Raising Computer Competency of Engineering Students

Shahnam Navaee[1]

Abstract

Rapid ongoing integration of computers and new technologies in upper level engineering courses now more than ever dictates that freshman engineering educators produce students that are more computer competent. In this paper a strategy will be outlined to familiarize the students with a variety of software packages, computing tools, and Internet services. The prescribed procedure was utilized in teaching four sections of the Computing for Engineers course (ENGR 1132) in the fall semester of 1999. In this course, the lecture and laboratory presentations were enhanced through the use of appropriate instructional technology equipment and a comprehensive web site which was specifically designed for this course. The ENGR 1132 course is the first computing course that freshman engineering students are required to take at Georgia Southern University before transferring to the Georgia Institute of Technology to complete their degree requirements. Included in this paper is a description and a follow-up discussion of a group final project which was assigned to the student in this computing course. Each component of the project was carefully planned to serve a specific goal and to achieve a certain goal in terms of student academic development. Through performing this project the students gained proficiency in utilizing a variety of software tools and learned how to apply these tools effectively to solve an engineering problem in a group setting. The project was designed in a fashion that allowed the instructor to be able to accurately evaluate the students' course comprehension, abilities, as well as their other skills related to the use of computers. A sample student project will be presented in this paper to further clarify and illustrate the points made, together with the author's specific recommendations regarding future improvements.

Introduction

The Computing for Engineers course (ENGR 1132) course is one of few primary courses that all engineering students regardless of their field of specialization are required to take at Georgia Southern before transferring to Georgia Tech. The intent of this course is to introduce the students to the basics of computing principles and to familiarize them with a variety basic software tools (word processing, spreadsheets, presentation graphics, etc.) as well as a few other Internet tools. The Internet related portion of the course included discussions on the use of electronic mail, listservs, file transfer, remote host computing, as well as other WWW tools. In teaching four sections of the ENGR 1132 course during the fall semester of 1999, the author utilized a special course web page and a computer projection to deliver his instructions. The students were then engaged in exercise and projects that were designed to enhance their knowledge of the material and to measure their course comprehension.

The web page that was created for the purpose of complementing the course allowed the students to be able to conveniently access a variety of important course related material. Material such as lecture PowerPoint slide presentations, description of the lab topics, description of the lab assignments, program examples, links to important web pages, as well as other course related documents.

---

[1] Associate Professor, Engineering Studies Program, Georgia Southern University, Statesboro, GA.

The computer projection system that was setup in the lecture room was particularly useful in allowing the instructor to teach the students about various computing and programming principles. Using this system a variety of problems was generated in the classroom as the instructor effectively modified existing programs to create new problems and scenarios. An electronic version of the problem which was created during the class discussions were then e-mailed to the students via a listserv which was specifically designed for this course. Access to the copies of the problems generated in the classroom relieved the students from taking extensive notes in class and allowed them to be able to pay careful attention to the material discussed. This method of delivery of the course material using the computer projection system and a web page as described above effectively enhanced the student course comprehension and created a great tool for instructor/student interaction (Navaee, 2000).

The paper presented here focuses on describing a special final project that was designed for the "Computing for Engineers" course to involve the students in a variety of course related activities. The details of the various components of this final project along with a discussion about why these components were selected are provided in the next section.

Course Final Project

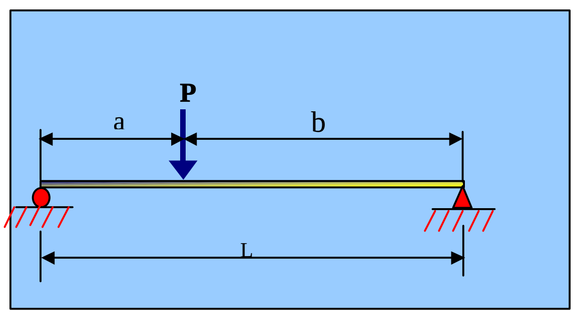
Group projects have been utilized by a great many engineering educators over the years as an acceptable mean to evaluate students' academic capabilities and performances. In assigning a group project the following questions can be of concern to the instructor; (a) How to make sure that all students are contributing equally to the different aspects of the project? (b) How to measure and fairly evaluate the contributions of each member in performing each of the project related tasks? (c) How to ensure that the performance of an academically weaker student (or non-interested student), or a stronger student does not jeopardize or have an inflated effect on the grades of the rest of the group members? To elevate the concerns mentioned, a special type of a group project (a "semi-group" project) prescribed in the manner below was utilized by the author in teaching the Computing for Engineers course.

In the fall semester of 1999, each of the four sections of the ENGR 1132 course were divided into seven groups consisting of four members each. The instructor used the student records as a mean to form groups that were mixed in terms of their member capabilities. At least one academically capable student was placed in each of the groups so that he/she can organize and direct the overall activities of the group. As an initial step in accomplishing this project, the students were assigned to individually perform a series of tasks related to the topics discussed in the course. These tasks were similar in nature, but different in specifics. The similarities between the tasks/problems served basically two purposes; (a) allowed the instructor to be fair and consistent in evaluating the students, (b) allowed the students to be able to seek occasional help from group members and learn in the process. The differences in the specifics of the assigned tasks/problems forced each group member to perform each task (or solve each problem) entirely on his/her own and be involved in all aspects of the project. As the final step of this project, the group members through their planned meetings were expected to combine their individual work into one well organized, consistent, and coherent package. This package was expected to be presented to the instructor and the entire class orally during the last lab session of the semester using a PowerPoint presentation. The length of each group's final presentation was expected to be fifteen to twenty minutes. Note that each group was also expected to submit a hard copy as well as an electronic copy of the final project to the instructor to allow him to be able to take a closer look at the details of student work and examine it for accuracy and completeness. The reasoning behind assigning the second part of the final project was to give these freshman students a chance to learn from some of the experiences involved in working with peers in a group setting. This portion of the project also provided the students with an experience of expressing their work in an oral fashion in front of an audience.

The detailed recipe for preparation of the final project in the format presented to the student is provided in the appendix. A brief description of each of the main components of the project and the rationale for assigning these components is included in this section of the paper. The final project for the ENGR 1132 course basically had five main components related to the following issues; (a) utilization of the World Wide Web, (b) utilization of various computing and programming principles related to solving an engineering problem, (c) application of a spreadsheet software package for solving engineering problems, and (d) producing a PowerPoint slide presentation.

In part (a) of the project dealing with the World Wide Web, group members were expected to create their own personal web site which contained their related information as well as links to five credible educational web sites that offered useful and valuable information related to the computing and/or engineering fields. The descriptions of the chosen web sites and the explanations of why these sites were selected were expected to be included in the PowerPoint slide presentation of the groups. In this portion of the project which dealt with the World Wide Web, each group member was also assigned to research and locate two pieces of software (freeware, shareware, commercial) which could perform a useful and important task for the student (creating and editing video and audio files, capturing and modifying images, compressing files, etc.). A discussion on the purpose, utilization, and importance of each software was expected to be included in the slide presentation of the group.

In part (b) of the final project related to computing and programming, each member of the group was assigned a separate problem dealing with analyzing a beam subjected to a particular loading condition. The members of each group were expected to solve these problems using several different approaches that employed the computing and programming principles discussed during the lecture sessions. Note that the assigned problems were similar in the sense that all students had to determine the deflection, slope, shear force, and bending moment at different locations along the length of the beams. These problems were different in the sense that all beams had different supports and loading conditions. One sample beam and loading condition and its corresponding equations for the deflection, slope, shear force, and bending moment are presented in Figure 1 (Bauld, 1986).



When $0 \le x \le a$:

$$v(x) = \frac{pbx}{6EIL}(x^2 + b^2 - L^2)$$

$$q(x) = \frac{pb}{6EIL}(3x^2 + b^2 - L^2)$$

$$V(x) = \frac{Pb}{L}$$

$$M(x) = \frac{Pb}{L}x$$

When $a \le x \le L$:

$$v(x) = \frac{Pa(L-x)}{6EIL}(x^2 - 2Lx + a^2)$$

$$q(x) = \frac{Pa}{6EIL}(-3x^2 + 6Lx - a^2 - 2L^2)$$

$$V(x) = -\frac{aP}{L}$$

$$M(x) = \frac{aP}{L}(L - x)$$

Figure 1 - Sample Beam, Loading Condition and the Corresponding Equations

Note that the uniformity between the types of problems assigned to different group members made it easier for the instructor to be able to provide all students with the same problem description and explanations. To run the FORTRAN programs developed in this segment of the project, the students were instructed to upload their programs to the university server using appropriate FTP software and run them using a Telnet program.

In part (c) of the project the students were asked to resolve the problem in part (b) using an Excel spreadsheet program to verify the results that they obtained in previous part. The spreadsheet and the corresponding plots that the students had to create for the sample problem shown in Figure 1 is illustrated in Figure 2.

ENGR 1132 (Computing for Engineers) - Final Project - Fall Semester 1999 Deflection of a Simply Supported Beam Subjected to a Concentrated Load					
x (in.)	Deflection (in.)	Slope (rad.)	Shear Force (lb)	Bending Moment (lb-in.)	
0	0.000000	-0.002260	24500	0	
12	-0.026990	-0.002227	24500	294000	
24	-0.053183	-0.002127	24500	588000	
36	-0.077780	-0.001961	24500	882000	
48	-0.099983	-0.001728	24500	1176000	
60	-0.118996	-0.001429	24500	1470000	
72	-0.134020	-0.001064	24500	1764000	
84	-0.144448	-0.000679	-10500	1638000	
96	-0.150431	-0.000323	-10500	1512000	
108	-0.152311	0.000005	-10500	1386000	
120	-0.150431	0.000304	-10500	1260000	
132	-0.145131	0.000575	-10500	1134000	
144	-0.136755	0.000817	-10500	1008000	
156	-0.125644	0.001030	-10500	882000	
168	-0.112139	0.001216	-10500	756000	
180	-0.096583	0.001372	-10500	630000	
192	-0.079318	0.001501	-10500	504000	
204	-0.060685	0.001600	-10500	378000	
216	-0.041027	0.001671	-10500	252000	
228	-0.020684	0.001714	-10500	126000	
240	0.000000	0.001728	-10500	0	
Beam & Loading Data:					
a (in.)	b (in.)	L (in.)	I (in^4)	E (psi.)	P (lb)
72	168	240	1830	29000000	35000

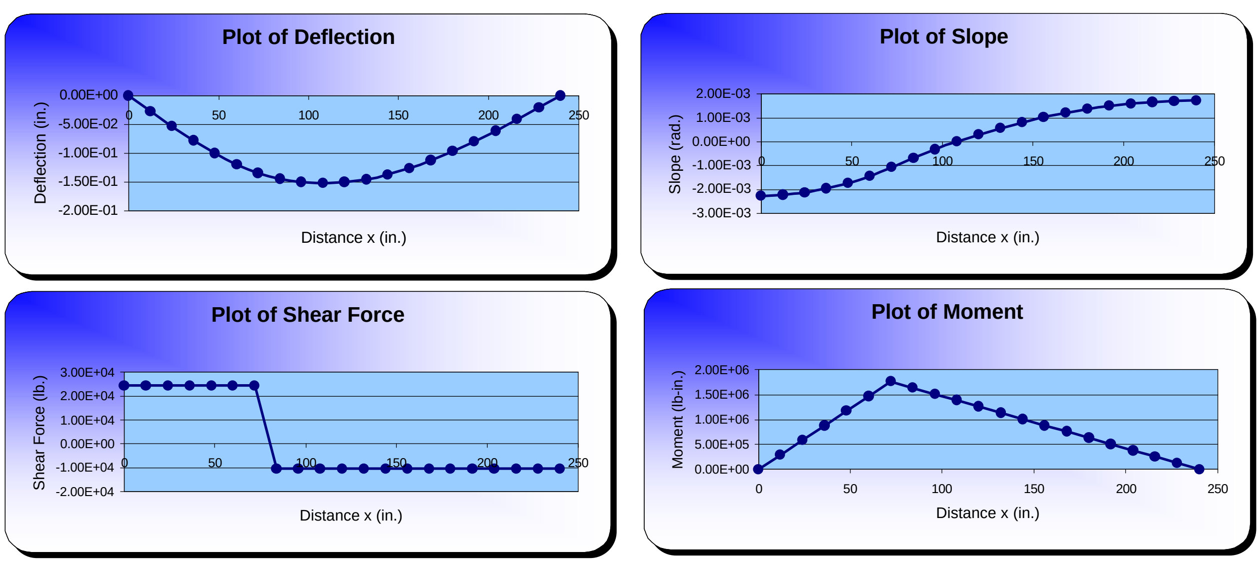


Figure 2 - The Spreadsheet and the Corresponding Plots for the Beam

In the last part of the project, part (d), the members of each group were expected to document, organize, and combine all of the work that they created in the previous parts into one single PowerPoint slide presentation. Utilizing a computer projection system, the group members used this slide presentation to describe their work orally to the instructor and the entire class during the last lab of the semester.

The final project selected for this course was designed to meet a number of objectives. A summary of the most important objectives attained in this project is summarized below:

- To provide an opportunity for the students to be able to apply the computing and programming principles that they have leaned to solve an engineering problem.

- To force the students to effectively utilize a variety of software packages and Internet tools (spreadsheets, presentation graphics, file transfer protocol, remote host computing, electronic mail, listservs, web authoring, etc.).

- To teach the students how to locate educational resources on the World Wide Web.

- To provide the students with an opportunity to experience working in a group setting on an engineering problem and learn from this experience.

- To allow the students to experience presenting their knowledge and ideas orally in front of an audience.

- To allow the instructor to be able to fairly evaluate the students competence and ability in using the principles and software tools discussed.

Conclusion

As a result of the prescribed final project in the Computing for Engineers course, the main objectives described in the previous section of the paper were attained. The quality of performance of the students in the final exam indicated that most students did benefit from performing this project and did learn the course concepts well. The knowledge and experience that the students gained through undertaking this project at the freshman level has armed them with useful tools that they can possibly utilize in their upper level engineering courses. The author's recommendation for improving this particular project is to possibly start it earlier in the semester mainly because of the following reason. To allow the students more time to research, locate, and describe/document the educational resources and the software that were requested from them in the initial part of the project. Evaluating the projects, it was noticed that a number of students could have documented this portion of their work in a better form, if they were provided with more time.

References

Navaee, S. (2000) “Computer Utilization in Enhancing Engineering Education,” *Proceedings of the ASEE Conference*, Saint Louis, MO.

Bauld, N.R, Jr. (1986) *Mechanics of Materials*, Second Edition, PWS Publishers, Boston, MA.

Appendix

ENGR 1132 (Computing for Engineers)
Fall Semester 1999
Final Project Description

The group members are expected to work on the individual tasks assigned to them independently and develop their own solutions. No collaboration or exchange of ideas/material outside the group is permitted. Group members are permitted to help each other on individualized tasks only on a limited bases. Occasional consultation with the instructor maybe possible. Final group projects should be presented electronically to the instructor and the class by the group members during the last lab period. The length of each group's presentation should be about 15-20 minutes. Each group should also provide the instructor with a hard copy and an electronic copy of their presentation. The electronic copy should be submitted via e-mail.

Final Project Components:

1. PowerPoint Slide Presentation:

Each group is responsible for creating a PowerPoint Presentations slide show which describes the project of the group. Obviously, this slide presentation should have a title slide which contains the group and course related information such as: course, section, semester, institution designation, program designation, group designation, group member names, etc. This slide show should also include sections that are individually created by each of the group members and describe the work of each individual. Each of the sections should specifically contain the following items:

- Links to each group member's web site as described in the next section.
- A description of at least five web sites for which the group members have created the links for in their web sites. A discussion about why these web sites are important should also be included in the slide presentation.
- In addition to the two items listed above, each group member is also responsible for researching and locating two pieces of software (freeware, shareware, or possibly commercial!) which can perform a useful and important task. A discussion on the purpose, utilization, and importance of each software should be included on the slide show.
- A slide which shows a diagram of the beam each group member has developed programs for as described in the third section of this handout. This slide should also show the equations for the deflection v(x), slope è(x), shear force V(x), and bending moment M(x). Note that all this information should be placed on the same slide.
- A slide which contains your Excel spreadsheet you have developed as described in the fourth section of this handout.
- Four slides each containing the four plots that you have created as described in the fourth section of this handout.

2. Group Member's Web Site:

Each of the group members should create a web site which contains their related information as well as provides links to five credible and legitimate web sites which present important and useful information to the student. As described in the previous section shown above the importance of these web sites should be discussed in the slide presentation show.

3. <u>Programming:</u>

The expressions for the deflection v(x), slope è(x), shear force V(x), and bending moment M(x) for the beam and loading conditions that are assigned to you are shown on the handout page that you have been provided with. In these expressions E, I, L, P, q, and M_o are respectively the modulus of elasticity, moment of inertia, beam length, concentrated load, distributed force, and concentrated moment. Other parameters used in these expressions are as defined on the diagrams. Note that x is measured from the left end of the beam. Each member of the group is expected to develop two FORTRAN programs and an Excel spreadsheet in a manner described below to compute v, è, V, and M along the length of the beam for the following given values:

E = 29 x 10^6 psi.
I = 1830 in^4
L = 20 ft
a = 6 ft
b = 14 ft
P = 35000 lb
M_0 = 25000 lb-ft.

Program 1 (Use of Subroutine Subprograms):

- The main body of the program should prompt the user to input the values for E, I, L, a, b, and depending upon which problem each group member is assigned to solve, either P, or M_0.

- The program should employ a subroutine subprogram which is designed to compute the values of deflection v(x), slope è(x), shear force V(x), and bending moment M(x) for values of x ranging from 0 to L using increments of 12 inches for x.

- Your program is also expected to employ anther subroutine to print the values of x and the corresponding computed values of deflection v(x), slope è(x), shear force V(x), and bending moment M(x) in a table format. Note that your program should create appropriate labels for each of the columns at the top your table.

Program 2 (Use of Function Subprograms):

- Just as in the first program, the main body of the second program should also prompt the user to input the values for E, I, L, a, b, and depending upon which problem each group member is assigned to solve either P, or M_0. The main body of the program is also expected to print the values of x and the corresponding computed values of deflection v(x), slope è(x), shear force V(x), and bending moment M(x) in a table format. Note that this program should also create appropriate labels for each of the columns in your table.

- The program should employ four function subprograms to compute the values of deflection v(x), slope è(x), shear force V(x), and bending moment M(x) for values of x ranging from 0 to L using increments of 12 inches for x.

4. <u>Excel Spreadsheet:</u>

- Using the Excel formulas and functions create a spreadsheet which contains the values for the deflection v(x), slope è(x), shear force V(x), and bending moment M(x) for the values of x ranging between 0 and L using increment of 12 inches for x. Embellish your spreadsheet by using borders and applying colors in your spreadsheet. Also make sure you place your name and course related information at the top of your spreadsheet.

- Create the following four plots in your spreadsheet.

  (A) Plot of v(x) vs. x.
  (B) Plot of è(x) vs. x.
  (C) Plot of V(x) vs. x.
  (D) Plot of M(x) vs. x.

  Note that you should label the axes, use appropriate titles for your plots, and embellish your plots using color.

- Import you spreadsheet and your plots (in the order stated above) into your PowerPoint presentation. Note that the spreadsheet and each of the plots should be placed individually on separate slides.

Shahnam Navaee

Shahnam Navaee is currently an Associate Professor in the Engineering Studies Program at Georgia Southern University where his primary responsibility is teaching freshman and sophomore level courses to engineering transfer students. Dr. Navaee received his B.S. and M.S. degrees in Civil Engineering from Louisiana State University in 1980 and 1983 and his Ph.D. degree from the Department of Civil Engineering at Clemson University in 1989. Since 1997, Dr. Navaee has regularly been offering workshop sessions related to the area of application of technology in teaching at the *Center for Excellence* in *Teaching* at Georgia Southern University.