VIDEO-STREAM LECTURE SERIES FOR REMOTE LEARNING BY ON-CAMPUS STUDENTS: RESULTS AFTER TWO YEARS

Jack R. Lohmann [1] and Gunter P. Sharp [2]

Abstract – *A two-year effort delivering an undergraduate course in engineering economy to on-campus students solely over the internet is described. The use of the internet for off-campus students has become increasingly popular; however, its use for the delivery of substantial course content for on-campus students is relatively new. The development of the internet-based course, assessment of its effectiveness, and the lessons learned are presented. The course lectures and reading materials are being prepared for delivery on a CD, whereas the course administration and day-to-day electronic interactions will continue to be supported by the internet.*

Index Terms – Electronic technologies, engineering economy, internet, remote learning, video-streaming

INTRODUCTION

Electronic technology, such as video tapes, satellite transmissions, and, increasingly, the internet, have been employed to address the needs for off-campus students where they are either geographically distant from the campus or their employment schedules preclude their attendance at on-campus classes. Increasingly, however, such technology is being used for the delivery of course materials for 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 either facilitate or supplement classroom instruction and laboratory exercises. That is, the traditional lecture and laboratory interaction between the faculty and the students has remained a principal mode of instruction. However, several factors are now making electronic technologies a principal mode of instruction, even for on-campus courses: most students now either own or have easy access to computing technology, and thus access to the internet; electronic technologies offer some pedagogical advantages over live lectures, such as repeatability and graphical presentation; electronic technologies and courseware are becoming increasingly easier to use by the faculty and, therefore, more readily adopted; and engineering enrollments continue to climb in face of diminishing resources in support of faculty instruction, thus encouraging engineering programs to pursue alternative cost-effective means to deliver their curriculum.

This paper describes the development and two-year evolution of an on-campus internet-based course that replaced a traditional live lecture class. The revised junior-level course, ISyE 3025 Engineering Economy, has been taught solely through the internet during the past two years. The course organization and administration, lectures, and question and answers between the faculty and the students occurred through the internet. Based on student feedback and the experience of the instructors, the course organization, administration, and faculty-student interaction will continue through the internet, however, the lectures and reading materials will be provided in the future on a CD in the form of an electronic audiovisual textbook.

The paper first describes the rationale for offering the on-campus course via the internet; it then presents the principal issues in designing the new course. This is followed by a discussion of the creation of an electronic audiovisual textbook. The paper then provides a description of the manner in which the course is offered as well as some observations from the experiences of the instructors during the last two years. The instructors offer six suggestions for those contemplating internet-based instruction.

RATIONALE AND ISSUES IN DESIGNING AN INTERNET-BASED ON-CAMPUS COURSE

ISyE 3025, Engineering Economy, is a required, 1-credit hour internet-based sophomore/junior-level course in the industrial engineering baccalaureate curriculum. It is also required by the mechanical engineering baccalaureate curriculum, and it is taken as an elective by many other baccalaureate engineering majors. Enrollment in the course is about 250 students per semester.

[1] ***Georgia Institute of Technology, Atlanta, GA, USA, Tel: (+1) 404.894.3350, Fax (+1) 404.894.0168, jack.lohmann@coe.gatech.edu***

[2] ***Georgia Institute of Technology, Atlanta, GA, USA, Tel: (+1) 404.894.2341, Fax: (+1) 404.894.2391, gunter.sharp@isye.gatech.edu***

The subject matter covered in the course was previously presented in two traditional live lecture 3-credit hour courses of similar numbering and titles: ISyE 3025, Engineering Economy, for industrial engineering sophomores/juniors, and a complementary course ISyE 4725, Engineering Economy, for all other engineering juniors/seniors. 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 economy earlier in their curriculum than was necessary for the other engineering majors.

Two events occurred in the mid-to-late 1990s that resulted in these two 3-credit hour live lecture courses being replaced by 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, and that all baccalaureate programs would be limited to no more than 120 credit hours, with some exceptions. As a consequence of this conversion as well as the credit hour reduction, some quarter-based courses were eliminated. However, most courses were combined and redesigned. ISyE 4725 was eliminated and the ISyE 3025 was redesigned from a 3-credit hour quarter-based course to a 1-credit hour semester-based course. This redesigned course was also to be complemented by a new course in Financial Modeling. Second, by the late 1990s, 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, consequently, more courses began to use computer technology to supplement live on-campus lectures and laboratory work outside of class.

The redesigned ISyE 3025 was unique in that this on-campus course would be offered without live lectures. 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 website, bulletin boards discussion groups and e-mail access to the instructors would be provided, and finally, streaming video lectures would be available together with accompanying PowerPoint™ presentations that could be downloaded. The only live interaction would be either during the optional help sessions provided by the teaching assistants (and occasionally attended by faculty), or through appointments with the faculty. The reduction in course hours coupled with the versatility of electronic technology made an internet-based course an attractive mode to provide the essentials of the subject matter in a cost-effective manner to a large population.

The faculty faced several challenges in redesigning ISyE 3025 solely as an internet-based course. They can be divided into pedagogical issues and technological issues.

In terms of pedagogical issues, the redesign of ISyE 3025 involved both a reduction in content of the course as well as a repackaging of the material from a format driven more by the need to fit the topics into 50-minute time increments (e.g., the traditional live lecture) to one focused on segments of content, or "knowledge bites," without time constraints. The reduction in content was driven by the credit hour reduction, and the principal challenge was identifying either material to be eliminated or ways to present the same concepts in a less time. This challenge was not too difficult since both instructors came to quick agreement on what they considered to be the essentials of engineering economy for a 1-credit hour course. The repackaging of the lectures into "knowledge bites" was driven by the internet delivery of the material and was more challenging since it required the instructors to think differently about how they would otherwise normally present the material. First, since students would view the lectures on a computer screen without the benefit of the normal face-to-face interactions that occur during a live class, it was felt that the material needed to be presented in shorter segments than a typical live lecture so as to keep their attention. Second, since it was desired that the lectures taped have a useful life beyond one semester, the material needed to presented in a maner that the lectures would not have to be re-taped each semester. Thus, the material presented in each video segment covered relatively few key concepts (often no more than three to five), focused only on the course subject and avoided discussion of time-dependent course administrative matters, and employed terminology and notation commonly found in most any classic textbook on the subject.

The development of the lectures required the instructors to develop a detailed outline of the key concepts, potential examples, and the ordering of the material. This outline was then organized into "knowledge bites" and lecture minutes were assigned so that the total lecture time was consistent with a 1-credit hour course. The selection of a textbook was somewhat challenging since most texts on this subject are designed for 3-credit hour courses. Nonetheless, among the considerations in selecting a textbook was one in which students could be guided in their reading to focus on key concepts consistent with a 1-credit hour course and used terminology and notation consistent with the most widely used terms and symbols in the field.

There were several issues to be addressed in redesigning course content to accommodate the technology, they were: the limitations of the presentation software and the quality of the image when viewed on a computer screen, the recording equipment and the room setup, and scheduling time to record the lectures. PowerPoint™ was chosen as the presentation software for the lectures. It worked quite well provided one used a bold typeface, large font (no smaller than 24 points), and dark colors (light colors, such as yellow, were difficult to see on the predominantly white background of a computer screen, and some colors, like red, had a tendency to "bleed" on the screen). It was also decided to have the instructor's upper torso appear on the screen as it was believed that an audio-only lecture would be too monotonous, and a "talking head" inset only would be too small to be seen well on most computer screens (especially laptops). Thus, the presentation format forced the instructors to

either split material into more than one slide that they could otherwise show in one slide in a live lecture class or present it progressively in layered slides because of the large font size needed and the need to leave about 1/4th to 1/3rd of the screen image blank so that the instructor would not stand in front of the material while he was presenting it.

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. This included common colors, headers, slide numbering, etc. Even the choice of clothing had to be considered. Because the instructors were lecturing to a green monochrome screen with the PowerPoint™ slides being merged electronically to produce ultimately a complete image to the viewer, green clothing had to be avoided and dark clothing was required so as to stand out against the light (white) background as it would appear finally to the viewer.

The lectures were taped in a well-equipped room in the Institute's continuing education facilities. They were taped without a live audience in front of a green monochrome screen in a fashion similar to weather reporting on television. Off camera and to each side were television monitors which the instructors used to position themselves on the screen and to point to material on the monochrome screen as necessary. While the instructors did not read from written scripts, it became apparent from the experimental taping sessions that the typical "free-wheeling" 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 more than one taping to produce a quality presentation. Because "splicing" taped material with audio and action was problematic, the instructors learned to occasionally step off camera and to pause briefly to allow silent opportunities for splicing, if necessary, and avoid re-taping an entire lecture. The instructors estimate about 20 hours of preparation for each hour of finished video material.

The notion behind an electronic audiovisual textbook is to: 1) integrate the video material with the written material so that a student can view a concise presentation on short sections of written material; and 2) permit the student to "click" on links to review quickly a particular topic or concept. Thus, depending on student's preferred learning style, he/she could either read material first and then view a lecture or view a lecture first and then read material. In either case, students can progress through the electronic audiovisual textbook in a fashion that requires neither extensive *a priori* reading nor *a priori* listening/viewing, but rather the two forms of learning can progress more or less equally. In effect, there are neither "chapters" nor "lectures" but instead a logical progression of topics in written, audio, and visual forms.

CREATION OF A CD-BASED ELECTRONIC AUDIOVISUAL TEXTBOOK

During two years of course offerings, several issues arose. Two issues, however, have resulted in modifying considerably the mode of delivery of the material: the quality of the internet-based lectures could be compromised significantly by either the network load or transmission technologies used by the students, and the textbook used was increasingly difficult to procure and no others seemed readily suitable for the course.

The quality of the presentation of the lectures from the internet obviously depends primarily on the quality of its transmission. If the internet is either busy or the connection technology used has a low rate of transmission, the quality of the presentation can be considerably diminished. Thus, while the instructors made every effort to prepare quality presentations, its delivery to the students could be easily compromised by either the network load or the connection technologies used by the students. Since the lectures do not require real-time interaction with the students, they could be provided on a CD and distributed to the students, thus assuring higher quality presentations on a consistent basis.

The instructors were having difficulty acquiring their adopted text, and therefore, they decided that a CD could also contain the reading material as well. However, rather than simply put the lectures and text as separate materials on a CD, it was decided to integrate them into an electronic audiovisual textbook.

DESCRIPTION OF THE COURSE OFFERING

The first lecture is live in a large auditorium where the mode of delivery of the course is explained and demonstrated. A website connection is typically made to a video stream server and part of the introductory lecture is downloaded and played, however, a PowerPoint™ slide presentation is kept as an emergency backup.

The course material was initially organized into two-week learning cycles in which students: read the assigned material from the textbook and viewed the lectures; did the homework assignments; attended the help sessions, if needed, offered six hours per week; reviewed sample quiz questions available on the internet site; took a 50-minute quiz administered to all students in a large lecture hall; viewed individual grades on the website as well as the class distribution; and obtained individual quiz papers either in a subsequent help session or at the next class quiz. A typical semester included seven learning cycles.

The website was 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 website 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.

Initially, there were a large number of absences for quizzes due to either job interviews by students approaching graduation, an inability on the part of some students to adapt to the new style of learning, or apparent attempts by some students to have make-up quizzes after they would have some information about the regularly scheduled quiz questions from friends. Further, many students performed poorly on the regularly scheduled quizzes. Thus, a general make-up quiz, an eighth quiz, was scheduled and made available to all students; this quiz covered most of the course material. Absences from quizzes have declined during the subsequent offerings of the course.

The new format will have the course organized into seven sections with each further subdivided into three to nine modules. Each module will contain text material (3 to 4 pages), a video presentation of approximately 5 to 8 minutes, additional solved problems in text format, and homework problems. All of this material will be provided on the CD in a browser format with links to a glossary, selected links to websites, and navigation links. A website will continue to be maintained with a bulletin board, homework and quiz solutions, and grades.

- Profit and Depreciation
  - Methods of Taxation
  - Graduated Corporate Tax Structure
  - Effective and Marginal Tax Rates
  - Special Cases for Large Firms
  - Parameters for Depreciation Methods
  - SL, SYD, DB Methods
  - MACRS Methods
  - Sale of an Asset, Depreciation Recapture
  - Financing With a Loan
  - Comprehensive Example
- INFLATION
  - Price Indices
  - Relationship between MARR and Inflation
  - Actual Dollar Analysis

The bulletin board will have topic forums by section, and additional forums for topics of current interest related to the course.

The course outline is as follows.

- INTRODUCTION
  - Organization and Navigation of the Materials
  - Learning Objectives
  - Four Principles
- FINANCIAL MATHEMATICS
  - Compound Interest
  - Equivalence
  - Equivalence Formulas
  - Single Cash Flow
  - Uniform Cash Flow
  - Arithmetic Cash Flow
  - Geometric Cash Flow
  - Interest Rate Conversions
- ECONOMIC DECISION CRITERIA
  - Fundamental Choice of an Economic Decision
  - Benefits and Costs
  - Net Future Value
  - Net Present Value
  - Net Uniform Value
  - Internal Rate of Return: The Basics
  - Internal Rate of Return: Some Complications
  - Benefit/Cost Ratio
  - Payback Period
- DECISION ALTERNATIVES
  - Defining Alternatives
  - Incremental Analysis
  - Case Study: Mortgage Refinancing
- TAXES
  - Constant Dollar Analysis
- UNCERTAINTY
  - Scenario Analysis
  - Expected Present Value
  - Breakeven Analysis, No Interest
  - Breakeven Analysis, Interest
  - Retirement Planning

OBSERVATIONS AND EXPERIENCES

After two years of offerings of the course, some observations can be shared from this experience. They can be classified into student perceptions and faculty observations.

During the first offering the most notable student reaction

was surprise and frustration. There was little if any advance notice of the internet-only method of lecture delivery. Many students had trouble with the video streams, especially those connecting from off-campus. Incompatible software, poor quality video streams for the 56K download, interrupted downloads, and improper switch settings contributed to the frustrations. During the subsequent offerings there was relatively little outspoken frustration. Apparently, the word had spread among most of the students and they were aware of the new format. In addition, feedback gradually became more positive and the overall course rating actually became higher than the last live lecture offering. There was an initial reduction in the response rates on the internet-based survey from 60% to 48% for the multiple choice questions, but an increase from 26% to 48% for the optional verbal comments. The latter were due to the negative reaction to the internet-based course. Thereafter, the multiple choice response rates were in the 20-29% range, and the optional verbal comments were in the range of 14-17%.

The comparisons presented in Tables I and II are based on feedback responses by students near the end of the academic term. The Fall '98 offering was a 3-credit hour, traditional live lecture class. The others thereafter were the 1-credit hour, internet-based class. Because of the difference in the scope of the material covered, the data for Fall '98 with the other offerings subsequently are not strictly comparable. Further, the response rates have been affected by an Institute-wide policy started in the Fall of 1999 that changed the collection of student feedback from paper forms distributed in class to one in which students submit their evaluations electronically outside of class on their own time. Nonetheless, student ratings remain somewhat below average for other, for the most part, live lecture classes at the Institute.

TABLE I
RESPONSES TO THE QUESTION,
"THE COURSE HAS BEEN VALUABLE TO ME."

Offering	*N**	*SA**	*A**	*PA/PD**	*D**	*SD**	*Rating**
Fall '98**	32	20%	30%	20%	20%	10%	3.5
Fall '99	120	10%	38%	23%	16%	13%	3.4
Spr '00	61	8%	45%	23%	10%	13%	3.6
Sum '00	20	14%	52%	24%	5%	5%	3.8
Fall '01	74	11%	37%	33%	14%	5%	3.4
Spr '01	78	16%	43%	26%	12%	3%	3.7

* N = Number responding; SA = Strongly Agree; A = Agree; PA/PD = Partly Agree and Partly Disagree; D = Disagree; SD = Strongly Disagree; Rating = Overall rating of the course, 1 = Low, High = 5.
** 3-credit hour, live lecture class. All others internet-based.

A summary of an analysis of the voluntary verbal comments is shown in Table II. There has been a gradual improvement from the initial negative reaction.

TABLE II
CLASSIFICATION OF VERBAL RESPONSES ON ALL ASPECTS OF COURSE

Offering	*N**	*VP**	*P**	*M**	*N**	*VN**
Fall '99	98	13%	16%	23%	38%	10%
Spr '00	36	13%	10%	23%	45%	8%
Sum '00	14	10%	10%	50%	30%	0%
Fall '01	44	11%	21%	18%	50%	0%
Spr '01	45	16%	24%	24%	37%	0%

* N = Number responding; VP = Very Positive; P = Positive; M = Mixed; N= Negative; VN = Very Negative.

The major complaints have focused on: 1) the method of delivery, mostly the lack of advance knowledge of the nature of the delivery of the course; 2) help sessions scheduled at times the students felt were inconvenient; 3) physical limitations of the classroom used for administering quizzes; 4) technical problems with downloading material, including the inability to save some material; and 5) the feeling there was too much material covered for a 1-credit hour course.

Help session attendance has dropped from the first offering. During the first offering, attendance in the second week of each learning cycle ranged from 4% to 12%, during the last offering it ranged from 0.2% to 8%. Obviously, the students changed their learning habits. We speculate they are learning how to deal with an internet-based course.

Interestingly, the overall grades achieved by the students has been generally higher after the conversion to an internet-only course, as shown in Table III. This must be tempered by the fact that the coverage of material was reduced considerably from a more comprehensive 3-credit hour course in which many subtleties could be introduced to one focused on only the very basic fundamentals delivered in a 1-credit hour course. An attempt was made to relate student grades to website visits and bulletin board articles read. The results, however, were not statistically significant.

TABLE III
GRADES ACHIEVED BY STUDENTS BEFORE AND AFTER CONVERSION

Offering	*N**	*A*	*A or B*	*A,B or C*	*D or F*	*I or W**

Fall '98**	53	23.1%	46.2%	86.5%	9.6%	3.8%
Fall '99	250	48.1%	53.7%	85.2%	9.3%	5.4%
Spr '00	259	26.2%	65.8%	89.2%	3.9%	6.9%
Sum '00	98	35.7%	67.3%	95.9%	2.0%	2.0%
Fall '01	252	40.2%	80.4%	95.1%	0.8%	4.0%
Spr '01	270	45.2%	85.2%	97.8%	1.4%	0.7%

* N = Number responding; I or W = Incomplete or Withdrew.
** 3-credit hour, live lecture class. All others internet-based.

There are a number of disadvantages with an internet-only course. One of the disadvantages of internet-only lectures is the lack of personal interaction between the faculty and the students. The element of real-time discovery is reduced. Further, video taped lectures do not lend themselves well to discussing ill-structured, real world examples to motivate the students about the material. There is an increased administrative burden in maintaining the website and bulletin board on daily basis, and in assuring that all documents are available and consistent.

On the other hand, there are several advantages. 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 either job interview trips or incur an illness. However, for all students, it frees up time in which they can schedule other classes. Obviously, students also have 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 the course more so than the live lecture method since typically all of the video taping must be done before the class even begins. An unintended consequence is that some students perceive a greater workload than they would with live lectures. We suspect that this is because they are learning how to manage their time with respect to a learning environment they have not previously encountered. A hoped-for consequence is that students might become better adjusted to remote video streams for the purpose of lifelong learning.

- Since most on-campus students still take live lecture courses, the surprise reaction of students should be expected and advance publicity of the manner of delivery of the course should be made to mitigate it.

- Students appear to adopt a much more relaxed approach to the course. In our case, this may be because it is a 1-credit hour course.

Finally, as the cost of technologies lowers and their use becomes easier for more faculty, more and more internet-based or CD-based materials are likely to be used in place of live lecture classes. There are a number of pros and cons to doing so. At the moment, most students have been exposed mostly to live lecture classes throughout their academic lives. As such, it is to be expected that their reactions will vary to this new form of educational delivery. As resources tighten and interest in engineering education and continuing education grows, the use of electronic technologies will become a much more prevalent part of our means of educational delivery.

CONCLUSIONS

We have six observations to offer for those contemplating internet-based instruction.

- The process for creating and administering the course is very time consuming, especially at the beginning. The learning curve has a high, initial step function.

- Every step of the process should be tried in an experimental form first. Anticipate and allow time to deal with technical surprises.

- More formality and rigor are required in the presentations than in a live lecture, and more attention to the details is required in managing the course.

- Internet-based courses must be reorganized into "knowledge bites" and the presentation style of the instructor must be modified to suit the medium

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