Designing a Self-Instructed, Project-Based Multimedia Course in Engineering Education

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Abstract:
Multimedia applications are finding their way into every engineering discipline as powerful tools to facilitate more effective learning via visualization and multi-dimensional comprehension. However, the high cost to develop such applications is recognized. A proposed economical solution to this issue is to utilize the senior or master's level engineering student projects in this endeavor. This solution requires the interested institutions or faculty to offer a course in multimedia production to provide the necessary collective training at no cost. This works both ways as it offers the students with valuable technological edge. The proposed course, in its major part, is project-based with a well-defined project theme for each offering. To optimize time, quality and resources of the course delivery, the authors developed a multimedia package to auto-instruct the multimedia skills in a structured curricular fashion. This application, Multimedia Auto-Instructor, has been preliminarily tested in conjunction with a formal multimedia class setting. The application is anticipated to be available on a CD-ROM and on line for future course offerings.

Introduction:
As we enter the new millenium, engineering education is facing challenges that ought to be met. More creative and effective teaching styles and tools need to be developed to meet the increasing demands on covering more of the ever-expanding domain of engineering knowledge and applications. The revolution in computer capabilities, affordability, compatibility and interconnectivity is paving the road for such an anticipated reform. One of the promising enabling tools is the development and integration of innovative ideas, different digital media and computer applications into seamless packages through hypermedia. Abbanat and Honchel[1] address the high cost involved in developing multimedia educational tools versus their small market. They suggest creating markets for such products through repackaging. The authors propose the better alternative of producing less expensive products to keep focus on development rather than business. It would appear to the reader that the appropriate infrastructure in this development process is the upper level undergraduate and Master's project work. For the sake of efficiency and quality of production, the training of senior and master's students in multimedia skills prior to or during engagement in their 3 credit hour project work is a necessity. Schools with interest in such educational reform, or in its increasing grant dollars, are finding an obvious need to start introducing multimedia authoring courses into their curriculum[2]. In this context, multimedia course training is self-sufficient, since it pays-off through tuition rather than grants, and self- productive, as it may utilize student projects during the same course to develop various application modules.

Despite the hundreds of multimedia applications authored for engineering education, the literature seems to be short of studies on developing courses that train engineering students in the subject. Gramoll and Craig[2] reported on introducing such a course at Georgia Tech. However, the focus in their paper was on presenting and comparing the software required to teach such a course. They concluded that the quarter-based (10-week) course work was not sufficient to cover tools needed to achieve the purpose. The authors agree that a 15-week semester course is found necessary to provide adequate multimedia training.

Multimedia Course Syllabus:
The Department of Civil Engineering and Construction at Bradley University has offered a graduate course in multimedia applications five times since summer 1997. The course is entitled "Multimedia Applications in Civil Engineering and Construction". This course was first introduced by Dr. Saad, currently at East Carolina University[3]. The senior author taught this class in Fall 1999, which was taken by 20 students of diversified backgrounds, mainly in engineering. The course did not have a textbook but relied heavily on a well-defined sequence of lectures, instructor's notes and experiences as well as few software manuals. The subjects covered in class included multimedia elements, presentations and navigation shells; still picture processing; digital sound and video processing; interactive authoring and scripting; animation and simulation in engineering applications; packaging and web publishing. The breakdown of the course material by topic, as outlined to students by the senior author, is listed in the Appendix. The software usage and timeline are provided in Table 1.

Multimedia Course Theme:
The technical content and engineering merit portion of this course is introduced through two-member team projects. Students select from a predefined list of subjects forming the theme of the course at the time of offering. These subjects are limited in scope and expectations to a 3-semester credit hour independent work with some project description and guidelines provided before hand by the instructor. The senior author has used the concepts and applications of fiber reinforced composites in engineering as a subject pool with a variety of topics for students to choose from. The final goal was to develop teaching and tutoring modules possible to integrate into an application serving the undergraduate/graduate engineering education. Students are expected to perform literature and media search on their respective subjects, outline their application structure and integrate different media to produce standalone self-sufficient packages deliverable on a CD-ROM. The subjects selected out of this course theme were:

1. Introduction to FRP Composite Materials
2. FRP Composite Manufacturing and Processes
3. Repair of Bridge Girders with FRP Composite Plates: Design and Installation
4. Repair of Bridge Columns with FRP Wraps: Design and Installation
5. Applications of FRP Composites in Civil Engineering and Construction
6. Applications of FRP Composites in Engineering.

Projects on other subjects were also accepted as they were justified by written statements to phase into the department instructional tool development needs.

Multimedia Auto-Instructor:
Acquiring the multimedia production skills requires a good computer background and minimum engineering or programming prerequisites due to the advancement in computer graphics and object oriented applications. Accordingly, teaching multimedia concepts may be easily automated in a step-by-step tutorial style. However, this automation is structured in a formal course format, which differs from the style of individual software tutoring available through various manuals or tutorials.

Auto-Instructor is intended to serve as an independent tutor to the multimedia course described above, Fig. 1. The application's table of contents was tailored towards the course outline presented in the Appendix. The teaching environment it offers has two distinct styles, a stepwise "how to do it" and a sample of "how it will look like". The first objective behind its development is to evaluate the merits of using it to replace formal classroom environment versus having it as a supplemental course material. Secondly, it is aimed to test the product as a distance learning tool by offering the course on campus and online simultaneously.

The navigation shell of Auto-Instructor is developed using Toolbook II Instructor of Asymetrix[4]. The media used to emulate the instruction process are screen movies, sequential step-by-step still picture frames and pop-up viewers. Screen movies are used whenever live animation is needed to illustrate a concept like linear or nonlinear navigation, slide transition effects and simulation, Fig. 2. Still picture frames are utilized to show the sequence of commands or steps taken to perform a task, Fig. 3. Pop-up viewers are made available for instant definition or help fields to the technical content of the application, Fig. 4. Auto-Instructor is supplied with a library of links to media web sites for student production usage.

Product Testing:
Twelve students evaluated the application and responded to the survey conducted by the authors. There were five main statements, which the evaluators rated on a scale of 5 (with 5 being the highest). These statements are:
1. The application could serve as the main instruction medium, with office hour help through a designated instructor.
2. The application could serve as the main instruction medium, operated in class under the supervision of a designated instructor.
3. The application should serve as a tutor or a supplement to the traditional class setting.
4. I will be interested to take this class online if taught through auto-instructor and email/chat interaction.
5. The instruction style of the application is very clear and easy to follow.

Fig. 5 presents the average scores obtained from the evaluations. Although all averages are in the same proximity, it is obvious that there is a merit and interest in the application. Students rated the use of the application in classroom under supervision the highest and

using it independently the lowest. While two students were completely against online course offering, five others gave it a perfect score of 5. The highest score given was on clarity of presenting the material, which is very encouraging. Some of the good additional comments indicated the need to more human interface within the application. As a result, more emphasis is currently placed on adding more audio elements to supplement visual instruction. Others stressed the need to add a search engine or index for quick reference. This will be introduced in the future.

Summary and Conclusions:
Multimedia is increasingly recognized as the proper development medium for advancing the teaching/learning environment. Accordingly, it is essential to include multimedia in undergraduate or graduate-engineering programs interested in instruction technology and instructional research and development. On the other hand, learning multimedia skills does not require rigorous technical coverage or traditional course work. It is based on well-planned sequence of lectures on using existing software packages to process and integrate different media. Engineering schools, interested in this field, have to normally spare a faculty member, specialized in another engineering area, to teach such a course. In this work, the authors are proposing a multimedia-based application to auto-teach multimedia courses as an effective means to save time and resources. It is suggested that an instructor should still be assigned to the course to monitor progress and assure quality. Students registered in such a course are expected to have access to the application through CD-ROM installation. The application will be provided with a web installation option and will be tested in the future. It provides students with weekly assignments that may be submitted by email to the instructor. The major part of the grade is based on a two-member team project. Team members should select a topic of interest, perform literature and media search and develop a multimedia application deliverable on a CD-ROM. It is suggested that the instructor define a project theme every time the course is offered. This way, student projects could form small modules possible to integrate into major applications. The article presents the structure of the proposed application, the media developed and the strategies designed to produce an efficient package with reasonable time frame and resources. Student evaluation, to the developed application, clearly recognizes its merits.

Acknowledgement:
The multimedia computational facilities of the Department of Civil Engineering and Construction at Bradley University were used to teach the multimedia course discussed herein.

Bibliography:
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2. Gramoll, K. and Craig, J. 1995. "Teaching Multimedia Course in Engineering Education." *Proceedings of the 1995 ASEE Conference*, Anaheim, CA, Session 3520.
3. Saad, I. 1999. " http://www.sit.ecu.edu/cm-dept/saad.htm," Faculty Personal Web Pages at East Carolina University.
4. Asymetrix Corporation 1996, "Toolbook II Instructor: A Guide to Creating Interactive Courses," Bellevue, WA, 348 pp., http://www.asymetrix.com.

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Appendix:
Excerpts from the multimedia course outline provided to students are given below:

GOALS: To build production skills in the areas of interactive technical applications and presentations, integration of various media and software packages and broadening technical knowledge in CE and CON through project-based work

TOPICS:
1. Introduction
    - Defining Multimedia
    - Types of Multimedia Presentations
2. Introducing Simple Multimedia Documents
    - Background
    - Text
    - Graphics
    - Pictures
    - Sound and Animation
3. Developing Simple Multimedia Navigation Shells
    - Linear Navigation Shells
    - Nonlinear Navigation Shells
4. Digital Sound Processing
    - Sound Recording and Playing
    - Sound Editing
    - Sound File Formats
5. Still Picture Processing
    - Screen Capturing and Editing
    - Scanning and Editing Pictures and Documents
    - Picture File Formats
6. Interactive Multimedia Authoring
    - Authoring Concepts
    - Object Hierarchy and Object Titles
    - Navigation Tools
    - Navigation Script
    - Navigation Design and Pitfalls

- Levels of Authoring Interaction and Control
7. Digital Video Processing
     - Video Recording and Playing
     - Video Editing
     - Video File Formats
     - Digital Video Capturing
8. Animation and Simulation
     - Object Animation
     - Simulation and Modeling
     - Recording Simulations
     - Simulation and Animation in CAD Systems
9. Application Packaging
     - Packaging Process
     - CD-R and RW Writing and Testing
10. Web Publishing
     - Web Page Authoring
     - Posting and Maintaining Web Pages

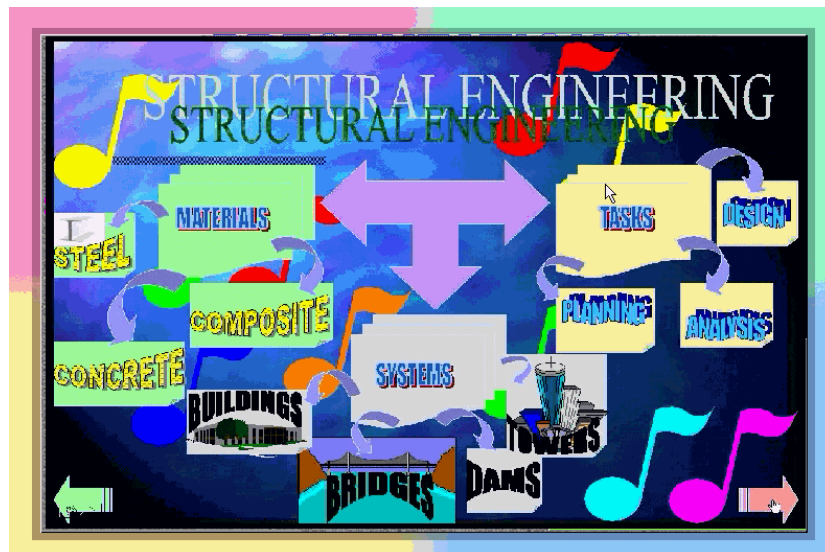Fig. 1. Visual Presentation of Multimedia Concepts
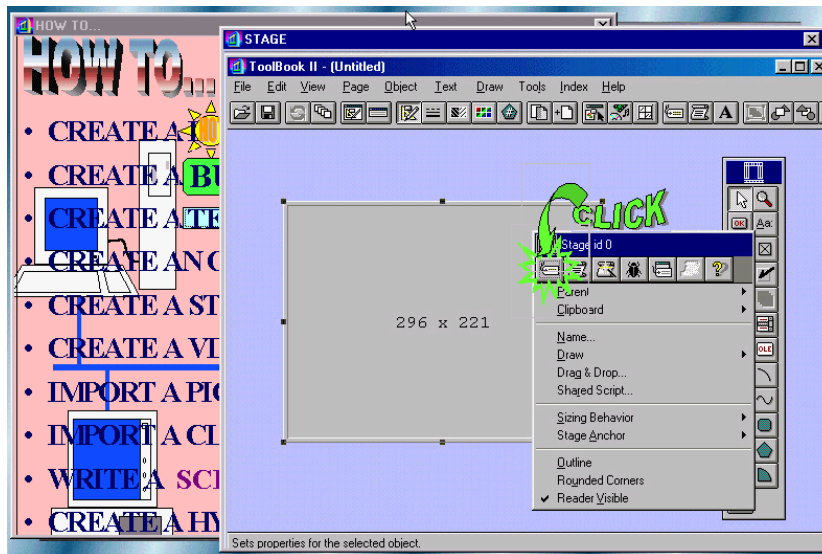

Fig. 2. Screen Movie on Linear Navigation

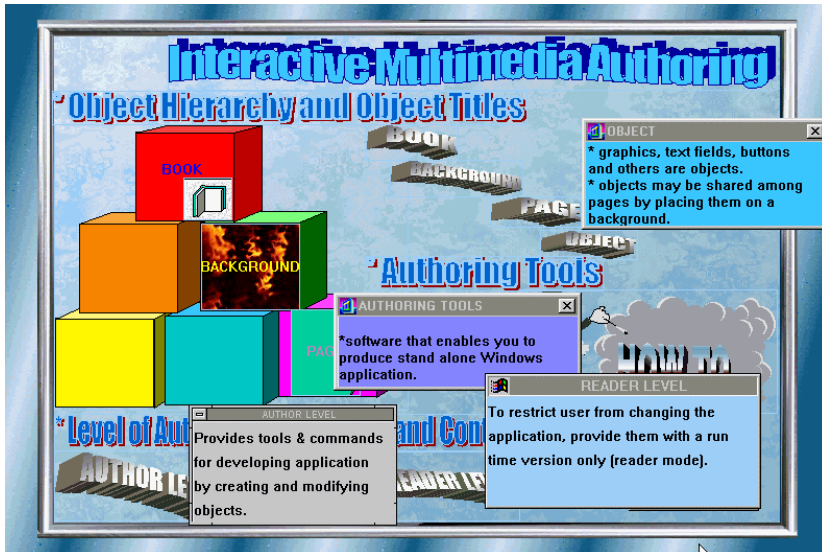Fig. 3. Step-By-Step Command and Procedure Instruction

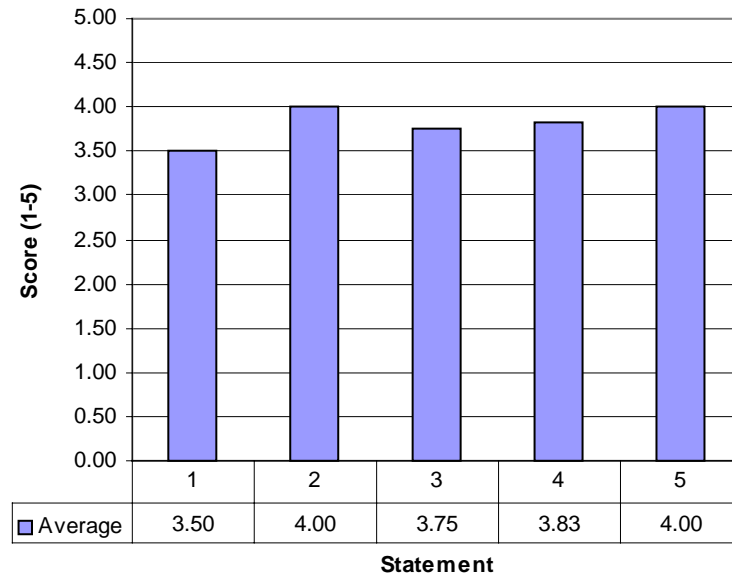Fig. 4. The use of pop-up viewers for instant explanation

	1	2	3	4	5
□ Average	3.50	4.00	3.75	3.83	4.00

Statement

Fig. 5 Student Evaluation Average Scores for Auto Instructor

Table 1. Proposed software and timeline for multimedia course

Topic	Software	Company	Week
1. Introduction	Power Point	Microsoft	1
2. Simple Multimedia Documents	Power Point	Microsoft	1 and 2
3. Multimedia Navigation Shells	Power Point	Microsoft	2
4. Digital Sound Processing	Audio Station 32	Voyetra	3
5. Still Picture Processing	Photo Editor	Microsoft	4
	Embellish	Dadaware	4
	Paper Port	Visioneer	4
6. Interactive Multimedia Authoring	Toolbook II	Asymetrix	5, 6 and 8
Presentation I			7
7. Digital Video Processing	DVP	Asymetrix	9
	Screen CAM	Lotus	10
8. Animation and Simulation	Working Model	MSC WK	11 and 12
	AutoCAD	Auto Desk	12
Presentation II			13
9. Application Packaging	Toolbook II	Asymetrix	14
10. Web Publishing	Word & Front Page	Microsoft	14 and 15
	Toolbook II	Asymetrix	15