Using New Technology to Deliver Traditional Courses – An Evolving Transformation

Ronald K. Williams, P.E., Ph.D.
Department of Technology
Minnesota State University Moorhead

As a part of the Pre-engineering curriculum at Minnesota State University Moorhead (MSUM), the author has been delivering three courses in Engineering Mechanics: Statics, Dynamics and Strengths of Materials, since 1990. The course content has not changed greatly in that time, focusing on problem-solving for analysis and design. A typical week includes a lecture highlighting and interpreting the text assignment for the week, presentation of representative problems by the instructor, presentation of homework solutions by students, and a quiz covering the week's topics.

Beginning in 1994, the 4-quarter-credit courses, delivered in four 50-minute sessions a week, were converted to 3-semester-credit courses, delivered in two 75-minute or three 50-minute sessions per week. Although the traditional "chalk-talk" delivery was still effective, the new schedules required a different approach to problem assignment and review. Under the 4-day per week structure, the instructor might assign 3 – 4 problems per day with the reasonable expectation that all would be done by the next class session. He or she might also expect to review 1 – 2 of the problems each day. Under the 2-day per week structure, students balked at tackling 6 – 8 problems between 11:00 on Tuesday and 9:30 on Thursday. Further, reviewing up to 4 problems per session took more class time than the schedule allowed. The author began searching for delivery tools and methods that might shorten the time needed for problem review, and allow students to grasp the problem-solving concepts even given a decreased number of assigned problems.

Computer-assisted instruction offered a number of possibilities. Kadiyala and Crynes[1] offered an extensive literature review on the effectiveness of using information technology in education, and found that such use enhances learning when the pedagogy is sound and technology and techniques match the learning objectives. Arden[2] offered the challenge of broadly educating engineers in several aspects of computing without sacrificing the development of intuition and design judgment. Clearly, the use of computers needed to enhance rather than replace existing problem-solving approaches. Janicki et al[4] offered a number of suggestions for developing a plan for computer-enhanced instruction, based on their reviews of basic learning and instructional design theories. They stress the importance of incorporating a number of different learning styles in such a plan, including: lectures, which tell or describe facts and processes; demonstrations, which show the students how the facts or processes are used; and exercises, which require the students to do the processes themselves. The traditional means of teaching Mechanics addresses all these forms, and thus it would appear that a computer-enhanced method should as well.

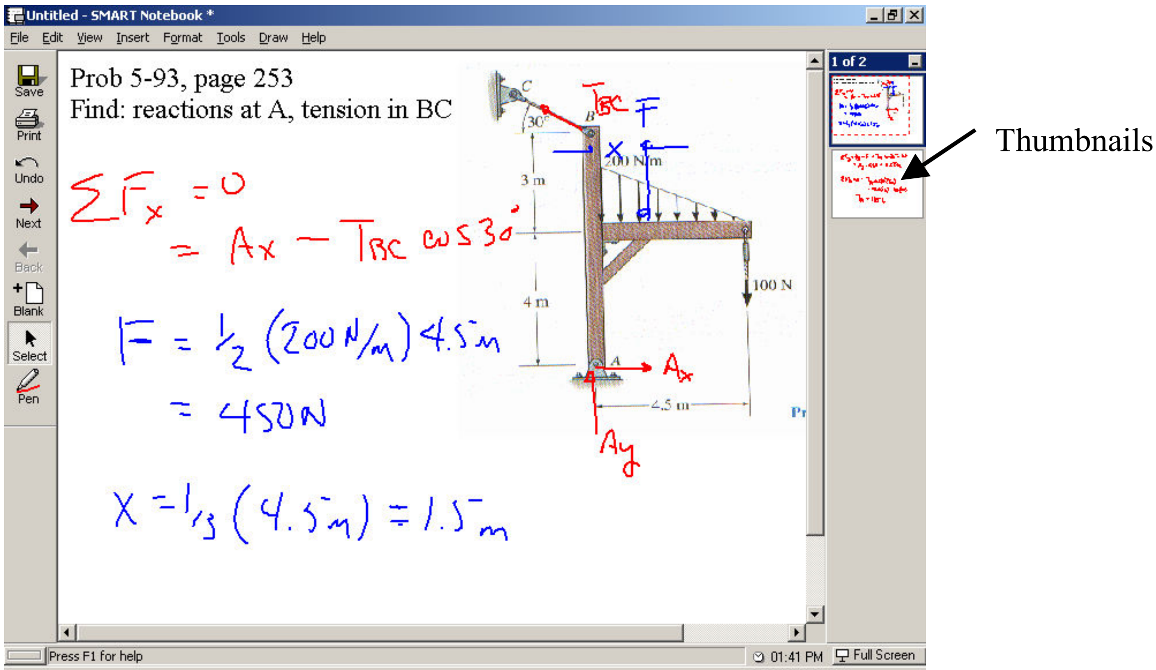
Any planning for computer-enhanced delivery will obviously be limited by the available technology. In 2000, the Department of Technology won internal grant funding to retrofit a classroom to incorporate new instructional technology: a computer, projector, document camera and a SmartBoard®. The computer had access to the Internet and to software including MathCAD, AutoCAD, SmartNotebook, and PowerPoint. The computer, the document camera and a VCR were all connected to the same data projector. The user switched between computer, document camera, and VCR images by means of the projector remote. Figure 1 shows the classroom after modification. The data projector hangs from the ceiling. The VCR, computer, and document camera are housed in the teaching station on the left. The SmartBoard sits on the front wall between two whiteboards.

The SmartBoard, a projection screen linked to the computer, offered a number of exciting possibilities. When used with PowerPoint, a touch of the screen acts as a mouse click, advancing slides or animation. This frees the user from always lecturing from within arms reach of the mouse. The SmartBoard also has electronic "markers" that allow the user to add colored annotation or highlighting to the image projected by the computer. The annotated screens can be saved and posted to the web for future reference.

The SmartBoard came with SmartNotebook software, which allows the SmartBoard to serve as a virtual whiteboard.. The user writes on the white screen using the electronic markers as if writing on a white board. A menu click saves the image and inserts a new page, but thumbnails along the side of the screen allow the user to return to any previous page. Images can be scanned and included in pages of a notebook, and pieces of text from one page can be copied and pasted to another. All the pages in a notebook can be saved as a web-based slide show. Figure 2 shows a sample screen from a Statics problem solution, including a scanned image and colored annotations.

Figure 1. Classroom after modifications

Figure 2. Sample SmartNotebook Image



The author was given minimal instruction in using this equipment, plus a brief introduction to web authoring using FrontPage. Armed with this new technology, he set out to transform the delivery of three very traditional classes in the engineering curriculum. The initial vision was to replace the traditional chalkboard lectures and problem presentations with dynamic on-screen presentations. It was hoped that these presentations would save time over traditional methods, would engage the students in participating in the process, and would have the added benefit of saving the results of the presentation for future retrieval by the students.

As with many who jump into the computer-enhanced classroom, the author's first approach was to convert existing lecture notes to PowerPoint shows. By incorporating scanned images instead of sketching on the board, the author hoped to save presentation time in class. He also hoped that presentations incorporating those images, annotations, and clearly presented formulas might be more engaging than his traditional lectures. In fact, at least two major points of concern arose.

First, the student's approach to receiving information changed. Warms[3] notes that lectures based on PowerPoint slides may allow the students to become passive players in the process. They download and print the slides, and then come to class with a complete set of notes. They watch the presentation, but are not actively involved in the process. Although the lectures still "tell" students about facts or processes, removing the need to write what they hear and see may disconnect them from that information.

Second, converting lectures to PowerPoint reduced the number of learning styles used by the students. Traditional lectures included some components of demonstration – showing the students how to apply the concepts as they were introduced. A part of the "chalk-talk" lecture was working through example problems, and having the students perform the calculations with the instructor. When converted to PowerPoint shows, the same examples may be shown, but the student's involvement is reduced to watching formulas and results appear on the screen.

To address these concerns, the author hoped to combine three pieces of technology to recapture the benefits of the traditional lecture, while reducing the time needed to complete the example problems. The SmartBoard, with its companion SmartNotebook software, would allow the author to write out the solutions by hand, but all the work would be captured to screens that could be called back as needed to reinforce critical concepts. The document camera would be used to show example pictures and example problems from the text. Finally, the math required to complete the examples would be handled in MathCAD. Much of the time involved in presenting or reviewing problems in a mechanics class is taken up cranking through the math as the analysis proceeds – e.g. solving simultaneous equations or cross products. MathCAD can quickly solve such problems, and can be formatted to display appropriate units to reinforce their value.

In theory, this means the author could display an example problem from the text using the document camera, then switch to the SmartNotebook displayed by the computer to write out the formulas and equations needed to find the solution. As needed, he could switch to MathCAD to process calculations. At the end of class, he could save the SmartNotebook file, and post the pages on a website for future reference by the students.

In actual practice, much of the technology was somewhat limited. The document camera requires a flat image to focus across a page, while the text lying open on the camera bed presents a curved surface. Short of cutting the spine off the book and presenting individual pages, the user must resort to propping one cover of the book up to allow the opposite page to lay flat. If the book must be moved to focus on different images on the page, the props must also move, and as often as not, the cover that must be propped up overhangs the bed of the camera, adding to the problem.

The SmartBoard requires patience and practice to achieve consistent results. One often needs to write larger letters on the SmartBoard to be as legible as those on a traditional chalk or whiteboard. This requires a greater number of screens to solve one problem than might be accomplished at a traditional board.

While MathCAD performed the calculations flawlessly, the use in this situation was limited in two ways. First, most of the students were unfamiliar with its structure, and much time was required to explain the need to define each variable in advance, etc. Further, much of the work in Mechanics classes is based on the use of {i, j, k} notation to represent Cartesian vectors. MathCAD does not support that notation, so the author needed to devise means to represent the problems in a form that MathCAD could solve, and then explain to the students how this solution represents the same problem as the formulation they expect.

All in all, the combined use of technology did not produce significant time savings in class. The additional benefit of saving class notes for retrieval by the students also did not work out as planned. The SmartNotebook files were often too large to copy from the teaching station to the web server using the available technology – zip disks. And the process of converting and posting the file was difficult and time-consuming. The original plan for technology enhancement of the courses was abandoned, or at least postponed.

As is often the case, new technology must wait for one key piece for other components to be effective. In this case, that component was the Internet. In 2001, the Technology faculty offices and classrooms were connected to the campus backbone. This allowed the author to create and support websites for each course from his office computer using Dreamweaver. Syllabi, schedules, and assignments are all provided on-line. Where PowerPoint is used for lectures, those files can be downloaded and printed. Larger files are stored in a hard drive mapped to all the faculty computers and teaching stations maintained by the Department. The images accompanying all assigned problems can be scanned and stored on the mapped drive, to be called up and inserted into a SmartNotebook file as needed.

Although the components of the course remain much the same as before technology was introduced, the methods of delivery are very different. In the past, 3 or 4 students might be called to the board to show solutions to homework. Today, the students are assigned to groups who prepare a written solution. One of the group members brings their solution to the document camera, and walks the class through his or her group's solution process. This involves all the students in the process, and requires the students to work in a neat and orderly fashion so the camera can display their work.

The campus network also has facilitated the process of saving and posting the in-class files. Annotated SmartNotebook pages and completed MathCAD solutions are saved to the mapped hard drive from the teaching station at the end of class. The author then accesses the files from his office computer, and posts them to the course website. Before the advent of technology, solutions to example problems survived only in the instructor's notes, and those taken by the students as the solution unfolded. The student's notes might not include the instructor's highlights, and might be incomplete. Today, the solutions generated in class are available to all the students as needed.

Access to large amounts of storage and fast delivery pipelines offer even greater possibilities for the future. The author currently creates on-line tutorials for other courses using Camtasia. This software allows the user to record their screen activity along with an audio narration to create tutorials that can be accessed from a course website. The software includes a compression utility that converts the original AVI format to a Shockwave file. Using this compression, a 15-minute movie of on-screen activities plus the audio narration requires less than 5 Mb of storage.

Although the author does not presently use these tutorials for his mechanics classes, the process offers interesting possibilities. Using this software in conjunction with a writing tablet, a tutorial can begin with PowerPoint slides explaining a process, add hand-written formulas, and then switch to MathCAD to see the resulting calculations. The author sees such tutorials as an exciting possibility for the future. Janiki et al[4], in addition to recommending education plans that address several teaching styles, highlight the value in methods that involve auditory as well as visual input, and those that call for repetition by the student. On-line tutorials that the student can watch and listen, as often as needed, fit both.

Technology in the classroom has transformed the way Engineering Mechanics classes are delivered at MSUM, but not in the dramatic way originally envisioned. The technology supports traditional delivery methods – lectures interpreting a respected text, example problems presented by the instructor, and students presenting their solutions to rigorous problems.

Bibliography

1. Kadiyala, M., and B.L. Crynes, "A review of the Literature on Effectiveness of Use of Information Technology in Education", *Journal of Engineering Education*, April 2000, pp. 177-189.

2. Arden, Bruce W., "The Synthesis of Computers, Communication, and Engineering Education", *Journal of Engineering Education*, January 1994, pp. 33-34.

3. Warms, Tom M., "An Interactive Lecture", *Proceedings of the 2004 College Teaching and Learning Conference Sponsored by Western Academic Press, Inc.*, January 2004, Article No. 347.

4. Janiki, Thomas N., Schell, George P., and Weinroth, Jay, "Development of a Model for Computer Supported Learning Systems", International Journal of Educational Technology, Volume 3, No. 1, November 2002