Media Enhancements for a Pilot Tablet-Based Engineering Design Graphics Textbook

D.R. Talancon and D.K. Lieu
Department of Mechanical Engineering
University of California, Berkeley
USA

Introduction

Electronic versions of textbooks are becoming popular in many fields. Such textbooks are not only less expensive to students, but are also lighter and more portable than most conventional textbooks when used with tablet or laptop computers. In addition, for many subjects such as engineering graphics, electronic textbooks offer a unique opportunity to provide a richer learning environment with added resources. For example, video and animation add unparalleled clarity to the conventional text description and static figures typically used for textbook presentations. In a pilot study, a interactive electronic textbook was created by a third party, SnapWiz , Inc., in cooperation with the textbook publisher, Cengage, Inc., and the textbook authors. Apple iPad 2 tablet computers were used as the hardware platform. A PDF version of the textbook Visualization, Modeling and Graphics for Engineering Design (Lieu and Sorby) was loaded onto each tablet, and media enhancements were added to the basic images. In addition, the enhanced electronic textbooks were linked to a server to provide forums for the sharing of notes and questions between all the users of the book.

Method

A 14 week study was conducted in the spring semester of 2012 using a quasi-experimental research design. A third party, Innovative Tailor-Made Training and Technology (ITTT), was contracted to assist with the assessment of the technology and its effects on teaching and learning. The study used a combination of surveys, interviews, and focus groups on a sample of 63 students (40 in the Treatment group and 23 in the Control group) who were enrolled in the Introduction to Engineering Design Graphics (E28) course at the University of California, Berkeley. The Control group used a web-based version of the Lieu and Sorby textbook, which essentially consisted of static PDF files. The Treatment group used the tablet application of the same textbook on an iPad as their course textbook. Both the Treatment and Control groups were provided their textbooks at no cost. All students were notified of the two-section study at the beginning of the semester, with the Treatment group requiring the use of an iPad (which would be provided free of charge during the semester). The assignment of students to either the Control or Treatment group was done randomly, and all students in the Treatment group had the option to transfer into the Control group (although none did). The instructor and teaching assistants were different for the two groups.

The tablet application synchronized the content to the device in real time and allowed students to learn offline. The instructor could enter notes, information, quizzes, key and/or frequently asked

questions, high resolution and rotatable illustrations, and videos that allowed students to interact with the textbook. This, in theory, would save significant amounts of time by posting answers to the same questions that many of students ask.

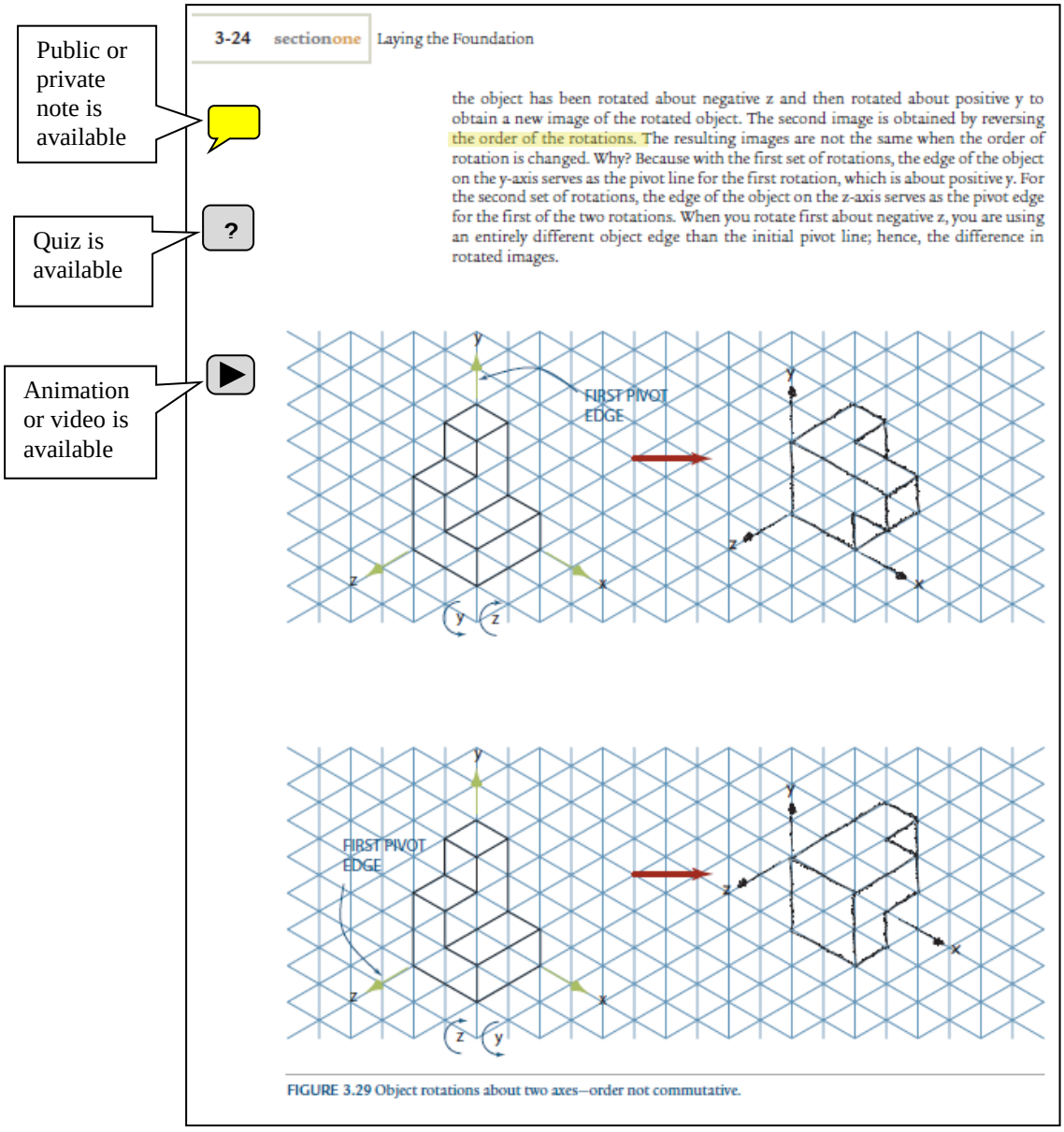

Figure 1. A page from the PDF version of the textbook, showing links to added resources.

The tablet-based textbook included the following media enhancements to the PDF files:

- Enhanced navigation - Navigation features were added to enable students to page forward and backward, jump to desired chapters from a Table of Contents, and jump to bookmarked pages.
- Lecture slides – A tab was provided to view PDF version of the instructor's lecture slides, as they became available.
- Link between lecture and textbook – When applicable, a touchable link was provided on each lecture slide to open the book to the relevant page where the lecture material is covered.

- Quiz questions – A multiple-choice, interactive quiz question was provided at every section within a book chapter. A series of multiple-choice, interactive quiz questions was provided at the end of the chapter.
- Streaming video enhancement for selected figures - Over 200 animations or videos were available by streaming from a server via Internet. These animations enhanced selected figures throughout the book.
- Personal and shared notes – The textbooks were networked to a server to enable students to highlight text and figure to create either private notes or notes that are shared with all users.
- Shared questions – Networking of the books also provided a forum for sharing questions, answers and comments, similar to social networking applications.
- Video presentation of solution – Video solutions were created for over 50 homework exercises from the end of the chapters.

A sample of the textbook interface is show in Figure 1. The basic image is the PDF image of a page from the conventional textbook. Students can add private or shared notes, or questions, by touching and dragging across text or figures to create a highlight. A text window then appears in which notes can be added, and a note icon appears in the margin beside the highlight. Notes and questions are hidden until the note icon is touched. Questions are listed on book's home page, and can be answered by any user. If a video is available to enhance a figure, the video icon can be touched to start streaming the video to a window that appears on the page. An example of a video window is shown in Figure 2. Video streaming and note sharing required a wireless Internet connection. The basic book file was resident in the tablet, and required no Internet connection to view

The effort required to produce the animations and videos required the full time attention of the instructor and a graduate teaching assistant between the Fall and Spring semesters (approximately 4 weeks), and the part time assistance of an undergraduate student (approximately 3 hours per week) during the Spring semester. Homework solution videos were created throughout the semester by the graduate teaching assistant, and were made available after each assignment was due. A sample frame from the streaming video, linked to a textbook figure, on fabrication processes is shown in Figure 3.

Results

Student focus groups were organized at the beginning of the course, and after the course ended. In addition, the course instructors were interviewed at the beginning and end of the course. The consensus of the students at the focus groups was that there were no significant disadvantages to using a tablet based textbook as opposed to a conventional textbook, and the navigation functions were quickly and easily mastered. There was agreement that the media enhancements significantly improved the speed and comprehension of many topics. The most useful enhancements were the videos and animations, particularly for the chapters on visualization, fabrication processes, and geometric dimensioning and tolerancing (GD&T). The results of a download tracker, shown in Table 1, revealed the average usage of certain features throughout the semester.

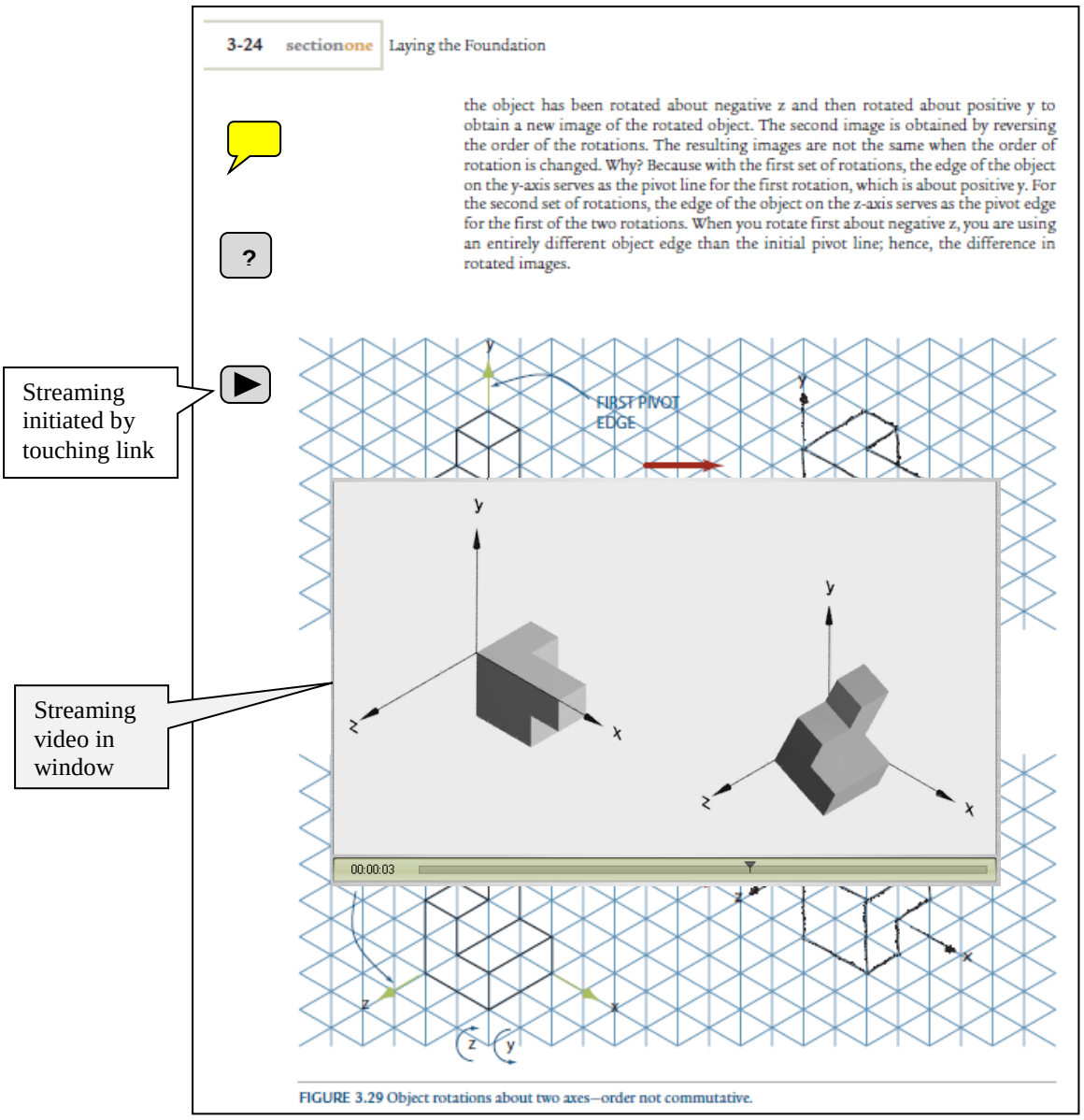

Figure 2. A frame from the streaming video for the figure after the link is touched.

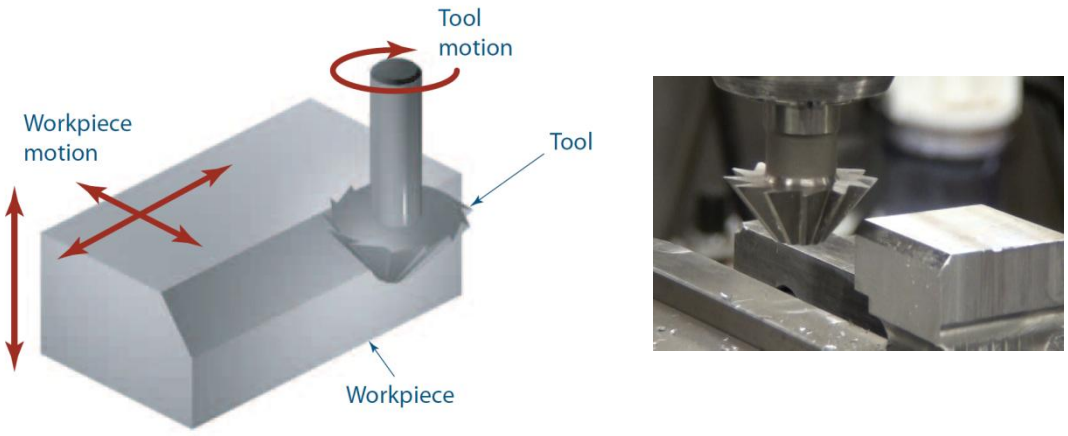

Figure 3. A figure from the textbook showing a machine shop process, and a single frame from the streaming video linked to the figure.

Feature	Avg. Usage/Day
Video	89.33
Q & A	21.83
Notes	18.58
Quizzes	13.33
Link	6.40

Table 1: Average App Usage Per Day

The range of usage showed a high of 89.33 uses per day on average for the Video feature and a low of 6.40 uses per day on average for the Links feature. This is consistent with student comments in the focus groups and on the questionnaires. The instructor and teaching assistant also believed that the video portion was a very valuable feature. Not surprisingly, that the number of video downloads increased dramatically prior to exams. The Q & A feature at 21.83 uses per day showed great potential. The consensus of the student and faculty responses was that this feature, along with the automatic syncing, helped students get answers to their questions quickly and see what other students were thinking. Notes and quizzes usage at 18.58 and 13.33 uses per day, respectively, indicated that students found the features to be useful, but did not use them as often as the video feature. Both the students and instructors viewed the links between the instructor's slides and the textbook as highly valuable, but the usage at only 6.40 uses per day did not reflect this notion.

There was disappointingly low participation in the two surveys of Treatment group: n = 10 for the first survey, and n = 6 for the second survey. However, the results of two questions stood out. Students scored "The videos were useful for learning" at 4.18 at the beginning of the course, and 4.20 at the end of the course (1 -5 scale, with 1 = strongly disagree, 5 = strongly agree). The data also indicated that the Q & A feature was useful at the beginning of the study and that students started the study with a high usage and satisfaction starting at 4.00. At the end of the study, student demand and interest for this feature decreased from 4.00 and 2.20. Students apparently abandoned this feature by the end of the course. This trend was apparently caused by an early problem in the software, which caused many shared questions, answers, and notes to randomly disappear during the first few weeks of the semester. These early problems apparently made students mistrustful of these features, and limited their use even after the problem was corrected early in the semester. It is important to note, however, that at the end of the study, the students stated in the focus group that the Q & A feature was very important when it worked properly. They thought that being able to post questions and get them answered immediately with multiple answers (from students and faculty) was highly beneficial and would be even more beneficial in a larger class.

Discussion and Conclusions

The students in the post-study focus group agreed that the interactive eBook was a powerful learning tool. Overall, they enjoyed using it and would use this interactive eBook app again. One student stated in the post-study focus group, "[The app] was really good for the textbook, …the videos were very helpful in understanding machining processes. It was light and easy to carry around …"

Another student stated, "What is most convenient about this app is that it allows you to have all your text notes, it allows to you connect text notes to the lab notes, lecture notes, and have assignments all in one place. It is really convenient because I don't have to go hunting [online] for things on [UC Berkeley's] bSpace."

The use of a tablet based electronic textbook appeared to create no significant disadvantages over using a conventional paper-based textbook. The media enhancements appeared to be useful for the comprehension of many complex engineering graphics topics. The media enhancements required only a moderate amount of effort to create, and most of this effort was non-recurring. The pilot study showed that it is possible for 3rd party developers to help integrate media enhancements into existing, static, textbooks, thus obviating the need for authors or publishers to develop electronic textbooks from basic components. Although the, question/answer and note sharing features in the pilot study were not utilized as much as had been hoped, these features may lead to significant development of media enhancements by students and third-party developers in the future. Links to these enhancements might then be licensed or shared among users of not only the primary textbook, but also to other textbooks of the same or similar topic. Finally, there was a strong recommendation from the student focus groups for imbedded access to video calling applications, such as Skype, for direct access to instructors or authors.

The post-study focus group reported the following weaknesses in the app that should be addressed:

a) Increase image resolution to avoid pixilation on zoom.
b) Create a handwriting component with a stylus for note taking in class.
c) Change the tap for zoom to a pinch feature.
d) The Q & A would be more effective in a larger size class.

The post-study focus group interviews students also reported that they benefited from using the eBook app during the semester for the following reasons:

a) All of their instructional material was organized in one place.
b) The videos illustrated important information in the text.
c) The professor's links from his lecture slides to the textbook helped them independently learn important concepts.
d) The Q & A feature is valuable and would be even more effective in a large class for more student input.

References

Lieu, D.K. and Sorby, S., 2009, *Visualization, Modeling, and Graphics for Engineering Design*, Cengage Publishers Clifton Park, New York.

Acknowledgements

The authors would like to thank Snapwiz, Inc., Cengage Publishers, and Innovative Tailor-Made Training and Technology (ITTT) for their support of this project.