, an extension to TeX, allows PDF files to be generated directly from TeX and LaTeX source files. An alternative is to utilize the DocMorph server provided by the National Institutes of Health [10] at no cost to the public. DocMorph transforms some 50 different file formats into PDF, creating downloadable files from the originals.

For web-based documents, we chose TeX4ht, a TeX-based tool which generates HTML files from TeX source. We also make use of hyperref, another TeX package, to create hyperlinks in PDF files.

We wanted to incorporate screen presentations (slides) in our lectures and web sites. There is a wide variety of systems which allow authors to produce slides: Wiedmann [11] surveys more than a dozen such systems. Included among the approaches are applications which produce PDF files and those that produce HTML files. Not all utilize LaTeX, although many do.

The need for "special effects" in our slides is currently fairly pedestrian: we want color, some ability for incremental screens, and some limited animation. We are much less interested in the more fanciful types of effects such as screen dissolves, sound effects, "dancing" letters, and so forth.

Along with the previously noted pdfLaTeX, the packages we selected to produce presentations are foilTeX, and Ppower4. As one might deduce from its name, foilTeX is used to produce slides. Ppower4 is a post-processor which can be used to add color backgrounds to slides along with other special effects, such as animations and incremental screens with pauses for emphasis.

Other open source applications we chose include gimp (GNU Image Manipulation Program) for capturing screen images, and Xfig (Facility for Interactive Generation of figures under X11) for drawing figures and diagrams. We also use emacs as our editor and aucTeX to customize it for LaTeX.

EXAMPLES

Utilizing these tools, we have been able to accomplish everything we had set out to do—providing hyperlinks in documents we had already written, creating slides for classroom and professional presentations, and incorporating mathematical typesetting and graphics in all our documents. Here we provide a few samples of how the various tools are being used.

Hyperlinks

Figure 1 shows the clickable Table of Contents from one of our online manuals as it appears in Acrobat, Adobe's PDF viewer. We had already written this manual in LaTeX to produce a printed handout for the introductory Computer Science course. It is one of the documents we wanted to place online with hyperlinks to topics to help students locate quickly and easily the information they needed. Of course, one can also page through it since it is a PDF file.

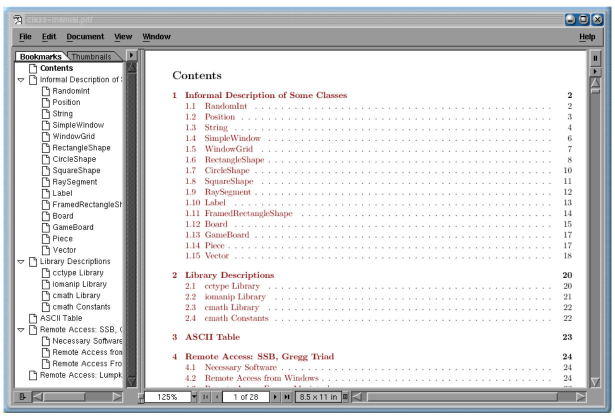

FIGURE 1. Online Manual with Hyperlinks

After learning how to use and incorporate the new packages, it was a fairly simple task to extend the LaTeX source document to automatically generate hyperlinks for section and subsection headings. The few lines shown in Figure 2 below were added to the LaTeX source document that already existed to utilize the hyperref package during generation of the table of contents. A link is created within the PDF document automatically for each section and subsection marked in the original TeX file. Both the entries in the table of contents and the bookmarks in Figure 1 (on the left) are hyperlinks.

```
\usepackage{color}
\usepackage[ps2pdf, colorlinks=true, bookmarks=true,
            bookmarksnumbered=false,
            bookmarksopen=true,
            linkcolor=webred]{hyperref}
\begin{document}
\pdfbookmark[1]{Contents}{tblc}
\tableofcontents
```

FIGURE 2. Lines from Manual Source Utilizing hyperref

Mathematics

It was especially important for us to be able to generate complex mathematical expressions for all our documents—slides, handouts, and online files. LaTeX again made this a simple process since it was created for just such typesetting, and through foilTeXand pdfLaTeX, any expression which can be created with LaTeX can be incorporated into slides. An example of this is shown in Figure 3.

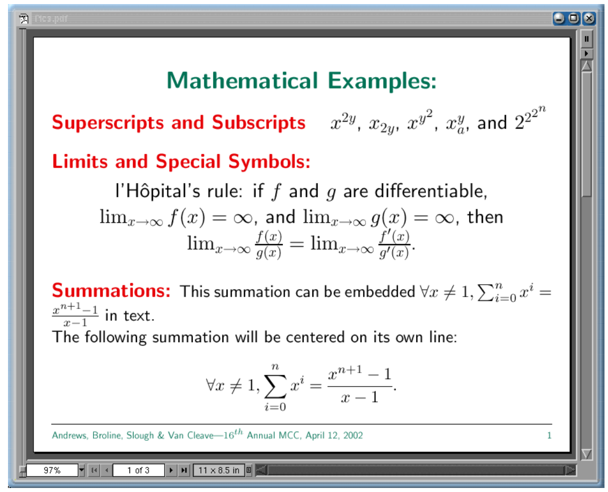

FIGURE 3. Sample of Mathematical Typesetting

Screen Presentations

Generating slides for lectures is time consuming, as anyone who has done so knows. However, there are many benefits in the long run. Several of us teach multi-section courses, and using the same slides helps keep us in synch. Slides arranged four or even eight to a page provide students with course notes in a compact format.

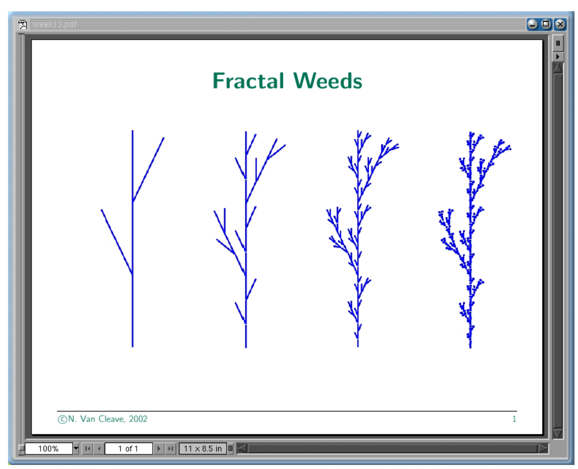

FIGURE 4. Slide Containing Four Screen Shots

Figure 4 shows a slide with the output from a C++ program. The program was executed four times, each resulting graphics output window was captured using gimp and then cropped and saved as an encapsulated Postscript file. These four graphics files were then placed on a single slide, side by side, using the same LaTeX command (includegraphics), which incorporates graphic files into any LaTeX document.

In Figure 5, a graphic file produced by Xfig is included, along with another gimp screen capture. Xfig was also used to draw the figures seen within the 4-up and 8-up slide examples in Figures 6 and 7.

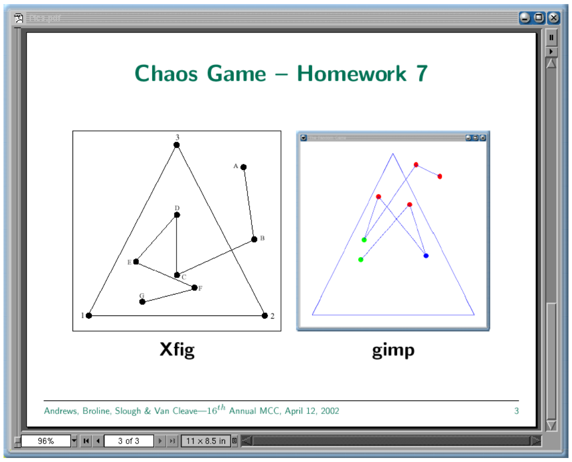

FIGURE 5. Slide Containing Both Xfig and Gimp Graphics

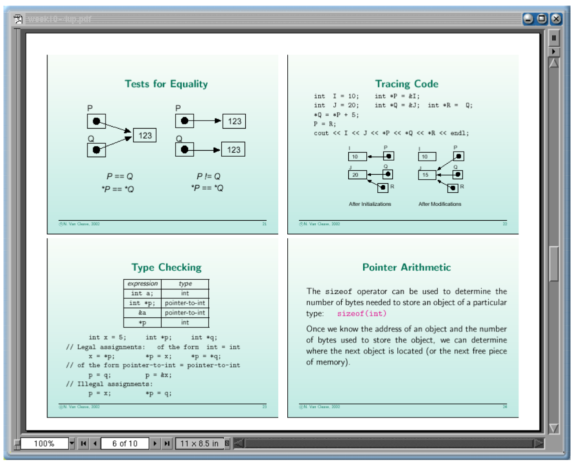

FIGURE 6. Sample Page of Slide Handout — 4-Up

The result of post-processing a PDF file of slides is shown in both Figures 6 and 7. The shaded background on each slide (originally in color) was accomplished with the Ppower4 application, then the resulting file was processed with pdfLaTeX to create either 4-up or 8-up output. This saves paper on handouts and makes it easier for students to page through the online version when reviewing or searching for information.

Web Pages

All of our work is brought together on our web pages. Here all the slides (in 1-up and 8-up form) are posted, as well as syllabi, course schedules, laboratory files—both writeups and archived program exercises and files, homework writeups and associated files, other course notes, and links to online manuals and other useful web sites (see Figure 8). The tar utility, available under Unix/Linux, is used to concatenate and compress files for archiving purposes, making them much quicker and easier to download. Associated with each weekly Computer Science lab are links to the PDF document describing the lab and exercises, a web page listing the individual files for the lab, and a tar file containing all the lab files. By placing all this information on a web page, we have made life much easier for ourselves.

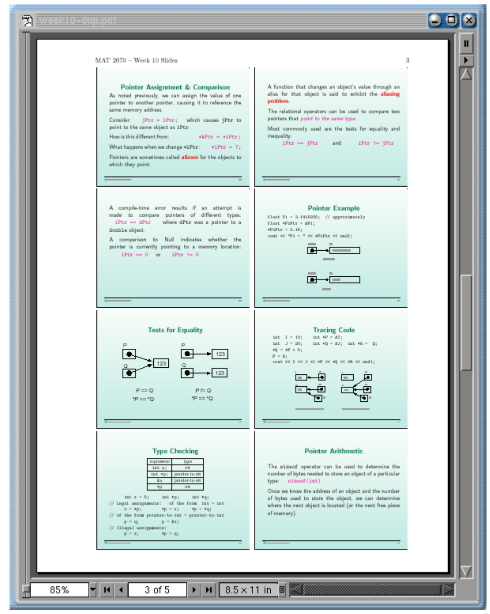

FIGURE 7. Sample Page of Slide Handout — 8-Up

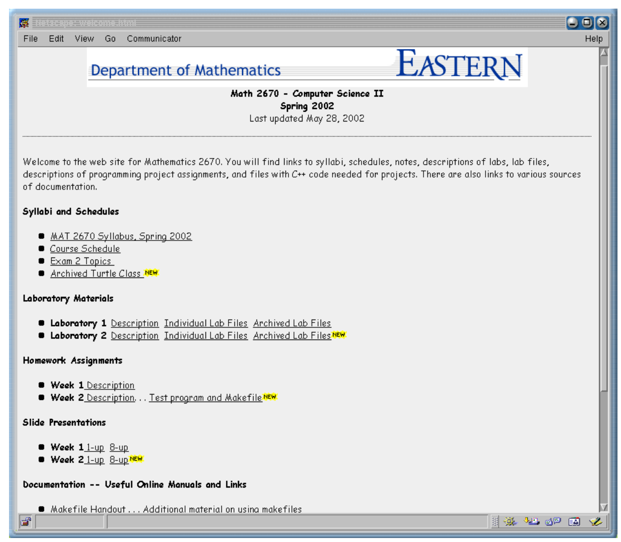

FIGURE 8. Sample Course Web Site

Using the web is an excellent method of dispersing information to students. They can access all these materials at their convenience and we no longer must search for handouts for those who miss class. As noted earlier, an additional benefit is that it provides a cross-platform mechanism for online distribution of all the documents and files generated with LaTeX and the other packages.

SUMMARY

To make the most of our resources, it was necessary to find fast, flexible, and inexpensive solutions to our educational publishing requirements. As more and more effort is put into online education, creating reusable digital resources, or learning objects, becomes increasingly important. To gain the most flexibility with the least re-processing, it makes sense to use standard file formats and open-source solutions.

The group of applications which we have found serve the majority of our needs include LaTeX pdfLaTeX, foilTeX, Ppower4, hyperref, TeX4ht, gimp, Xfig, emacs, and aucTeX. All of these resources are available free of charge via the Internet. These packages provide the specialized typesetting and other services required to produce professional quality documents. They were, after all, used to produce this paper.

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