eText: Electronic Textbooks

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ABSTRACT

The eText Project intends to create an "electronic textbook" for parallel software engineering. The Project has produced teaching and reference materials using custom applications, World-Wide-Web and Mosaic, and a new authoring and publishing environment, the eText Engine. The Engine is a user-friendly, object-oriented, compound document editor that provides a document-centric metaphor for hypermedia, as well as a flexible testbed for developing custom interactive media objects. Demonstrations of each of the systems discussed within highlight the use of hypermedia publication and education.

KEYWORDS: Compound Document Architecture, Hypermedia, Education, Publishing, Object-Oriented Design, User Interface Design

1 INTRODUCTION

Caltech's Archetypes eBook Project was established to create an "electronic textbook" to teach computer science concepts such as parallel programming. In our vision, a student can be guided by the textbook, an intelligent, multimodal, interactive knowledge base, as well as professionals. The eText Engine was developed when we determined that existing tools for authoring (and publishing) large hypermedia documents were not suited to presenting our content.

The Archetype software design methodology is the domain of a larger community of computational scientists, at Caltech and elsewhere. Our goal is to build a support system for that research, trying to balance the competing requirements to provide interactive simulations for teaching undergraduates, a professional-grade development support system, and publishing the system as widely as possible. For more information on the project, consult [1, 4, 5, 8].

2 SYSTEMS DEVELOPMENT

To some degree, the eText Project is systems-driven. Our vision for the text has been largely shaped by the capabilities of current hypermedia tools. As we developed the editorial structure of our text (see §3), we also surveyed the field and prototyped several systems, which eventually led to the creation of our own tool, the eText Engine.

2.1 Prototypes

In the early stages of the project, our plans were defined by the features of three systems we worked with. We studied, but did not adopt, database-oriented systems, small-focus systems ("card", "frame", and "web" metaphors), hyper-"text" systems that could not support interactivity, time-line based presentation packages, or systems not currently supported (e.g. *Intermedia* [6]).

MediaView [7], running on *NeXTSTEP* was our initial inspiration. One demonstration of *MediaView* featured an interactive graphics paper, including narration from the author, graphic and textual annotations, and a working simulation of the actual lighting model embedded in the document. From this, we appropriated a compound-document metaphor, and the need for interactivity. Rather than an animation or even a video of the lighting model simulation, we noted that the power came from actually implementing the model, right there for the reader to play with. However, *MediaView* did not have any support for linking documents or navigation in general, nor continued support from its authors.

Xanthus *CraftMan*, also on *NeXTSTEP*, is an interactive, interpreted prototyping environment we used to develop our first chapters. With it, we refined our ideas about interactive media by developing more algorithm visualizations, simulations, and quizzes. We began to attack the navigation problem, but each "document" we created was really an in-

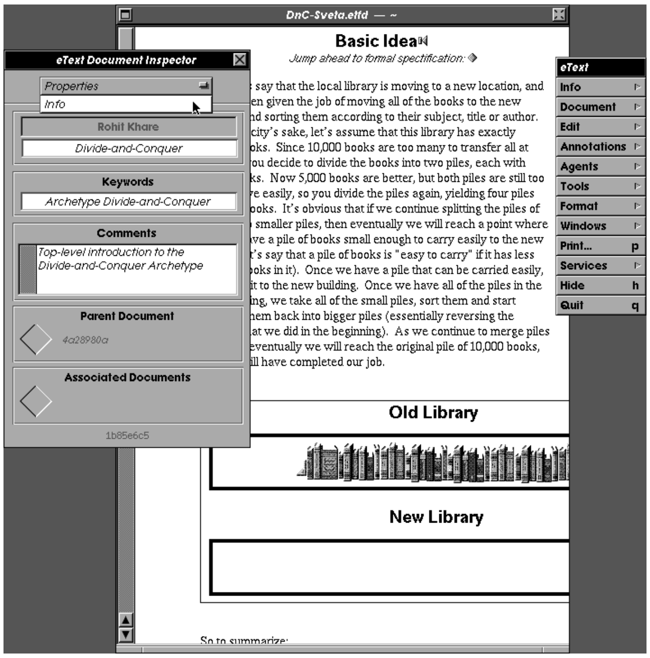

Figure 1: *An early* eText Engine *version of the Divide-and-Conquer chapter seen in Figure 4. The first button is a miniature speaker icon; the diamond is a link. The graphic is an inline slide show. The inspector is currently displaying the basic navigational information about this document: author, date, etc, and has diamond-shaped link-wells for dropping links to associated documents.*

dependent application, so the whole model was not designed to scale to handling hundreds or thousands of documents, nor to easily creating new ones. Publishing documents to a wide audience was also limited by the hardware and software requirements of the system.

The advent of the *World-Wide-Web* [2], particularly *Mosaic*, made publishing possible for our project. We refocused our development on creating HyperText Markup Language documents, and were successful with porting text structure, links, and some media types, but could not present the interactive ideas we had developed earlier. We had some success with using X toolkits to reimplement one of our simulations as an X application, and we are exploring the new capabilities of Forms, but we felt a real need to integrate the capabilities of the the two variants of our textbook.

2.2 The eText Engine

We planned a document-centric authoring system that could support hypermedia documents with fully interactive components, but could also automatically publish a subset of these documents to the Web, and other formats in the future.

The eText Engine is being developed under *NeXTSTEP* [3], an advanced object-oriented development environment, and is shown in Figure 1. For creating, viewing, and converting documents, it is comparable to a word processor, with multiple documents, multiple undo/redo, rulers, WYSIWYG, printing, faxing, spell-checking, drag-and-drop, and so forth. New annotations can be created in a variety of ways. For example, an audio annotation can be created by importing an audio file, pasting audio data from another application, dragging in a sound icon, or choosing a menu command. Click on the sound-icon, and the Inspector displays the waveform, editing, and playback tools. Similar ease-of-use applies for other media types, even running custom simulations. Linking is achieved through a drag-and-drop operation; simply create a bookmarked region, and drag it out to another document.

3 APPLICATIONS

The three variants of the textbook we have worked on have taught lessons in their applications to our twin challenges of education and publishing.

3.1 Education & Reference

We initially deployed the *CraftMan* version to teach an undergraduate course at Caltech. From student feedback we observed that the interactive features were a valuable part of the experience. Contrasting this with later experience with the *Mosaic* version, we noted that developing custom extensions should be an integral part of an authoring environment.

Navigation is simplified by the regular structure of Archetypes over the three-level Archetype, Application, and CaseBook implementation hierarchy. However, scenarios for an expanded textbook along with a much wider selection of implemented codes all require more powerful navigational models, particularly for exploring the text. Full-text search is the beginning of the process for a professional programmer trying to find a relevant Archetype for parallelizing code; associated documents need to be retrieved, links made from point-to-region, and incorporation of information outside the hypermedia system. Teaching scenarios included guided tours, personalization, and user-tracking navigation. Many of these lessons have been incorporated into the Engine's architecture and implementation.

3.2 Hypermedia Publishing

The compound-document model used at the core of the Engine outputs Enhanced Text Format documents (ETF) using Microsoft RTF for formatted text and a directory for object annotations to store component data (images, audio, simulation state). This mechanism can be remapped to produce other formats, such as HTML. By automating the process, we can maintain the same document base in two formats simultaneously, allowing *NeXTSTEP* and *OpenStep* users to create an view the complete documents, and others to access the bulk of the information on the Web.

4 CONCLUSIONS

A Demonstration highlights several lessons learned from the eText Project to date. In the search for a system appropriate for producing interactive textbooks, we designed and built the eText Engine. In designing the educational content of a hypermedia textbook, we saw how support for navigation, interactivity, and open publishing are equally important. We have attempted to balance these three concerns in our custom systems development, use of HTML and the World-Wide-Web, and in the architecture of the Engine.

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