

AC 2010-191: COMBINED INDIVIDUAL-TEAM BASED PROJECT

Robert Creese, West Virginia University

Deepak Gupta, Southeast Missouri State University

Combined Individual-Team Based Project

Abstract

The basic manufacturing processes course was selected for an interdisciplinary team project for ABET requirements by the Industrial and Management Systems Engineering (IMSE) Department. The project is an integration of design criteria, material properties, mechanical properties and product cost. A software package is used to assist the students in the evaluation of various materials and structural shapes. To improve the student learning, assessments are made to evaluate student progress during the project and to determine improvements to be made in the software, in the project problem and in the evaluation of team performance.

Introduction

One problem in the project is that some team members have minimal participation in the project. One or two students will do most of the work, and the other team members expect the same grade for their being a “member” of the team. The first approach to correct this problem was to have each team member evaluate all team members, including themselves. The performance factor was multiplied by the project score to give the individual team member score. This has helped a little, but students are hesitant to give fellow classmates a low grade even though the evaluations are considered confidential.

The team based course project¹⁻⁶ has been used for several years and the problem has been changed each semester so the students do not copy previous projects. In the first years of the project, teams were formed and the project was graded at the end of the semester. These reports were often poor as the students had difficulty in writing reports, in interpreting the results they obtained, and in presenting their recommendations for the best material and shape. A suggested report format was given to the students and the reports were better, but some reports were rushed at the last minute and others decided to use their own format. Since there was only one report, the questionnaire to evaluate students’ learning was administered on the day the report was submitted.

The next step⁶ was to change the grading from a single report to have three preliminary reports, each of 10 points, and then the final report of 70 points. The purposes of the multiple reports were three fold. First, the students would need to start the project earlier to as the preliminary reports were due earlier in the semester and thus some work would be required before the final project. Secondly, this was an opportunity to use multiple assessments to evaluate progress during the semester. The assessments asked some specific questions about what progress they had made and indicated specific items that would be expected in the final report. Many of the assessment questions were milestones which the students should have completed or should be considered for the next report. Finally, these reports provided an opportunity to provide feedback so the final report would be more complete as well as be written in better form. One of the problems is that many students do not know the basics of writing reports, such as that the titles of tables should be above the table whereas the title of figures

should be beneath the figure. The report quality improved, but there was still a problem with full team member participation.

Previously the project problem for the semester was given to each of the students. The project teams were formed with the students selecting their team members with the restriction that a team had to have at least one member from industrial engineering and one from mechanical engineering. The project was demonstrated to the class and a sample problem with a square cross-section solved step-by-step using the blackboard. After the solution was presented, the software was demonstrated and utilized in class to show the students how to use the software. The software instructions and the software were e-mailed to each student to their university e-mail account. The teams were then to prepare the four reports at the specified due dates. The first report was focused on adding an additional material to the material file and obtaining the results. This was to have the students learn how to find material property and material cost data, which was more difficult than they expected. The second report focused on adding an additional shape to the software for evaluation and this required that the students be able to determine expressions for the moment of inertia and centroid for the shape they selected. The third report was a preliminary draft of their final report so that omissions in the report content and poor formatting of tables and figures could be corrected for the final report. The grading of four reports was a bit tedious, but most of the weight was on the final report.

New Procedure

A new procedure has been implemented to prepare the students to be able to more readily participate in the project as a team member. The project, software and software directions are e-mailed to the class immediately prior to presenting the project in class. The project is demonstrated to the class with the square cross-section problem using the blackboard and then the software is presented and used to solve the square cross-section problem. Now each student is given a specific set of material and cost data and is required to submit the results as an individual report indicating how their material compared with the materials in the data base. They are to include tables produced by the software program in their report. This requires that each student be able to utilize the software. This first report is evaluated for 15 points of the total project grade. This is the individual part of the project and students who do not submit a report are given a grade of zero for the first report and thus would have a maximum grade of 85 for the project.

The project teams are formed after the first report has been submitted by the students. This occurs 2-3 weeks after the beginning of the semester and most of the students who will drop the course will have dropped the course by this time. The teams must have at least one member from industrial engineering and one member from mechanical engineering, but the teams select their own members. Now all of the team members are familiar with the software and thus everyone is capable of working on separate cross-sections and can validate the solutions obtained by other team members. Previously, usually, only one member would run the software and obtain the results. The team members now select their additional shape for the project and their additional material. The second report, which also is evaluated at 15 points, is submitted approximately three weeks before the final report and is to be a draft of the final report. The final report has an evaluation of 70 points. When the final report is submitted, each student is

given an evaluation sheet to rate the performance of all team members including him/herself. This performance factor was used to adjust the evaluation of the final 70 points of the project, so if the report was evaluated at 60 and the students' performance was evaluated at 90, the student would receive a 54 for that portion of the project grade. Most students were evaluated at 100, but a few had evaluations lower signifying that they had not fully participated in the project.

Assessment Surveys and Results

The results of the surveys were handled differently than the previous surveys. Previously all surveys were done by individuals, but this time only the first survey was individual based. The second and third surveys were completed by the team rather than separately by the individual team members. The survey form for the first questionnaire is in Table 1 with average responses to the numerical questions. The total surveys completed were approximately 30. The results were similar to the results in previous years.

The second survey came approximately 60 percent through the project time. The second survey was completed by the teams and all nine teams completed the survey. This survey is in Table 2 and was a combination of the second and third surveys when four reports were submitted instead of the current three reports. The last five questions were reminders of what should be included in the report and the low values are expected as students tend to focus only on running the program and printing the results. Some of the results are interesting as the response to Question A was 4.8 and the response to Question B was 5.0. It would be unusual for the teams not to have made the final selection of their added material when they have obtained the material and cost values for their added material. Again, Questions D and E give somewhat conflicting results as the students have entered the equations for centroid and moment of inertia into the computer program according to Question E but some have not determined the expressions for the centroid and moment of inertia as indicated by their response to Question D.

The third survey came after the final report was submitted and was completed by all nine teams. The survey questions and summary results are in Table 3. The first several questions (A through F) were on previous surveys and should have a value of 5 if the report is complete. Questions G and H should also have had a 5 as the directions required a sensitivity analysis. Questions I and J were discussed in class and should have high values as they were expected to be in the final report. Question K was optional as the ME students had used ANSYS in other courses, but some were not confident in using it and some of those who did use it had poor results or could not interpret the results correctly. The opened ended questions were summarized by the teaching assistant and the results were more positive than expected. Many of the responses to questions M, N and O were rather mild and there was an in-class example, explanation and demonstration. One issue would be to do a more complex example (such as the I-beam) so the students know how to correctly interpret the results.

Summary and Conclusions

The project reports were, on average, better than those submitted by previous classes. It was surprising that some student teams still have problems making drawings of the cross-sections after they have obtained a numerical solution. In an attempt to correct this problem, the

next time the students will be required to solve one of the more complex shapes (I-beam or hollow box) and make a cross-sectional drawing of the shape in the first report, which is the individual report. Forcing every student to run the program allowed greater team participation as everyone could run the program whereas previously only one team member would run the software program. Only one student did not do an individual report and he also was not a good team member as evaluated by his team members. The two students who were ranked lowest by their team members failed the course, but the project accounted for only 25% of the total grade. These two students also had poor attendance and did poorly on the exams.

The forming of the project teams after the first report worked well as only one student dropped the course after the first report was submitted. A total of eight students dropped the course and this would have caused much more difficulty with the teams. In previous years several students would drop the course and teams had to be combined to maintain the interdisciplinary nature of the project.

The concept of having an individual report utilizing the software was very successful and will be repeated in the future. A more complex example will be required for the initial report as well as a drawing of the cross-section. The software does give students an opportunity to analyze a variety of shapes and materials and to determine the best shape-material combination to meet the design requirements of a specific problem. The interdisciplinary team gives students an experience where they must work with others of a different background which is what will happen to them after they graduate. This individual-team based project approach has been the most successful in having the students work in teams for solving the project.

Bibliography

1. Creese, Robert and Gupta, Deepak, "Multi-Disciplinary Team Project with Software", Proceedings of the 2008 American Society for Engineering Education Annual Conference & Exposition, 2008, American Society for Engineering Education.
2. Creese, Robert C. and Gupta, Deepak, "Economic Evaluation of Structures of Different Shapes and Materials with Processing Considerations", Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition, 2005, American Society for Engineering Education.
3. Creese, Robert C. and Gupta, Deepak, "Software for Materials Evaluation", Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition, 2007, American Society for Engineering Education.
4. Creese, Robert C. and Gupta, Deepak, "An Integrated Approach to Manufacturing Design" Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition, 2007, American Society for Engineering Education.
5. Robert C. Creese, Deepak Gupta, and Yang Zhi., "Team-based Design Using Custom Designed Software", Looking Forward: Innovations in Manufacturing Engineering Education, CIMEC(CIRP) 2005, 3rd SME Intl, Conf. on Manufacturing Education, Copyright 2005 Society of Manufacturing Engineers, ISBN 0-87263-824-3, pp 320-327.
6. Creese, Robert and Gupta, Deepak, "Software Development for Team Projects in Manufacturing", Proceedings of the 2009 American Society for Engineering Education Annual Conference & Exposition, 2009, American Society for Engineering Education.

Table 1. Assessment Questionnaire 1 with Class Average Rating(Individual Results)

Name _____ Fall 2009 Date _____ (After Report 1)
IENG 302 Assessment Questionnaire 1 for Computer Program and Project

This survey will not unfavorably impact your grade.

To assist in understanding of the interaction of the material properties, mechanical properties, and the product shape upon the total material cost, the computer program was developed to reduce the calculation discrepancy in evaluating numerous shapes. You were requested to evaluate one or two shapes not in the computer program to illustrate that you understand the calculation process. The following questions are asked to assess the value of the software. Please use a scale of “1” to “5”, “1” being “**Completely Disagree**” or “**Definitely NO**” and “5” being “**Completely Agree**” or “**Definitely Yes**”.

	Average Individual Rating
A. You have opened the program and used it with your specific material.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
B. You tried the program on the example problem and obtained the same results	4.2
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
C. The program was relatively easy to understand and work with compared to other software program you have used.	4.2
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
D. You did try the graphics option and were you successful	2.6
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
E. The team size of 2-4 students seems optimal for the project.	4.4
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
F. What are the three factors that you liked about the program – please be specific.	
1. <u>Ease of Use(17)</u> _____	
2. <u>Good Information(8)</u> _____	
3. <u>Effectivness(7)</u> _____	
G. What would be the improvements you would like in the program – please be specific.	
1. <u>Need to Keep Previous Material Data Automatically (7)</u> _____	
2. <u>Give Error Comments for Bad Input (3)</u> _____	
3. <u>Better Tutorial, Better Graphics(3)</u> _____	

Table 2. Assessment Questionnaire 2 with Team Average Ratings(Team Based)

Team _____ Fall 2009 Date _____
IENG 302 Assessment Questionnaire 2 for Computer Program and Project

This survey will not unfavorably impact your grade and this is to be completed by the team rather than an individual and the answer represents the consensus of the team.

To assist in understanding of the interaction of the material properties, mechanical properties, and the product shape upon the total material cost, the computer program was developed to reduce the calculation discrepancy in evaluating numerous shapes. You were requested to evaluate one or two shapes not in the computer program to illustrate that you understand the calculation process. The following questions are asked to assess the value of the software. Please use a scale of “1” to “5”, “1” being “**Completely Disagree**” or “**Definitely NO**” and “5” being “**Completely Agree**” or “**Definitely Yes**”.

	Average Team Rating
A. Your team has made the final selection of your added material.	4.8
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
B. Your team has the material, mechanical, and cost values for your added material.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
C. You have made the final selection for your additional shape	4.8
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
D. You have determined the expressions for the centroid and moment of inertia for your additional shape.	4.7
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
E. You have entered the centroid and moment of inertia equations into your computer program.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
F. You have done the sensitivity analysis.(1=done nothing, 5 = completed)	4.4
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
G. You have plotted the changes in cost versus the changes in load.	2.8
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
H. You have plotted the changes in cost versus the changes in the deflection limit.	2.7
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
I. You have determined the amount you have saved(cost) over the initial square shape for the same load. (1=done nothing, 5 = completed)	2.4
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
J. You have determined the amount you have saved(weight) over the initial square shape for the same load. (1= done nothing, 5 = completed)	2.4
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
K. You have done an ANSYS run of your final material/shape combination(although not required)	2.1
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	

Table 3. Assessment Questionnaire 3 with Team Average Ratings (Team Based)

Team _____ Fall 2009 Date _____

IENG 302 Assessment Questionnaire 3 for Computer Program and Project

This survey will not unfavorably impact your grade and this is to be completed by the team rather than an individual and the answer represents the consensus of the team.

To assist in understanding of the interaction of the material properties, mechanical properties, and the product shape upon the total material cost, the computer program was developed to reduce the calculation discrepancy in evaluating numerous shapes. You were requested to evaluate one or two shapes not in the computer program to illustrate that you understand the calculation process. The following questions are asked to assess the value of the software. Please use a scale of “1” to “5”, “1” being “**Completely Disagree**” or “**Definitely NO**” and “5” being “**Completely Agree**” or “**Definitely Yes**”.

	Average Team Rating
A. Your team has made the final selection of your added material.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
B. Your team has the material, mechanical, and cost values for your added material.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
C. You have made the final selection for your additional shape	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
D. You have determined the expressions for the centroid and moment of inertia for your additional shape.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
E. You have entered the centroid and moment of inertia equations into your computer program.	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
F. You have done the sensitivity analysis(1=not started, 5 = completed)	5.0
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
G. You have plotted the changes in cost versus the changes in load.	4.9
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
H. You have plotted the changes in cost versus the changes in the deflection limit.	4.9
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
I. You have determined the amount you have saved(cost) over the initial square shape for the same load. (1=done nothing, 5 = completed)	4.6
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
J. You have determined the amount you have saved(weight) over the initial square shape for the same load. (1= done nothing, 5 = completed)	4.3
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	
K. You have done an ANSYS run of your final material/shape combination (not required).	3.6
<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5	

Table 3. Assessment Questionnaire 3 with Team Average Ratings (Continued)

L. What were the three (at least) best factors you liked about the program – please be specific.

1. **Easy to Use** _____
2. **New Materials are easy to input** _____
3. **Results are easily obtained** _____
4. **Has pre-assembled shapes with formulae** _____

M. What were the three items (or more) you disliked most about the program – please be specific.

1. **The equations for the new shape were difficult to input** _____
2. **Only one shape can be evaluated at a time** _____
3. **Materials don't save in file** _____
4. **Program can crash** _____

N. What specific improvements would you suggest making to the program to improve its usability?

1. **Running multiple shapes at a time** _____
2. **Better instructions to input equations** _____
3. **Rank the results** _____
4. **Ease of inputting shape** _____

O. What additions do you have for the instructions (second set) to improve use of the model.

1. **Be more specific in syllabus what you want** _____
2. **Instructions were clear** _____
3. **In class example** _____
4. **In class explanation** _____

P. Other comments and suggestions

1. **It was rough in beginning but enjoyed it** _____
2. **Overall nice program** _____
3. _____
4. _____