

Computer Utilization in Enhancing Engineering Education

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Abstract

In June of 1998, with an initiative from the Board of Regents of the University System of Georgia, the Georgia Institute of Technology was placed in charge of developing plans to further enhance the educational opportunities in engineering across the state. Georgia Tech Regional Engineering Program (GTREP) was specifically created to accomplish this objective. GTREP is based in southeast Georgia and offers undergraduate programs in the areas of Civil and Computer Engineering in collaboration with Armstrong Atlantic State University, Georgia Southern University, and Savannah State University. In the summer of 1999 with the funds from Georgia Tech, the computer laboratories and teachable lecture room facilities at Georgia Southern University were updated and equipped with computer projection systems, Elmo units, SMART BOARDS and other instructional technology equipment to meet the demands of the GTREP program. The paper presented discusses the methodologies currently utilized in these improved facilities to enhance the teaching effectiveness of the instructors and the course comprehension of the students.

During the fall semester of 1999, these methodologies were employed to provide instructions for a total of about two hundred students enrolled in seven sections of the course entitled Computing for Engineers (ENGR 1132). A web site is specifically designed for this course to aid the instructor in relaying the course material to the students effectively and to give them easy and convenient access to the course material. A discussion will be included in this paper to illustrate the components which are included in the web page and to clarify how these components are utilized to enhance the instructions. The utilization of a listserv specially designed for this course and electronic mail will also be discussed in this paper together with the utilization of variety of software packages and tools including the use of Internet services and resources. The paper also sheds light into the following questions: Why were the discussed techniques and tools selected? How are they supposed to work? What effect do they have on the course delivery of the instructor? How do they effect the student learning?

I. Introduction

Georgia Southern University is one of eight universities in the state of Georgia which provides a wider access to engineering education through its engineering transfer program. This program is designed for students who find initial entry into the only state funded engineering school in Georgia, Georgia Institute of Technology, difficult or inconvenient. Through the Engineering Studies Program students have an opportunity to complete their first two years of engineering education at Georgia Southern and upon successful completion of their course work transfer to

Georgia Tech. The course sequence in the Engineering Studies Program is designed with the assistance and approval of Georgia Tech to ensure that the courses are transferable.

In the summer of 1999, the funds allocated by the GTREP program as well as funds from other campus sources were used in creating and upgrading lecture rooms and computer laboratory facilities in support of engineering instruction at Georgia Southern University. This paper mainly discusses how some of these facilities were utilized during the fall semester of 1999 in delivering instruction to two hundred Engineering Studies students enrolled in seven sections of a course entitled "Computing for Engineers". The paper addresses a variety of subjects dealing with the following issues: (a) the rationale for selecting the purchased equipment and a discussion of how this equipment was utilized in support of engineering instructions, (b) the methodologies which were implemented in improving the course delivery, (c) The techniques employed to enhance and accelerate the students learning.

II. Instructional Technology Equipment and Computers for the Facilities

As an initial step for creating a suitable computing environment for effective delivery of course instructions, two teachable lecture rooms and one new computer laboratory were created and two other existing labs were upgraded. Each of the teachable lecture room facilities can accommodate an average of thirty-two students and the computer laboratories an average of thirty-five. All the lecture room and computer room facilities created and upgraded in this project were equipped with instructor computer units, Elmo document cameras, multimedia lecterns, and high resolution projection systems. Multimedia lecterns selected for the lecture rooms are compact lockable units that house the instructor's computer and Elmo unit. These compact lecterns provide easy viewing for all students and allow the instructor to secure the equipment in place effortlessly after the lecture without shutting down the system, disconnecting cables and putting away the equipment. The system is already in standby position ready for the next instructor to use. It should be mentioned that all the instructors' computer stations housed in the lecterns are setup in a fashion that they can be operated with a remote control mouse and wireless keyboard. This allows the instructors to be able to move freely in the lecture room and still be able to control the pointer's motion on the screen and operate the computer without being fixed behind the lectern.

All the facilities created/upgraded for this project except one lecture room are also equipped with SMART BOARDS. The SMART BOARDS in the facilities discussed are setup in a fashion that allow the instructors to be able to write on a 6 ft x 6 ft special screen using markers and project the image on a larger 9ft x 9ft screen for students' easy viewing. SMART BOARDS are used as an additional tool to aid the instructor in relaying the course material to the student. Figure 1 show photographs of one of the teachable lecture rooms and computer laboratories created at Georgia Southern University in support of engineering instructions.

The projection systems in all the facilities mentioned were mounted from the ceiling for security purposes, for ease of use and for space limitations. It should be mentioned that the instructors were using a mobile computer and projection system located on a rolling cart for several semesters. This system was found to be very inconvenient and unsuitable both for the instructor

and the students for the following reasons: (a) The courses scheduled to be taught in the same lecture room facility in the back to back time slots did not provide the instructor with sufficient time to setup the computer/projection system and connect the wiring and startup the computer and the programs, (b) In order to acquire an image large enough for all students to view, the cart/projection system had to be moved back toward the center of the room away from the projection screen. This dictated a change in the students' seating arrangement in order not to block the students' passage into the lecture room, (c) Shutting off the computer and the projection system, disconnecting cables and moving the equipment out of the lecture room in time for the next class to enter the classroom was always a challenge



(a)



(b)

Figure 1. Created Computing Environments
(a) Teachable Lecture Room, (b) Computer Laboratory

The computer units selected for the computer labs have Intel 500 MHZ, Pentium III processors, with 128 MB RAM, 512 cache, and 13 GB hard drives. These units are also equipped with super disk drives, DVD-ROM drives, and CD-recordable/rewritable drives. The specification for these computers are selected in a fashion suitable for supporting instructions in a variety of engineering/engineering technology related courses.

III. Methodologies Implemented in Teaching the Computing for Engineers Course

Computing for Engineers course, designated as ENGR 1132, is basically a freshman level course designed to introduce the students to the basic concepts of computing including the use of algorithms, flowcharts, and programs. The laboratory projects in this course are designed in a fashion that not only teaches the students about various computing principles, but also instructs them about the utilization of a variety of basic software tools including Internet services and resources. The software tools discussed in this course are word processing, spreadsheets, presentation graphics, and databases as well as a few other packages. The segment based on the use of the Internet basically included discussions on the utilization of electronic mail,

newsgroups, listservs, file transfer, world wide web, and remote host computing. The instructions provided in the course were directly geared for effectively preparing the students for subsequent computer related engineering courses that they are required to take for completing their degree requirements.

During the fall semester of 1999, the author of the paper created and was actively utilizing a web page to teach four sections of the Computing for Engineers course. This web page was also used to provide useful information and supporting material for three other faculty members who were assigned to teach three sections of this course for the first time. A snapshot of the instructor's web page is shown in Figure 2.

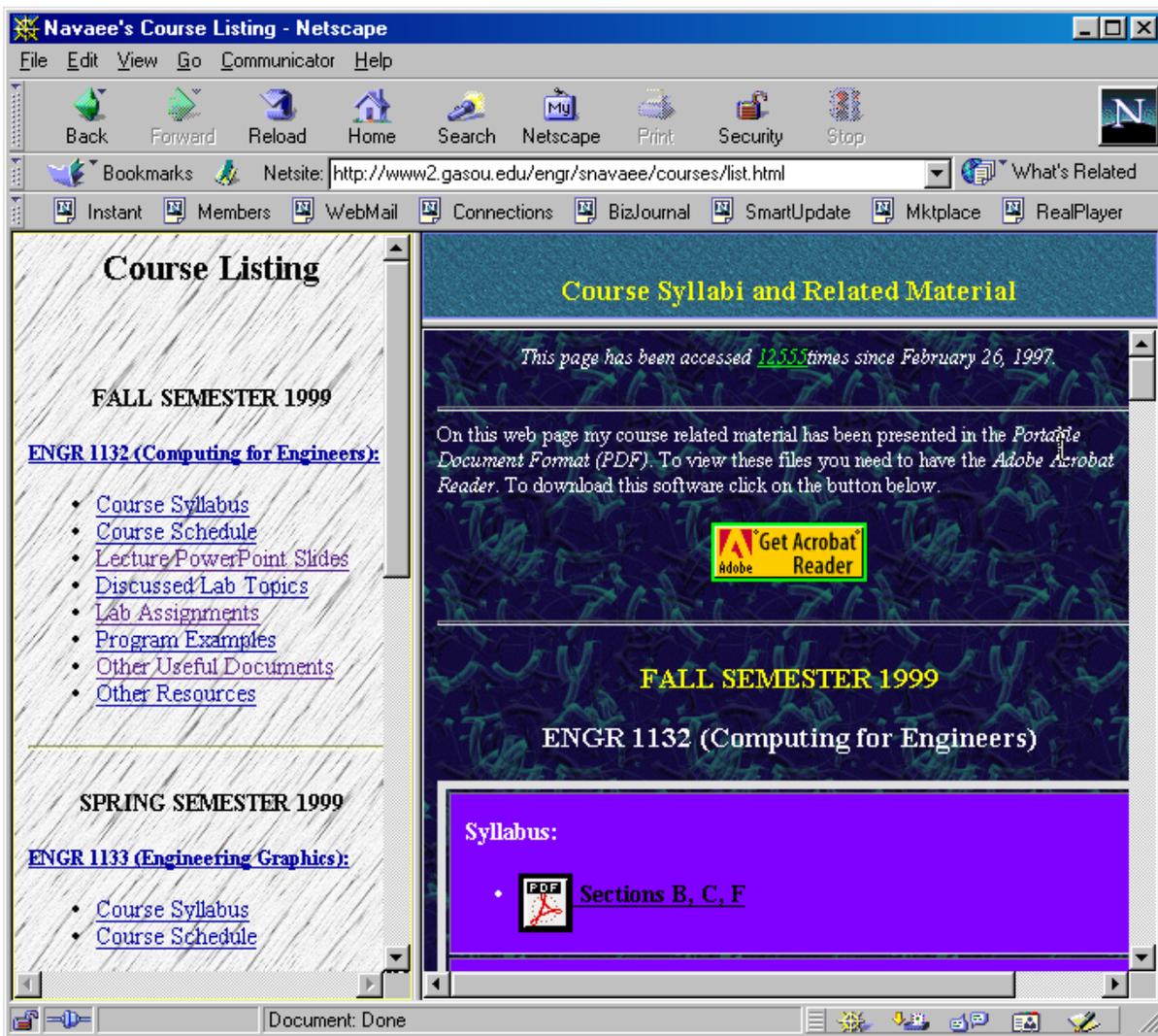


Figure 2. Web page for the Computing for Engineers Course

This web site which was continuously updated and improved contained a variety of useful information such as; lecture slide PowerPoint slide presentations (primarily containing text, links, graphics, scanned images, and animations), instructions for utilizing various Internet

services and resources, links to important web sites, description of the discussed lab topics, description of the lab assignments, program examples, as well as other course related material. Note that all the above-mentioned files were prepared in the Portable Document Format (PDF) using the Acrobat Exchange software to give students and other faculty easy and convenient access to these files. The PowerPoint slide presentations placed on the web site were basically created to complement the text and to provide the students with understandable modules that they could use as study guides. These slide presentations were produced in two formats black & white and color. The black & white version contained smaller size slides that could be printed easier and faster on the printer, and the color version contained larger size slides for the purpose of viewing them on computer monitors or on projected screens. The color version of the PowerPoint slide presentation modules were effectively utilized by the instructor during instructions to complement the lectures.

When teaching in the lecture room or laboratory, the instructors were frequently accessing the course web page to be able to project and utilize various supporting documents, files, and other course related items on the computer screen. Access to a computer/projection system in the lecture room facility probably has its greatest effect when the instructors were discussing various programming principles for the students. Using this projection system, the instructors were able to develop and discuss various programming constructs during the lecture and test them for accuracy by running them on a remote host computer. This delivery approach was very effective and efficient, since the instructors were able to generate a wide range of problems very quickly by changing or relocating a few programming steps and by creating different scenarios for class discussion and participation. This served as great tool for enhancing the students course comprehension. The example problems created and discussed during the lecture were sent to all students at the end of the class period via electronic mail by utilizing a special listserv named "navae-l". This listserv was specifically created for the use of this course in order to encourage and foster student/instructor interaction. All additional instruction and helpful suggestions in regards to performing the assigned projects were also provided to the students using this listserv mainly during off times and weekends. The students were also encouraged to post questions to this listserv and in some cases answer their fellow student's questions in the absence of the instructor.

Availability of course related documents through the author's web page and listserv relieved the students from taking extensive notes during the lecture period and allowed them to be able to concentrate more on understanding and absorbing the material. The use of the discussed web page together with the utilization of electronic mail and the discussed listserv provided the students with a convenient mean to obtain continuous support and assistance from the instructor.

IV. Computing for Engineers Lab Projects/Exercises

In teaching this course, during the fall semester of 1999, the students were engaged in a variety of projects/exercises to sharpen their acquired knowledge and skills in the course. These exercises tested the students' course comprehension and their ability in applying the provided instructions in solving engineering problems. A collection of lab projects for this course is

provided on the author's course web page.

To better provide a sense of what was accomplished during each lab period, one sample project in its entirety is provided in Figures 3 and 4.

ENGR 1132 - COMPUTING FOR ENGINEERS
FALL SEMESTER 1999
LAB # 9

Part 1: Excel

Create the following exercises on successive pages of a single Excel spreadsheet, and provide the instructor with a hard copy and a soft copy of each of the pages. The soft copy must be submitted through Netscape Messenger as an attached document. Choose your name as the name of the file and don't forget to include your name, section number, and lab assignment number on the subject line. Also, note that you must have appropriate titles and subtitles for your charts, and should label the axes. Please personalize your sheets by using the following as the subtitle for your charts: "By: Student Name". Use gridlines on all spreadsheets.

- Distribution of Engineers by their fields is recorded in the table shown below (according to the *Science & Technology Data Book, 1988*):

Field	Percent
Electrical/Electronics	24
Mechanical	20
Civil	14
Chemical	6
Aeronautical/Astronautical	5
Other	31

Plot this information using the following charts (show the spreadsheet and the charts on the same page):

 - Two-dimensional column chart,
 - Three-dimensional column chart,
 - Two-dimensional pie chart,
 - Three-dimensional pie chart.
- For a motorcycle traveling along a road, the plots for the distance (x), velocity (v), and acceleration (a) versus time are given below. Using Excel produce these plots for the time values ranging from 0 to 15 seconds using increments of 0.5 second for time. Note that you are required to use the **IF** function in producing the values for x, v, and a. Show the spreadsheet and the three graphs on the same page.

Plot of Distance vs. Time

Distance (m) vs. Time (s)

Equations:
 $x = 0.625t^2$, when $0 \leq t \leq 4$
 $x = 5t - 10$, when $4 < t \leq 10$
 $x = 15t - 0.5t^2 - 60$, when $10 < t \leq 15$

Plot of Velocity vs. Time

Velocity (m/s) vs. Time (s)

Equations:
 $v = 1.25t$, when $0 \leq t \leq 4$
 $v = 15 - t$, when $10 < t \leq 15$

Plot of Acceleration vs. Time

Acceleration (m/s/s) vs. Time (s)

Equations:
 $a = 1.25$, when $0 \leq t \leq 4$
 $a = -1$, when $10 < t \leq 15$

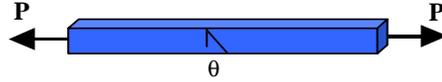
Figure 3. A Sample Lab Project for the Computing for Engineers Course

**ENGR 1132 - COMPUTING FOR ENGINEERS
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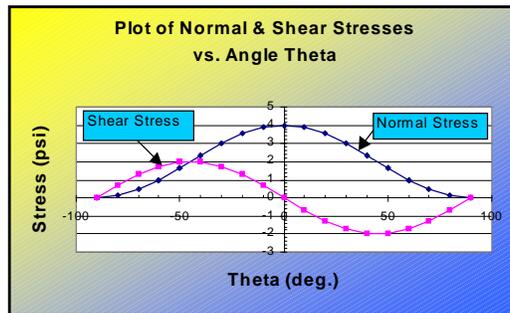
3. For a bar which is subjected to a force of P , the normal stress and shearing stress on a plane with an angle of orientation θ can be obtained using the following equations:

Normal Stress: $\sigma_{\theta} = (P/A) \cos^2 \theta$

Shear Stress: $\tau_{\theta} = - (P/A) \sin \theta \cos \theta$.



Using $P = 48000$ lb and $A = 12$ in², plot these distributions in the range of θ between -90° and 90° using increments of 10° . Don't forget to indicate the units when labeling the axes and also label each of the two graphs.



Part 2: Computing Principles & Programming

Perform and submit exercises 13.1, 13.2, 13.4, 13.9, 13.11, 13.12, 13.15, and 13.20 on pages 328-332 in your text.

Figure 4. Sample Lab Project for the Computing for Engineers Course (Continued)

This project was basically consist of two parts. The first part included three exercises on the use of the Excel software package and the second part included problems dealing with concepts of computing and programming. The exercises were designed utilizing several engineering text^{1,2,3}. The problems on the second part of the project were from an introductory computing text⁴ used in teaching this course. As a result of performing this project, the following objectives were accomplished.

- The students were familiarized more with utilization of variety of formulas and functions, including mathematics and trigonometric functions in spreadsheets.
- The students were taught how to create two and three dimensional plots using data stored in spreadsheets. Plots requested in this exercise forced the students to explore and learn more about the special features and capabilities of this particular software package.
- The problems included in the project on computing and programming issues tested the students' ability in applying the principles discussed during the lecture in solving problems. To perform this segment of the project, the students were instructed to type their program in a text file, upload this file to the campus server using a FTP program, and run it using a Telnet software. The detailed step-by-step instructions for accomplishing this task were

provided for the students in a PDF file placed on the author's course web page. The objective of this segment of the exercise was not only to familiarize the students with basic concepts of computing but also introduce them to issues involving transferring files (FTP) and remote host computing.

- The request for submission of electronic copies of the project to the instructor, required the students to learn about the concepts involving sending electronic mail⁵. Access to the student's electronic file, allowed the instructor to be able to take a closer look at the students work and examine it for accuracy and details. For example, the instructor could click on individual cells on the spreadsheet to view whether the student had utilized the proper formulas/functions. The details in creating data in spreadsheets normally cannot be seen by simply viewing the hard copy of the document.

The exercises included in this project not only taught the students about utilization of spreadsheets, computing principles, and Internet services/resources, but also introduced them to a few issues related to the engineering profession and engineering concepts.

V. Summary and Conclusion

The presented paper discussed the preparation and creation of several lecture rooms and computer laboratory facilities in support of engineering programs at Georgia Southern University. The focus of this paper was on demonstrating the methodologies which were implemented during the fall semester of 1999 in these facilities for teaching an introductory computing course. It was determined that the utilization of the techniques implemented greatly enhanced the delivery of the course and played a key role in the student course comprehension. Methodologies similar to the one described in this paper for teaching the Computing for Engineers course can easily be developed to support a variety of other engineering courses on or off campus.

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