FAMU-FSU M.S.M.E. Online Program

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Abstract

This paper describes the adaptation of a master's degree program so that the degree can be obtained by taking all the courses over the Internet. The degree program is Master of Science in Mechanical Engineering at the FAMU-FSU College of Engineering. A distinguishing feature of the adaptation is that it attempts to approximate the live classroom experience as closely as possible. This paper reviews, near the end of the first semester in which the required M.S. core classes have been offered live over the web, our motivation and experiences. Despite some minor drawbacks, the program is judged successful and will be made available to all eligible students worldwide starting Fall 2000.

1 Introduction.

Teaching is not just a matter of providing factual information, exercises, and tests. Although hard to quantify, social issues can be very important for students, for example: personal interactions with instructors and fellow students, (both of which may provide benefits such as comfort, reassurance, and some feeling of control); the advantages and pressures of belonging to a group; humor and unexpected events that liven up the classroom experience. The recent explosion of the Internet has started to make it possible to offer a classroom experience to remote students at a level of interaction far beyond what could previously be done with correspondence courses.

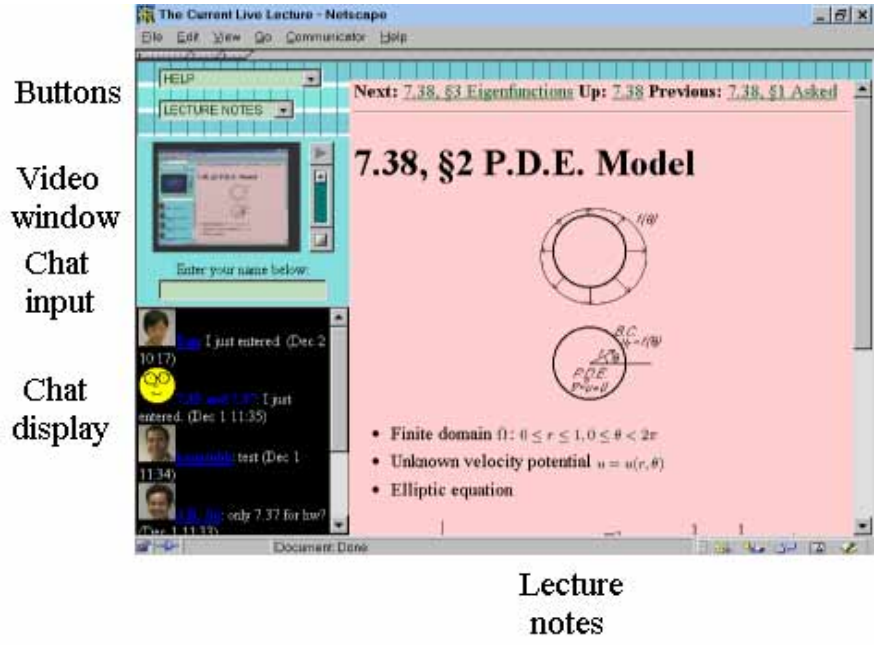
Recognizing this opportunity, the FAMU-FSU College of Engineering is converting their M.S.M.E. degree so that it can be taken completely over the World Wide Web from anywhere in the world. Our program has five main features: (a) Full integration of the online students as normal students in our existing classes; (b) Emphasis on encouraging personal relationships; (c) Robustness; (d) Standard, generic software; and (e) Enhanced education for the local as well as online students.

Full integration of the online students in the program means, among others, that online students follow the class as much as possible according to the same schedule as the local students. We do not know of any other program that emphasizes this critical and novel aspect of distance education. The students are requested to follow the lectures live, and are required to comply with the same due dates for homework and exam times as the local students. This approach will obviously not be ideal for every student, since it represents some loss of flexibility compared to most distance education. We designed the program based on our conviction that it will be of benefit to many students. It can provide a more structured and more personal approach that is of advantage to both the students and the faculty. Aside from social factors such as the ones mentioned above, the students (and their employers) must commit themselves firmly to definite class and exam times, due dates for homework and exams, and so on. We believe such

commitment is important for everybody. In a sense, we do not try to improve upon a classroom experience that has established itself over many millennia: we simply try to achieve it. Yet there are benefits that do extend to the local students, as discussed later.

During Fall 1999, we have started offering the two required Fall core classes of the M.S.M.E. program, Analysis in Mechanical Engineering and Continuum Mechanics, live over the web[1]. The remaining three required core classes will follow this spring. The program will be available to eligible students at large, starting Fall 2000, at which time elective classes will be added. This semester, the two core classes are being taken by 30 local M.S. students, of which only half fit in the small room we are currently using to teach the live web classes. The other 15 students take the class as distance students from a computer lab elsewhere in the building, on a rotating basis. Attendance is required, (at least in the analysis class), but students can take the class remotely from any location where there is an Internet connection. Attendance is verified when the students sign in at the start of the lecture and when they fill out an electronic feedback form after class. A small fraction of the students tend to take the classes from their home or from their research labs.

In addition to the local students, three true distance students also signed up for the classes. These students take the classes on a satellite F.S.U. campus in a neighboring city, while also working full time jobs. They are enrolled in our existing distance learning program (the FEEDS program) that ordinarily uses a direct two-way video link between the campuses. This semester the students were switched from the video link to the Internet. All three signed up for Analysis in Mechanical Engineering, and one also signed up for Continuum Mechanics. In agreement with previous FEEDS practice, live attendance was not required. However, the students do need to meet the same homework and test dates. The student who wrote up for both core classes has attended virtually all lectures live, while the other two students have followed the archived lectures at a later time. One of the two students that did not attend the live lectures has since withdrawn. Based on these experiences, at least one of the three core classes to be offered in spring will have mandatory live attendance for all.



The live lectures are based on Real Media streaming audio and video, as shown in the figure. To allow classes to be attended from low bandwidth locations such as student homes, the video window is small. It functions mainly as a pointer into full size prepared lecture notes that are served to the students as web pages. The other function of the video window is to reinforce the notion of being in a

classroom with a live professor and fellow students.

The need for prepared lecture notes may be permanent. While much larger bandwidth is likely to be available in the near future, allowing larger video windows, it is doubtful whether reliability concerns will disappear. Computers will continue to crash, power outages will continue to occur, bottlenecks on the long network connection from the classroom to the students' homes will continue to become saturated. Students should have enough information to tide them over minor rough spots without having to fall back on the archived lecture.

When we started the program, we experimented with two-way video conferencing with the students in addition to the one-way streaming media link. On consideration, we concluded that it was too distracting for both the instructor and the students, not easy to manipulate for inexperienced users, and too much of a demand on the hardware. As a result, video conferencing has been relegated to office hours, and a chat program takes it place. The chat frame changes color whenever a student types in a question or remark, as a visual cue to the instructor. To make it somewhat more personal, a tiny picture of the student or instructor is prefixed to their remarks. Despite the several seconds time delay created by the chat program, (which is addition to the time delay created by the streaming video), the chat box works well in real life.

Besides the chat frame, we minimize distractions for the instructor further by having a T.A. present during the lecture. The T.A. manages the video to show the instructor, students asking questions, or the computer video screen as needed. The T.A. also watches for proper operation of all equipment. Before the lecture, the T.A. sets up all required hardware and software, which takes about 10 minutes. After the lecture, the T.A. links the lecture notes permanently to the archived video and sets up a web page for it. With practice, this takes about 20 minutes.

Though it is up to the instructor to either use the blackboard or a computer to project the prepared lecture notes, both instructors preferred to use the computer. This will probably also be the case in the spring semester. Further, both instructors have converted their notes into true HTML, rather than into scans of hand-written notes. This represents a significant effort and is probably inspired by the increased visibility of having the lectures publicly available.

2 Objectives

The main objective of our program is to enhance life-long learning by providing a more structured and rewarding learning experience for distance students. By presenting the lectures live and requiring attendance, we provide an impetus to stay current with the course. Live lectures also enforce that the professor is a real person, and that the student is a member of a class. The students become aware of the difficulties that fellow students experience. Comparing themselves to local students that are on schedule, there may be more motivation for the distance students to stay current too. The more personal, people oriented, atmosphere will hopefully also foster a greater enjoyment of the courses.

A greater a priori commitment is required compared to asynchronous learning, since the class times and due dates are fixed. In our opinion, this is likely to be beneficial. It becomes less

likely that the students will commit themselves to more than they can possibly handle. It is hoped that all these effects will increase retention and success rates for the distance students.

Our local students also benefit from having a distance offering. Having the lectures archived enables them to watch a section of a lecture which they did not understand a second or a third time. The archives can also significantly reduce the effects that absences due to sickness or other have on the students. Further, even local students may sometimes want to watch the live lectures as distance students (when they are ill, when they cannot make it to campus, etcetera.) Local student too can make use of the additional avenues of assistance: E-mail, video-conferencing, and the class newsgroup. Prepared lecture notes on the web allow weak students to prepare for classes beforehand, as well as pay more attention to understanding, rather than copying, what is said during class. Having lecture notes and lectures cross-linked can assist in obtaining a deeper understanding of selected areas than studying the lecture notes alone. There are also the many enhancements a quality hypertext course web page can bring; although the distance program does not require such a web page, it provides a strong motivation for it.

The department also stands to benefit. As a result of web offering, there will be increase in enrollment for the M.S. degree programs. The offering provides a great visibility of the department among other universities, private companies and funding agencies. When potential students take the courses from private agencies and government facilities, the department establishes a permanent rapport in terms of student base and research opportunities. The department can use archived lectures to offer classes for which the enrollment at any given time would be too small to offer the class live. This can greatly expand the electives available to our students.

3 Technical Issues

Reliability is a vital requirement for a program of this kind. Most of us would consider canceling even a single class and sending the students home to be a major calamity. Yet streaming media classes involve a long list of hardware, (at least three different computers, networks, projector, camera, audio equipment, etc.) as well as a considerable amount of software. The failure of any part may require the class to be cancelled. Recognizing this, from the beginning redundancy was made a primary goal. Almost all of our equipment can be replaced on the fly. After our experiences during this first semester, we would also be very uneasy of starting a program like ours if the support for the network and computer infrastructure was not local or not willing to assist rapidly on a moment's notice.

To verify proper operation of all equipment before class starts, the instructor's browser window loads on startup a "pilot's checklist". Like flying, the well being of the class depends on a lot of high tech equipment.

Unfortunately, there is not much direct control over failures at the client side. To reduce the effect of client computer crashes, bandwidth saturation, and so on, full lecture notes are required and lectures are archived for later viewing. We recommend that students reboot their Windows machines before each lecture, but many arrive at the last moment and do not.

For serving the live lectures, a streaming server, Real Server in our case, is required. Such a server is also highly desired for the archived lectures. In addition, since our true distance students are separated by a firewall at work, we decided to make the latest two lectures from each class also available for download via http.

To allow lectures to be attended over standard phone lines, and to reduce the chances of creating bottlenecks, we chose a small 160x128-pixel video size popular on the Internet. Larger sizes might be acceptable at low frame rates, but we feel they come over as artificial and static. We found that the video codecs for Real Player G2 are significantly better than those of Real Player 5, so we require that our students download the (free) G2 version. Our video size is too small to allow much information to be transmitted directly. For that reason, in our approach the video window serves as a pointer to the full size lecture notes, rather than as a standalone viewer.

When the instructor uses a computer to lecture, an electronic magnifying glass allows selected text under discussion to be magnified so that it becomes readable in the video window. Such a magnifier comes with the accessibility options of Windows 98. However, this magnifier reserves a permanent area of the screen; we prefer the magnifier coming with the CompUSA mouse, which is of the pop-up type. During blackboard presentations, it would be up to the person controlling the camera to zoom in. We use a Canon VC-C3 zoom camera, which has the capability to automatically return to six preset positions in the classroom. This capability is extremely useful.

During live lectures, the lecture notes do not update automatically, since for spontaneous lectures, server push would be needed to update them. The students need to follow the instructor through the notes based on the video window. It does prevent them from being totally inactive. To assist students that have become distracted or came in late, we do provide a “catch-up with instructor” button, which puts the student on the same web page that the instructor is on. This was achieved by a simple custom cgi-bin script named Loglink.

Typically, the lecture notes are further color-coded to assist in page identification. Initially, we subdivided the lecture notes into very small sections, but these have grown in time without apparent student hardship.

For instructors that use a computer to lecture, it is important to have a computer screen projector with enough lumens. This allows sufficient lighting in the classroom without washing out the projected screen.

The archived lectures are edited so that the lecture notes do load automatically. This is achieved using the Real Media rmevents utility; the task is simplified by data gathered by the Loglink utility mentioned above. We are working on a shell script that also automatically cross-links the lecture notes back to the archived lectures of the various years.

Good quality audio is a concern. For minimum bandwidth, we use the 5kbps voice codec. It took us quite some time to get the audio optimal, including extensive experimenting with the mixer and sound processor settings. Initially we had considerable hum (with all this hardware, it is difficult to get a clean audio environment) which was eliminated through low cut filters and

better equipment. A hearing impaired student asked us to provide compression to help him understand the archived lectures better (he is permitted to attend all live lectures in the classroom.) We initially chose a 4:1 compression ratio; however, informal testing seemed to indicate that quality deteriorates and we retreated to a 2:1 compression ratio. The room microphones for the students present some other difficulties. Shy students require noticeable volume, increasing background noise and disturbances. After experimenting we settled for a compromise. In the dedicated web-courses classroom we are building, directional room mikes are being installed for every two seats, and each mike is being gated and compressed separately. For the client computers, it is recommended that the line outputs be taped over so that they are not mistakenly used instead of the speaker output. We also recommend that the headsets do not have their own volume controls and mute buttons.

In addition to Real Media, our software is mostly custom written HTML and Perl by one of us (LvD). We found available packaged software to be hopelessly confining, (no Java, no video, no Unix shell scripts, prescribed appearance, ...), and the required programming is no rocket science. Having our own source code allows us to respond on-the-fly to changing conditions, And when a dominant educational software vendor eventually emerges, we expect it to be a lot easier to switch to the vendor's proprietary format from our standard format than from the competition's proprietary format.

To respond to questions from the students, and add to the lecture notes on the fly, we currently use a low-tech "whiteboard" (really the Corel PhotoHouse drawing package) with a Wacom PenPartner drawing pad. We taped a preschool slate to the pad so that the instructor can see the drawing without looking at the computer screen. The line thickness is chosen so that the text will show up clearly through the small video screen. This works well, although the amount that can be fitted on one screen is limited.

As mentioned before, feedback from the distance students during the lectures is mostly through a chat program frame embedded in the live lecture window. This approach was chosen above, say, video conferencing because of its reliability, its lack of required setup, its low demands on bandwidth and computer resources, and its ease of use. The program was patterned after the EveryChat chat program with modifications to allow color changes depending on who wrote the last remark in it, to include pictures of the participants, and to simplify and miniaturize it.

We also have provided a video conferencing link to the computer lab downstairs in which the overflow local students attend.

When starting a program such as ours, it is important to obtain a dedicated classroom. There is a lot of hardware to be set up and software to be initialized, and it helps if this does not have to be done from scratch before each lecture. Even with all the hardware ready to go, it takes the T.A. about 10 minutes to initialize everything for the lecture.

4 Instructional Issues

The issue that affects the instructor most in our program is the requirement for prepared lecture notes. High quality notes take a great deal of effort to prepare. For the students, it does have the

advantage that they can spend less time on copying what is being lectured, and more time on understanding it. However, when the instructor lectures by computer, the lecture is likely to go at a more rapid pace because the constraint of writing essential information on a blackboard is gone. One of us (NC) increased the number of examples, while the other (LvD) expanded explanations. NC also expanded explanations in his notes, while LvD's notes reflect what he used to write on the blackboard in earlier years. NC added a significant number of worked-out examples not previously possible. All the web pages used in the lectures were compiled by chapter and are made available to students.

One of us (LvD) once taught an entire lecture through the whiteboard when the web server did not want to serve the lecture notes. Several positive student responses were received in the feedback; however, this may have had much to do with the fact that the instructor went deliberately slow and covered noticeably less than he intended to.

While the live audio and video presentations provide a motivation to require attendance during the actual lectures, it also makes some sort of attendance policy highly desirable. We are afraid that without such a policy, some of our students would start postponing lectures on the strength of having the archives, and get hopelessly behind.

Last year, LvD started to put some small active learning exercises in his class: ask the students a question, give them a couple of minutes to think, and then ask a random student to answer. This gets more cumbersome with the time delays inherent in the streaming media and the chat box. After asking a remote student, there is a delay waiting for the student to respond, while the students in the classroom know they are off the hook. We are considering ways to improve this.

5 Experiences

The chat box that provides for student communication during live lectures is received well: there is usually a good amount of feedback through it. Sometimes one student will answer the question of another student in it. It further indicates who is attending remotely.

We also have provided a video conferencing link to the computer lab downstairs in which the overflow local students attend. However, it has so far not become popular, which may be an indication that generally the students are satisfied with the chat box. There is probably not much reward in being called to answer an active learning question and having to walk all the way to a video conferencing computer to say that you do not know the answer. The separate link is also a distraction for the instructor.

One of us (LvD) has religiously provided video-conferencing office hours using MS NetMeeting. So far, no students have made use of the opportunity. We believe this is due to the limited number of true distance students and the trouble of installing, configuring and using the software. We do believe video conferencing has significant benefits to offer and we plan to promote video conferencing more vigorously when we have more true distance students. At that time we will also make another attempt to popularize a course newsgroup.

E-mail has been a very popular communication medium in the past, and is still so for the usual reasons. In addition to spontaneous E-mail, there are typically also a couple of requests for clarification in the feedback forms that the remote students fill out after each live lecture.

The hardware and software involved do distract the instructor. While it would in principle be possible for the instructor to teach unaided, the need to keep an eye on all aspects is simply too much. Typically the instructor ends up with the video on his face when it needs to be on the computer screen, or on the students in the classroom. For that reason, during the lectures the T.A. remains present to care for the hardware and software, and the instructor only keeps an eye out for color changes of the chat frame.

A program that depends on this much technology may not be for overly nervous instructors. The major mishaps this semester were:

a) A disk crashed on the computer used for lecturing. This was before we had a backup for all hardware in the room. NC substituted his personal portable and the lecture proceeded.
b) The Real Media server stopped serving about 20 minutes into one of LvD's classes since the software felt it was expired. We had a backup, but it took time to identify where the problem was; besides, the backup would have had the same problem. The remaining 30 minutes of class was cancelled.
c) The video capture card went bad, producing poor quality video during one of LvD's lectures.
d) The web server stopped serving during one of LvD's classes. LvD taught everything through the tiny video window using the whiteboard. He covered a lot less material than he had hoped.
e) The network to the classroom area was gone at the start of one of LvD's lectures. A bad network UPS was identified and class started about 20 minutes late.
f) Updates to the chat frame software and the software that logs the instructor's web page moves were incorrectly installed. LvD's lecture proceeded without them.
g) The computer lab for the "remote" (overflow) students was not opened in time, causing LvD's lecture to start about 5 to 10 minutes late.
h) With 15 client computers, a client computer crash is not uncommon and obviously an annoyance for the student involved.
i) A couple of headsets were plugged in the wrong audio port, leading to complaints of soft and poor audio.

Supposedly or hopefully, we now have the steep part of the bathtub curve behind us. We have backups that can be swapped in on the fly for all directly involved equipment, which should avoid future failures such as (a) and (c); (b) should no longer be a problem; the college is working on new, redundant web servers that will avoid (d); we now have procedures to avoid repeats of (g) and the interactive help warns students about (i). But with so much technology involved, there will always remain a chance of something going wrong.

The instructors spent a large amount of time on lecture notes. Fortunately, for fundamental classes such as these, the lecture notes do not tend to change that much from one year to the next. For other classes, scanned handwritten notes will no doubt be the preferred way to go. We did request T.A.s to help with the remaining three core classes the next semester. It does provide some satisfaction that our lecture notes are now of higher quality than in the past and more complete, and that they now include much additional important information and tools.

One of us (NC) typically travels to professional meetings and invited seminars about three to four times a semester. In the Fall semester NC traveled on three different occasions. On each of those occasions, the entire lecture was pre-recorded and broadcast "live" during the actual class hours with the TA monitoring the class. The TA responded to the questions raised by the students during the lecture thus simulating a near "live" experience. NC plans to increase the authenticity of the experience by answering questions by the students during those simulated "live" lectures from remote locations when on travel.

6 Students' response

All the students were required to submit a feedback form after each of the lecture. .It is clear from those forms that students were initially reluctant to accept the new technology. In addition to the hardware problems, the students were not used to the format of presentation and not completely familiar with the required software. One of us (NC) interviewed five students at the end of the semester to determine their reactions. One of the students felt very comfortable with the technology and did not find any difference between the lectures during which she was in the actual class room (in-class) and those in which she was in the computer lab (remote). She felt that the archived lectures helped her a great deal during home works and exams. However, she accessed them only about ten times during the semester. She did find that she would rather be in-class rather than attend remotely.

A hearing impaired student, who was allowed to attend all lectures in the class room, found that the pace of the lecture seemed to increase with the web offering. (We believe that the increased pace is due to the prepared lecture notes). Though the archived lectures were useful, there was not sufficient time to access them. The well organized web sites were very helpful He found that the magnifier used during the lectures was distracting.

As far as the other three students were concerned, their comments were very similar. They too did not find that attending the lectures from the computer lab did drastically decrease the quality of the class. They said that it is easy to be distracted when watching a monitor, especially in a long class (e.g. NC class lasts for 75 minutes). There were also some complaints about distractions from fellow students. The students suggested that links to additional course materials and early posting of lecture notes would be beneficial. It was the general consensus that in-class attendance provides the best experience. However, remote attendance is acceptable if the equipment works well.

It should be noted that the interviewed students may not accurately represent the average student. Some of the weaker students were invited to comment, but they failed to show up. We do know that there are some students who dislike the web experience.

During the end-of-semester graduate student survey (not conducted by us), the question was asked: "Web-based teaching is as effective as in-class teaching." The possible responses ranged from 2 (strongly agree) to –2 (strongly disagree.) There were 27 responses with an average

response of –0.63. It appears that although our program can provide an acceptable substitute for live lectures, the true in-class experience remains preferable.

As far as use of the archived lectures is concerned, analysis of the server log for a randomly chosen week near the end of the semester showed that on average 5 different computer nodes per day accessed archived lectures. This does not include the lectures that are accessed using http.

Some local students also take advantage of the possibility of attending live lectures from home or from their research lab instead of from the classroom or the computer lab. Examination of the computer records showed that during the last month in the analysis class, an average of three local students attended each class from a nonstandard location. This seems to depend more on the student than on whether the student is assigned to the computer lab or the classroom.

7 Efforts in Progress

Currently, we are working on a dedicated classroom set up for the web classes. Reliability will be further increased by means of redundancy such as dual encoders and servers. Dual encoders can also be used to serve different video sizes to different audiences during a lecture.

We are working on improved software to allow us to cross link lecture notes back to lectures, seamlessly integrating the two. We have plans for some improvements to the chat program to facilitate active learning, in particular private and more direct communication. We do expect to gradually transition to instantaneous two way video and audio. However, we feel this may be an uphill process for reasons only partly related to technology, especially for the current class sizes (30 graduate students.) A chat box is more reliable, less formidable for shy international students, and no problem to install, configure, or use.

8 Conclusion

We have heard many reasons why we should not to start a program along the lines we are pursuing: It is too much of a distraction for the instructor. The local students will suffer because of it. It takes too much time. There are no distance students to take it. The technology is not reliable. There are alternate approaches.

We were realistic enough from the beginning to recognize that there would be drawbacks, but we also believed there would be compensating advantages and significant potential rewards. After almost a semester of truly offering our first two core classes over the web, the sky did not come down. Yes there were annoyances, and yes there were rewards. We have learned and we go into the second semester of the program confidently and wiser.

Bibliography

1. URL: http://www.eng.fsu.edu/me/courses/web.

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