Development of a Video-Stream Lecture Series for Remote Learning

Jack Lohmann [1] and Gunter Sharp [2]

[1] *College of Engineering, Office of the Dean, Georgia Institute of Technology, Atlanta, GA, USA: http://www.coe.gatech.edu*
Tel: (+1) 404.894.3350, Fax (+1) 404.894.0168, jack.lohmann@coe.gatech.edu
[2] *School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta, GA, USA: http://www.isye.gatech.edu*
Tel: (+1) 404.894.2341, Fax: (+1) 404.894.2391, gsharp@isye.gatech.edu

Abstract: The development of a video-stream lecture series for remote learning for an on-campus engineering course is presented. The lecture series was unique in that it replaced a live lecture course with one taught entirely through the internet. The events leading to the change are first presented followed by the major challenges involved in redesigning and repackaging the course to suit the new mode of delivery. A description of the first two offerings of the course is also presented. The paper concludes with some key observations, and pros and cons from this new type of course delivery.

Keywords: video-streaming, remote learning, engineering economy, internet-based, computer technology

1. Introduction

Electronic technology, such as video tapes, satellite transmissions, and, increasingly, the internet, have been employed to address the needs for remote-learning programs where either the students are geographically distant from the campus or the students' employment schedules precluded their attendance on campus. Increasingly, however, such technology is now being employed in traditional on-campus courses where neither distance nor scheduling is an issue. For the most part, the use of such technologies in these situations has been to facilitate or support classroom instruction and laboratory exercises. That is, live interaction between the faculty and the students remained a principal part of the instruction offered on campus with electronic technologies providing deeper insights into subject matter than could otherwise be presented. Because of the nearly ubiquitous access to the internet by most students, coupled with the diminishing resources in support of faculty instruction in the face of increasing class sizes for many engineering programs, programs are now pursuing alternative means to deliver their curriculum.

This paper describes the development of a new on-campus internet-based course that recently replaced a traditional live lecture class. The junior-level course, ISyE 3025 Engineering Economy, is now taught primarily through the internet. The course organization and administration, all lectures, and question and answers between the faculty and the students occur through the internet. In the next section, a brief description is provided of the process and issues involved in redesigning the course. Included in the discussion are issues with respect to repackaging the course content as well as issues of converting the course content to accommodate the technology. This is followed by a description of the instructors' experiences and observations in offering the course for the first time during the academic year 1999-2000. Student feedback on the course is also discussed. The paper concludes with some thoughts about the pros and cons of offering on-campus internet-based courses in place of traditional live lectures.

2. Events leading to the internet-based ISyE 3025

The redesigned ISyE 3025, Engineering Economy, is a required, 1-credit hour sophomore/junior course in the industrial engineering curriculum. It is also required by mechanical engineering. Enrollment in the course is presently about 200-250 students per semester. The subject matter covered in the current course used to be presented in two 3-credit hour courses of similar numbering and title: ISyE 3025, Engineering Economy, for industrial engineering sophomores/juniors, and a complementary course ISyE 4725, Engineering Economy, for all other engineering juniors/seniors. Both courses had long been offered as traditional on-campus courses given by live lectures. The content of the courses was the same; the separate course for industrial engineering majors was primarily to expose them to the concepts of engineering economics earlier in their curriculum than was necessary for other engineering majors. Two events occurred in the mid-to-late 1990s that precipitated a major redesign of these two 3-credit hour traditional courses into a single 1-credit hour internet-based course.

First, in 1995, the Board of Regents, the governing body of the University System of Georgia, mandated that every unit within the system would convert from a quarter-based system to a semester-based system no later than the

Fall of 1999. In addition, it mandated that all baccalaureate programs would be limited to no more than 120 credit hours, with some exceptions. Many former courses were combined and/or completely redesigned into new courses, some were reduced in terms of the number hours of credit, and others were eliminated. ISyE 4725 was eliminated and the former ISyE 3025 was reduced from a 3-credit hour quarter course to a 1-credit hour semester course. However, this new course was also to be complemented by a new course in Financial Modeling. Consequently, with the merger of two courses into one condensed course, an internet-based course was viewed as an attractive means to provide the essentials of the subject matter in a cost-effective manner.

Second, the evolution of computing technology, and particularly the internet, had advanced to the point where courseware had become more versatile and accessible for both faculty and students. All Georgia Tech students were required to purchase computers beginning in 1997, including the non-technical majors. Consequently, more and more courses required computer technology to supplement live on-campus lectures and laboratory work outside of class. In a few cases, advanced computing technology is currently being used in classes and laboratories, and in one case an entire classroom, known as Classroom 2000, is outfitted with a wide array of high-technology audio, video, and computing equipment. The redesigned ISyE 3025 was to be unique in that the course would be offered without live lectures. That is, all of the material would be presented via the internet; specifically, all course materials, administrative policies, procedures, and announcements, would be posted to the course site, bulletin boards discussion groups and e-mail access to the instructors was also provided, and finally, streaming video lectures were available together with accompanying downloadable PowerPoint™ presentations. The only person-to-person interaction was either during the optional help sessions provided by the teaching assistants (and occasionally attended by faculty), or through appointments with the faculty.

While students and faculty are accustomed to on-campus courses supplemented by computing technology and the internet, few are accustomed to an on-campus course being delivered in a mode more typically employed for remote-learning students. As such, it was a unique challenge for the faculty to substantially condense and redesign two traditional 3-credit hour on-campus courses to a 1-credit hour internet format.

3. Redesigning ISyE 3025 as an internet-based course

3.1 Organization of content

The redesign of ISyE 3025 involved both a reduction in content as well as repackaging the material from traditional 50-minute lectures into "knowledge bites" of about 15-25 minutes. The reduction in content was driven by the credit hour reduction whereas the repackaging was driven by the internet delivery of the material. With respect to the internet delivery of the material, there were two principal considerations. First, since students would watch the lectures on a computer without the benefit of the normal interactions that occur during a live class, it was felt that the material needed to be presented in shorter "attention span" segments than a typical live lecture class. Second, it was desired that the lectures taped have some useful life. While changes are made, it was desired not to have to retape every lecture every offering. Thus, each segment was designed to be as complete a unit of material as possible. The material presented in each taped segment covered no more than about three to five key concepts.

During the summer of 1999, the instructors met frequently to discuss the redesign of the course. A detailed outline of the key concepts, potential examples, and ordering of the material was developed. This outline was then organized into "knowledge bites" and lecture minutes were assigned so that the total lecture time was consistent with a one-credit hour live lecture course. The instructors also reviewed several textbooks. Among the considerations in selecting a textbook was one that focused on key concepts consistent with a one-credit hour course yet was suitable as a more comprehensive reference text in the future (most texts were designed for three-credit hour courses), and used terminology and notation consistent with the most widely used terms and symbols in the field (so that taped lectures could be used again even if the textbook was changed).

3.2 Technological issues

There were several issues to be addressed in converting the content of the redesigned course to accommodate the technology. Many of these issues became apparent after the instructors conducted a sample taping and reviewed the results. The issues were the limitations of the presentation software and the quality of the image when viewed on a computer terminal, the recording equipment and room setup, and scheduling and delivering the lectures.

PowerPoint™ was chosen as the presentation software for the lectures. Overall, it worked quite well provided one used a bold typeface no smaller than 24 font. A font size smaller than 24 font was difficult to read when viewed on a typical computer CRT screen that students would be using. Further, some colors were avoided, e.g., red because it had a tendency to "bleed" on the screen, and light colors, such as yellow, which were difficult to see on the predominantly white background that was used. The PowerPoint™ medium forced the instructors to split

material onto two or more slides when it would have fit onto one transparency. In addition, portions of graphs had to be enlarged; eventually, Visio™ was selected as the preferred graphical tool.

Another issue considered was whether to have the instructor visible while lecturing or to have only audio with the presentation. It was decided not to have audio only as it was believed it would make the material too monotonous. The instructor could appear in an inset box as a "talking head," or the instructor's upper torso could be viewed at the side of the screen image. The later mode was selected since the small inset would be too small to be seen on most computer screens used by the students. However, this also meant that about 1/4th to 1/3rd of either the left-hand or right-hand side of screen image needed to be left blank so that the instructor would not block the material being presented on the slides. Otherwise, the instructor would have to either move side-to-side or off screen temporarily to allow all of the text to be seen at some point in the presentation of the slide. The instructors found the movement to be too distracting when they reviewed the sample taping. Further, a common template for the presentation slides was adopted so that the lectures would appear "seamless" regardless of the instructor who might present the material. Common colors, headers, slide numbering, etc. were agreed upon.

The choice of clothing also had to be considered. Because the instructors were lecturing to a monochrome screen with a green background, with the PowerPoint™ slides being merged electronically to produce a complete image as the instructors lectured, green clothing had to be avoided. Similarly, dark clothing was required so as to stand out against the light (white) background.

The lectures were taped in a well-equipped room in the Institute's continuing education building, without a live audience in front of a green screen in a fashion similar to television weather reporting. Off camera and to each side were television monitors, which the instructors used to position themselves and to point to material as necessary. While the instructors did not read from written scripts, it became apparent from the sample taping that the typical lecture style used in live lectures was not a mode well suited for this medium. More formal, well-rehearsed lectures were required. As a result, nearly all lectures required retaping to produce a quality presentation. Because "splicing" taped material was somewhat problematic, the instructors learned to occasionally step out of the camera and to have a brief pause in the audio so as to allow opportunities for splicing if necessary. The pauses also served to provide time for students to absorb the material. A rough estimate of the preparation time by the instructors is 20 hours per hour of finished video material.

The digitizing was done with VidCap™, a video capture program, and an Osprey 100™ digitizing card. The resulting very large AVI format files included both video and audio. Then Real Producer Pro™ was used to convert the AVI to 'Real Video' format, build the SMIL surround (the web page with controls) and link in the slide pages.

4. Description of the first two course offerings

The radical changes from a traditional learning environment motivated the two instructors to expend extra effort to ensure that the learning experience by the students would be satisfactory.

The first lecture was held before a live audience, where students were informed for the first time about the delivery method for lectures. Accordingly, a web-site connection was made to the video stream server, and the first, lecture was downloaded and played. A PowerPoint™ slide presentation was kept as backup. The purpose was to demonstrate the proof-of-concept.

For the first two offerings of the course, the material was organized into two-week learning cycles: 1) read textbook, 2) work homework assignment, 3) attend the help sessions if needed; these were offered six hours per week, 4) review sample quiz questions, 5) take a 50-minute quiz in a large lecture hall, 6) view individual grades on the web site as well as the class distribution, and 7) obtain individual quiz papers back in the help session or at the next quiz. A typical semester included seven learning cycles.

The quizzes, offered every two weeks, covered mainly the material for that learning cycle. There was no comprehensive "final exam," except for the general make-up quiz, which was added after the course began.

The contents of the web site were organized into five main categories: 1) administrative, which contained the course schedule and grading policy, 2) links to the video stream lectures and PowerPoint™ slides accessed by the video streams, 3) homework assignments, homework solutions, sample quiz questions, and solutions to quizzes - solutions were provided one week after the homework assignment or quiz, 4) bulletin board for questions about class material and technical problems related to viewing the video streams, and 5) grades received on quizzes. A separate e-mail account was maintained for questions related to individual student situations, such as excused absences, errors in adding points for a quiz, etc. The web site was housed on three servers: 1) the campus video stream server, 2) a local site in the department that contained the links to the video streams, and 3) a campus WebCT™ server for the homework and sample quiz questions.

The large class sizes of 250 and more students led to some modifications of the original plan for offering the course. The first major modification was to provide printouts of the PowerPoint™ slides for the lectures. The method of converting six slides to one page of PDF material was not satisfactory, especially when graphics were included. Although some students downloaded the individual slides, the economy in printing the six slides per page favored the method of providing printouts.

The help sessions, scheduled during the late afternoon (regular class time was early morning) were not convenient for many students. Accordingly, extra help sessions were scheduled on at least three occasions.

There were an unusually large number of unexcused absences for quizzes. The reasons for these were: 1) job interviews by students approaching graduation, 2) inability on the part of some students to adapt to the new style of learning, and 3) apparent attempts by some students to have make-up quizzes after they would have some information about the regular quiz questions from friends. In addition, many students performed poorly on the regular quizzes. Thus, a general make-up quiz, an eighth quiz was scheduled and made available to all students; this quizzes covered most of the course material. Absences from quizzes declined during the second offering of the course.

The large class sizes of 250 or more required other modifications. For example, student ID numbers, which normally correspond to Social Security numbers (sensitive, private information) could not be used on quiz papers, since most papers would eventually be placed in a public area for retrieval. Other problems included a failure to have information on the help sessions included in the registration materials, a textbook that the instructors learned was out-of-print after the publisher sent them two desk copies, and a room with desks that were unsuitable for giving quizzes. Last, the grade roll required two versions, one for WebCT, where quiz absences were represented by a blank space to avoid biasing the class distribution, and one for Excel™ , where absences where represented by a zero.

A peculiarity to the Georgia Institute of Technology is that graduating students are exempt from final exams during the semester of graduation (this policy will change in the near future). To provide a parallel grading policy for both regular and graduating students, special tailored homework assignments, with parameter values based on the student's address, were given to the graduating students; these were graded, with the grades counting for quizzes.

5. Instructor observations after two offerings of the course

After two offerings of the course, and during the middle of the third offering, some observations can be shared from this experience. These can be classified into student perceptions and experiences, and faculty observations.

5.1 Student performance and reaction

During the first offering the most notable student reaction was surprise and frustration. There was little if any advance notice of the web-only method of lecture delivery.

Many students had trouble with the video streams, especially those living at home. Incompatible software, poor quality video streams for the 56K download, interrupted downloads, improper switch settings, etc., contributed to the frustrations. Even on campus there were occasions of network congestion.

During the second and subsequent offerings, there was relatively little outspoken frustration. Apparently, the information about the course had spread, and most students accepted the new format. However, the feedback on student surveys differed little from the first offering. There was a drastic reduction in the response rates on the web-based survey from 50% to 25% for standard multiple-choice responses, and from 44% to 15% for optional verbal comments. The comparisons presented in Tables 1 and 2 are based on feedback responses by students near the end of the academic term. The overall rating in Table 1 should be compared to a typical rating of an average of 4.0 out of 5.0. Thus, student feedback ratings were below average.

Table 1. Response to question, "The course has been valuable to me."

Response	strongly agree	agree	partly agree and partly disagree	disagree	strongly disagree	overall rating
%, first offering	10%	38%	23%	16%	13%	3.4/5.0
%, second offering	8%	45%	23%	10%	13%	3.6/5.0

More concerning were the verbal comments, which were classified into types, as shown in Table 2. Typically, these voluntary verbal comments are balanced between negative and positive for a live-lecture course.

Table 2. Classification of verbal responses on all aspects of course

Verbal comment type	very negative	negative	mixed	positive	very positive

%, first offering	10%	38%	23%	16%	13%
%, second offering	8%	45%	23%	10%	13%

The major complaints focused on: 1) method of delivery, including lack of advance knowledge, 2) inconvenient scheduling of help sessions, 3) room for administering quizzes, 4) technical problems with downloads, including inability to save, and 5) too much material for 1-credit hour course.

Help session attendance dropped precipitously from the first offering to the second. During the first offering, attendance in the second week of each learning cycle ranged from 4% to 12%, during the second offering from 0.4% to 3%. Apparently, the students' learning habits had changed during the second offering, based perhaps on knowledge of the first. Some students reported that they simply studied the sample questions posted on the web site.

However, overall grade performance achieved by students was generally higher after the conversion to web-only lectures! An attempt was made to relate grades to web site visits and bulletin board articles read. The results, however, were not statistically significant.

Table 3. Grades achieved by students before and after conversion

Grade achieved	A	A or B	A,B, or C	D	F	Incomplete	Withdrew
%, Fall 1998, ISyE 3025	23.1%	46.2%	86.5%	5.8%	3.8%	0.0%	3.8%
%, first offering	48.1%	53.7%	85.2%	5.6%	3.7%	0.6%	4.9%
%, second offering	26.2%	65.8%	89.2%	2.7%	1.2%	0.0%	6.9%

5.2 Faculty perspective on live instruction versus web-only lectures

One of the major disadvantages of web-only lectures is the lack of the interaction between faculty and students. The element of discovery is greatly reduced. It is difficult for the instructor to motivate the students with an ill-structured, real world example. There is an increased administrative burden in maintaining the web site and bulletin board on daily basis, and in ensuring that all documents are available and consistent. As newer technology develops, the video streams and supporting material may need to be recreated.

The advantages accrue mainly to those students who know how to budget their time. The flexibility of viewing the lectures at any time is convenient for those with illness or trips, and even students who have a time conflict with the normal class time can be served. The student has the ability to rewind and review the video streams at any time.

The remote learning method forces the instructor to clearly define the contents of a course in a logical sequence and present video streams and documents. An unintended consequence is that some students perceive a greater workload than they would with live lectures. A hoped-for consequence is that students would become adjusted to remote video streams for the purpose of lifelong learning.

6. Conclusions

After two offerings of the web-only method of delivering lectures, the following conclusions have been drawn: 1) the process is very time consuming, especially at the beginning; 2) every step of the process must be tried in experimental form; one must allow time to deal with technical surprises; 3) more formality and rigor are required in the presentations, and detailed attention is required in operating the course; 4) the instructor must reorganize the course into "knowledge bites" and rethink the presentation style to suit the medium; 5) the surprise reaction of students should be expected, and advance publicity should be made to mitigate it; and 6) student grades did not change much from the first to the second offering. However, the students adopted a much more relaxed approach to the course during the second offering.

Based on student feedback after two offerings of the course, it is expected that the following changes will be tried: 1) on-line practice quizzes will be offered starting Summer 2000, 2) live lectures by teaching assistants will be considered for Fall 2000, and 3) a reduction in course content will be considered for Fall 2000.

7. References

Those interested in viewing the course on-line should visit: http://www.isye.gatech.edu/~engecon/