Statics On-Line: A Project Review

David B. Oglesby, Edwin R. Carney, Michael Prissovsky, Dave Crites
University of Missouri - Rolla

Abstract: Software developers and content experts from the Basic Engineering Department at the University of Missouri-Rolla are engaged in the development of on-line learningware material for Engineering Mechanics - Statics. An initial, draft release of *Statics On-Line* is planned for the Fall 1998 semester. This paper provides an overview of the project.

Statics On-Line is described from a number of different perspectives. The eventual commercial product is envisioned for use by on-campus students with their on-campus instructors. The product, with its audio/graphic mini-lectures and various interactive components, presents an instructor with the opportunity to experiment with how classroom time is spent. The pedagogical components that comprise Statics On-Line are discussed in some detail.

The Statics On-Line project emerged from two separate, but related, projects. One was a multimedia project aimed at developing tools to aid the instructor in the classroom. This first project was called "BEST" (Basic Engineering Software for Teaching) Statics. A second project, On Call Instruction (OCI) for Statics, was directed more toward the students from the outset. Its aim was to provide audio mini-lectures and other supplementary material directly to the student over the Internet on a "just in time" basis. By combining the two projects into Statics On-Line, the result has been a product that better addresses the needs of both teacher and learner. Portions of the software are currently in use by on-campus students and instructors at the University of Missouri-Rolla.

Introduction: The faculty of the Basic Engineering Department at the University of Missouri-Rolla (UMR) are actively engaged in the development and use of technology in the classroom. Two software tutorial projects, funded in part by the Instructional Software Development Center at UMR, have emerged under the BEST™ series of products banner. The first and most mature BEST™ (Basic Engineering Software for Teaching) project is the Engineering Mechanics - Dynamics[1,2] project. This project was followed by the "BEST" Statics project. Yet another project[3], sponsored by the department, experimented with distributing course material and competency quizzes via the Internet. A more recent project, On Call Instruction for Statics, experiments with the delivery of course mini-lectures via the Internet.

Many of the lessons learned and much of the material developed by the projects outlined above are now being combined to form a new product referred to as *Statics On-Line*. Statics On-Line evolved from "BEST" Statics and On Call Instruction for Statics. "BEST" Statics was primarily a multimedia project aimed at developing tools to aid the instructor in the classroom; while, On Call Instruction (OCI) for Statics was directed more toward the students with the aim of providing audio mini-lectures and other supplementary material directly to the student over the

Internet on a "just in time" basis. By combining the two products into Statics On-Line, the result has been a product that better addresses the needs of both teacher and learner.

The project tasks included the initial design of a learningware architecture comprised of pedagogical components. This led to early prototype implementation and on-going refinement of the architecture. Finally, the development of the topic-specific educational content is on-going. This paper does not address bandwidth issues, emulation versus simulation, video versus audio/graphic mini-lectures, graphic formats, or any of the other technical issues and debates that are continually being dealt with as part of the project. Instead, the focus is on the pedagogical components that make-up Statics On-Line. It includes many of the lessons learned throughout the development process. Questions such as who uses it, how is it used, and what has been the response, are addressed as well.

Learningware Components: Statics On-Line is being designed to complement what is often referred to as a course on the Internet. Courseware material, as the term is used here, would include a course syllabus, lecture notes, problem solutions, sample exams, and perhaps E-mail links and/or on-line news groups. There are numerous examples of this sort of "course on the web." See www.umr.edu/~jthomas/statics/statics.htm or www.umr.edu/~eg10 for good examples of course material on the web.

As stated above, Statics On-Line is designed to complement today's on-line courseware material. It belongs to a new category of educational software for the web that is better described by the term *learningware*. A goal of Statics On-Line is to "provide a new environment for students to study and do their homework." It is positioned somewhere between today's textbook and classroom instructor.

Statics On-Line is a "work in progress." The components being designed for it are outlined below. Not all of them are implemented at this time. The project, in its current form, can be viewed at www.umr.edu/~oci.

    Concept Maps - material overview with forward and back links in the curriculum
    Conceptual Mini-Lectures - sequence of short audio/graphic lectures with back links
    Conceptual Self Tests - T/F and MC questions to test understanding
    Interactive Example Problems - students play "what if" by changing problem parameters
    Homework Problems - randomized, automatic submission, grading with instant feedback
    Electronic Bulletin Board - instructor/students asynchronous communication

Some additional features are planned for the future. These include the following.
    Whiteboard & Chat Facility - synchronous communication, "virtual office hours"
    Separate Instructor Accounts -
        Class grade reports, Exam material, On-line syllabus design tool
        Class project plans and other supplementary course material

The on-line material is arranged in the classical, sequential outline form. However, students may

choose to explore it in any order they desire. For the student that jumps too far ahead or is in need of review, keyword back links are included within the Conceptual Mini-Lectures. The back links point to earlier mini-lectures that cover the more fundamental concepts upon which the current material is based. These back links are not limited to the current course. In the future they may serve the important function of connecting an otherwise disjoint curriculum in the minds of the students.

Conceptual Mini-Lectures, Example Problems, and Concept Maps consist of a combination of audio, text and graphics. The graphics are synchronized with the audio. The result is similar to a view graph presentation where the speaker constantly changes the view graph as he or she speaks.

Too often progress is slowed due to misconceptions that are formed when studying new material. Conceptual Self Tests are included with most of the Conceptual Mini-Lectures. For most topics, the points at which students are likely to struggle are well known. The self tests are designed to trap and eliminate the common misconceptions as early as possible. They consist of true/false and multiple choice questions. Answers submitted by the students are automatically graded and instant feedback is provided. Hints are provided when a question is answered incorrectly.

On-Line homework problems with automatic grading and secure logging of grades are used to ensure that work is done in a timely manner. For instance, the amount of credit can be increased for homework that is submitted before a certain date. This can be used as incentive so students come to class prepared for the topic of the day. Randomized homework problems also help to ensure that each student does his or her own work.

For both distance education and on-campus courses, a combination of synchronous and asynchronous communication between students and their instructors is necessary. Threaded discussion groups and live chat sessions are planned for the future.

Learningware Users: As previously stated, Statics On-Line finds itself positioned somewhere between the textbook and course instructor. For the moment, it will not replace the textbook; and be assured, it will not replace the instructor. Statics On-Line is primarily intended for use by on-campus instructors with their on-campus students. It can also be used for distance education, but that is considered its secondary application.

A question that is often posed in light of the on-line audio/graphic mini-lectures, automated homework, and various interactive components is, "Will the students still come to class?" The answer is yes. An experienced instructor will have little difficulty maintaining classroom attendance. Statics On-Line presents an instructor with the opportunity to experiment with how time is spent in the classroom. Some of what is currently being done with class time (proofs, example problems, collecting and returning homework) can now be done outside of class. This allows time for other activities during class time. These could include: design and build projects, student presentations, classroom demonstrations and group discussions. The advent of on-line learningware will allow instructors to experiment with new models for classroom instruction, models that go well beyond the conventional "chalk and talk" lecture.

Not all students and not all instructors will use the product the same way. So, who will benefit the most? From the student's perspective, the "A" student probably doesn't need it. The product is designed for the "B" student that wants to become an "A" student, and so on. From the instructor's perspective, it should be noted that the community college instructor who teaches eight different courses in an academic year will view on-line learningware somewhat differently than the university instructor that teaches several sections of the same course semester after semester. The community college instructor might use the learningware material as a major component of the course relieving them of preparation and grading effort, whereas the university instructor might use the material as a minor proportion of the course. Different instructors will benefit in different ways.

The development of learningware material is expensive and time consuming. Once developed the material can be used to save instructor time and effort. The widespread adoption of the material is needed to offset the initial costs involved in development and distribution.

Student and Instructor Response/Feedback: Students and instructors at UMR have had access to portions of "BEST" Statics for several semesters. On Call Instruction for Statics made its debut during the Summer 1997 semester. The content development and integration of the two software programs are on-going. The Statics On-Line learningware material remains fragmented and incomplete at this time. Consequently, students have been encouraged but not required to use the material.

An experiment designed to assess student feelings concerning the software was conducted.   For one week the software was used every day during class. The students were also given additional assignments to view the material outside of class. At the end of the week an opinion survey was taken of the class. The response was more positive than negative; and, as one might expect, some components received more favorable ratings than others. Statements made by the students relating to how often they used the software were loosely correlated with data collected by the counters attached to the web pages. It was concluded that nearly all of the students viewed at least some of the material. Some students viewed all of the material, and a few students viewed the material more than once. Between five and ten percent of the students reviewed the material just before their next exam.

This early attempt to evaluate student opinion of the software also resulted in some discoveries about teaching with the software. It was found that even for someone who is very familiar with the software, it was often difficult to find a particular display or navigate to the display. This resulted in changes that allow more direct navigational paths to the material.

Future Plans and Development: Both current and long term objectives for the Statics On-Line learningware project include: accessibility, scalability, and platform compatibility. These issues are also being addressed by Educom's[4] National Learning Infrastructure Initiative. More specifically, they are addressed by the Information Management System (IMS) project. Compliance with the emerging IMS specifications is a goal of the Statics On-Line project.

It is too early to form any conclusions about the effectiveness of the software. It does appear that

some students will find it more useful than others. A more formal and complete assessment of the efficacy of the software is planned for the future.

It is felt that when complete, the learningware material should be made an integral part of the course for it to be successful. The so called "bolt on" approach to including educational software with a course has come under criticism. Students come to view the software as something extra that is being added to an already full course. It will require experimentation and innovation by willing instructors to reformat a course in a way that effectively utilizes the software. As stated previously, the goal of Statics On-Line is to "provide a new environment for students to study and do their homework."

References:

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4. Educom, http://www.educom.edu

DAVID B. OGLESBY
David B. Oglesby is an Associate Professor of Basic Engineering at the University of Missouri-Rolla (UMR). After completing his D.Sc. at the University of Virginia, he joined the faculty at UMR in 1968. He is currently leading a UMR effort to develop multimedia software that will improve how statics is taught and learned. He has received sixteen outstanding teaching awards while at UMR.

EDWIN R. CARNEY
Edwin R. Carney has been a lecturer on the faculty of the Basic Engineering Department at the University of Missouri-Rolla for four years. He earned Bachelor and Master of Science degrees in Electrical Engineering at UMR in 1979 and 1986 respectively. Mr. Carney is a licensed Professional Engineer in Alabama. He is President of NextGenTexts, Inc., a start-up Internet publishing company.

MICHAEL PRISSOVSKY
Michael Prissovsky is a student programmer for the Basic Engineering Department at the University of Missouri-Rolla. He is from Houston, Texas. Mr. Prissovsky expects to graduate with a Bachelor of Science degree in Computer Science in May, 1998.

DAVE CRITES
David Crites is a student programmer for the"BEST" Statics project in the Basic Engineering Department at the University of Missouri-Rolla. He is from Popular Bluff, Missouri. Mr. Crites expects to graduate with a Bachelor of Science degree in Mechanical Engineering in December, 1998.