

The Value Added By A Semester Paper In A Graduate Engineering Economy Course

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Abstract

This paper reports the authors' experiences with including a semester project as a portion of the course requirements in a graduate course in engineering economy. The required projects are intended to allow the students the opportunity to apply course concepts in real applications. Since the majority of the students in the program in which the course is taught are working professionals, this allows them to demonstrate the benefit of the education they are receiving to their employer.

The Graduate Program

The Engineering Management and Systems Engineering Department at Old Dominion University offers a MS and Master's in Engineering Management (MSEM and MEM respectively). Both degrees require ENMA (Engineering Management) 600 (Cost Estimation and Financial Analysis) in the core curriculum. These programs are offered live on campus and via live televised feed (one or two way video with two way audio) as part of the University's TELETECHNET distant learning program and the state's CGEP (Commonwealth Graduate Engineering Program) system.²

The students in these masters' programs are predominately, working professionals.^{1,3} While there are some full-time students taking three or more courses per semester and working part-time as graduate assistants, the majority of the students take classes on a part-time basis of one to two courses per semester. Of the working professionals, approximately one-fourth are serving officers in the military (Navy and Coast Guard officers are common), one-fourth work directly for a government agency (Department of Defense, Department of Navy, state department of transportation), one-fourth work for companies primarily working on government contracts (such as Newport News Shipbuilding), with the remainder working for "typical" for profit companies (manufacturers, engineering firms, power companies).

The program accepts students with a wide range of backgrounds into the program. While the typical student has an engineering degree from an ABET accredited program, students with engineering technology degrees, degrees in other technical disciplines, and students who are willing to make up deficiencies in preparation (typically, a lack of a sufficiently rigorous

mathematics background to include calculus through integral calculus or differential equations and a calculus bases statistics course) are accepted into the programs.

The Course

ENMA 600 (Cost Estimation and Financial Analysis) is the required graduate course in engineering economics. Since the program accepts students with a wide range of undergraduate degrees, there is no undergraduate course in engineering economics as a prerequisite for this course. The course covers the material typically in an undergraduate engineering economics course during part of the semester and for the remainder of the semester covers more advanced topics. Included in the more advanced topics are capital budgeting, risk, the stochastic nature of projects, multi-attribute analysis techniques, activity based costing in depth, and selected topics from the current research literature.

The course is typically taught as a TELETECHNET course. TELETECHNET is ODU's distance learning presentation of a course in real-time via one-way video and two way audio to a series of remote locations. In the Fall 2001 semester ENMA 600 started with approximately 80 students at 17 locations. Some sites had as few as one student while others had 10 to 12 students. The originating site on campus had approximately 20 students. The course met Tuesday night from 7:15 PM to 10:00 PM for 15 weeks. In the Fall 2002 semester ENMA 600 was offer Saturday mornings from 11:00 AM to 1:45 PM for 15 weeks. This semester the course was sent to roughly the same number of sites (16) and started with 60 plus students.

The Assignment

A major assignment for this course (20 percent of the student's grade for the course) is a semester project, which is reported in a 15-page (maximum) paper. The following is the assignment sheet for the semester project from the syllabus:

“Semester Project Description

Focus:

To build the bridge from the course material to the work place, each student will evaluate one or several of the financial tools, methods, or practices employed by his / her firm. This is an opportunity to expand job and career related understanding of financial practices into new areas.

Purpose:

The purpose of the semester project is to allow you to use the tools and information from class to address or investigate a financial issue on the job. We hope it is a chance for you to make a difference in your career and for your employer. Students in the past have used this as an opportunity to augment their career knowledge, investigate an ignored problem, gain workplace notoriety, or examine an area of personal interest.

Grading:

The semester project will be graded on four areas:

- Professional qualities of the report including spelling, paragraph and sentence structure, integration of appropriate graphics and tables, etc.

- Integration of topics from the course or related to the course.
- Quality of the analysis. This includes newness of the study (we don't want to rehash the same old war stories), innovation, complexity of the problem examined, analytical thinking.
- Importance or impact of the work to the individual or the organization.

Possible Topics for Analysis:

The following topics demonstrate the type of information that can be addressed in the semester project. They are not intended to be a comprehensive topical listing or outline.

- Consideration of costs: Are project or budget costs “real” or are inaccurate allocation methods and non-cash cost impacts considered? How does the approach include both the capital and expense cost implications of the project?
- Project measures: What measures are used to evaluate capital investments? What factors go into these measures (e.g. inflation, taxes, depreciation, etc)?
- Cost of capital: How does the expected rate of return relate to the expected market return and the financial performance of the firm?
- Integration of strategic and financial plans: How and at what level are the financial and operational plan integrated? Does the issue of capital versus expense cause problems?
- Do performance metrics promote results that achieve real bottom line cash flows?
- Risk / portfolio considerations: How does the firm manage risk and the portfolio of capital projects or new products?
- Understanding of financial measures: How well are the financial goals and measures of the firm understood by the organization? Does this hinder or help organizational performance?

Schedule:

- 150 word abstract due by mid term exam
- Final result due by last class

Length:

Length is limited to fifteen pages of quality material, with 1½ line spacing, 12-point font, and 1-inch margins. I stop reading after 15 pages and that is your grade.

References:

Be sure you reference all information you use. Plagiarism will not be tolerated.”

As can be seen from this assignment sheet, the assignment is open-ended and the student is left to define a project of interest (and hopefully, relevance to the student's career). The requirement to submit an abstract by the middle of the class has two objectives: (1) to get the student started on the assignment in time to complete a meaningful project and (2) to give the student early feedback on the appropriateness of the proposed project. The abstracts are reviewed and feedback is furnished to the student in the form of (1) an acceptance, (2) an acceptance with a “warning” that certain things will be expected in the paper to make it meet the intent of the

assignment, (3) a “suggestion” to reduce the scope of the paper, (4) a request that the student contact the instructor to discuss the topic to insure that both parties are in agreement with what the project is to be, or (5) a rejection of the abstract as not meeting the requirements of the assignment and requesting a new abstract. While about half of the abstracts are accepted on the first pass, a large number require a meeting (in person or by telephone) to work out a project, which is mutually acceptable. For many of the students at remote off campus sites this is the first dialog they have with the course’s instructor.

The submittal of the abstract is the only progress report required of the student before submittal of the paper. Students are left to involve the instructor as little or as much as they wish in the development and review of the project as it progresses.

The students with the most trouble in identifying projects are those who are not currently working full time and those who do not believe that their work has any financial implications for their organization. Many of those who are not currently in the workforce easily find a topic of interest from a friend or are looking to start a business upon graduation. Some of these students are able to work a project, which is relevant to the job they had prior to starting their graduate studies – this is particularly true of international students who plan to return home upon completion of their degree and have kept in contact with their old firm.

It is particularly difficult to convince some students that they have any involvement with the financial well being of their company. This attitude seems to be most strongly held by employees of government contractors and civilian employees of government agencies. Conversely, it is usually easy to convince military officers of their involvement with suitable topics for projects.

To address the cases where the student does not have access to a project or cannot be convinced that their company/agency does have a concern for costs and the justification of expenditures, students are allowed to write research projects based on literature reviews and the analysis of the literature on a topic currently in the engineering economy journals.

The Projects

The projects conducted by the students in ENMA 600 in the past two years include:

- Investigations of starting new businesses
 - a. A restaurant
 - b. A helicopter taxi service
 - c. A custom motorcycle building shop
- Investigation of whether to rent or sell an existing home when buying a new, larger home
- Investigation of the financial incentives necessary to make the purchase of low water usage washing machines viable for self-service laundries
- Investigation of the structure used to determine if the cost of new power service to a location should be charged or waived.
- Developing an activity based costing structure for a military organization, which services multiple types of customers that require different levels of services.
- Developing a justification methodology to evaluate training courses in a large government organization
- Developing a plan to reduce costs in an organization
 - a. A military organization

- b. A regulated utility
- Investigation of cost impact of using different heating methods for aircraft repair hangars

The Outcomes

Since the stated goal of the projects was to allow the student to use the tools and information from class to address or investigate a financial issue on the job and to hopefully to make a difference in the student's career, the primary evaluation of these projects' outcomes should be against that goal. As can be seen from the project list above many of the student's have taken advantage of this assignment to impact their personal or professional lives. The following are some of the professional and personal outcomes reported by students:

- A student working for a for-profit organization presented his project at work. The report and recommendations were forwarded to the new president of the company for his consideration. The student was told to not submit the report as a course assignment since they were planning to implement his suggestions but need to get regulatory approval prior to announcing the implementation. The student requested approval of a new project, which he was able to submit on time in lieu of the original project.
- A military officer's project is reported to be the basis for his recommendation for a medal. The student identified an activity of his command, which he was able to eliminate analyzing the need for the activity and identifying an existing source for the same service. This allowed elimination of the redundant equipment and the calibration of this equipment resulting in large recurring savings in calibration cost and a one-time income to the government from disposal of the surplus equipment. This project has the potential of being duplicated in several other sites throughout the Navy.
- A student approached a team trying to justify training costs in their organization. This student research the justification of training programs and developed a justification methodology for the team. As a result of her efforts she has been assigned to this team on an ongoing basis and has been recognized as an expert on justifying training courses.
- A student was considering going into business with a friend. As a result of his analysis of the cost side of the equation, he was able to identify the demand needed to break even on the business. As the original target market does not have the demand needed to reach a breakeven point, the startup of the business (and the investment of most of his savings) has been placed on hold until additional markets for the service can be identified.

While the professional and personal outcomes seem to be achieved, the academic outcomes have not been uniformly as acceptable. While good to excellent projects and papers predominate, there have been disappointments in the projects. The paper on justifying training costs for example was based largely on research in the training literature and the student based the justification methodology on this literature. The methodology the student selected was ROI (Return on Investment) due to the training literature's belief that NPW (Net Present Worth) was too difficult to explain (and by extension understand).

For the student, the cost of the project is high. The student must invest a reasonable amount of time in doing the project. An additional investment of time is required to prepare a quality paper reporting the project and the outcomes. For working professionals with limited amounts of time to allocate to their academic efforts, the project causes the course to be problematic. The project is particularly onerous to students who do not believe that (1) their current or future job involves financial analysis or that (2) costs are not relevant to their organization. While many students

leave the course reporting that the project is helping their career, others see the project as an academic exercise of little value.

From an instructor's point of view, the cost is also high. Simply reading the volume of papers submitted is time consuming. Because each project is unique, these papers require more time to grade since each paper must be graded on its own merits and not against a common expectation. Additionally, the instructor may need to spend considerable time during the abstract selection and approval stage working with students to select a project that is both worthwhile and accomplishable during the semester. Different students will request different levels of input during the project. Some will request considerable help during the conduct of the project phase of the assignment. These help request vary from seeking reassurance that the student is on-track with the assignment to technical direction/assistance in addressing problem.

Conclusions

Semester projects can be a valuable addition to a graduate course in engineering economics. The courses where they are probably most effective are those in programs where the students are working professionals. Additionally, programs which draw the majority of their students from more senior/experienced professionals in for-profit industries and service organizations will probably experience the least difficulty in finding projects and experience the most student satisfaction from the project.

References

1. Kauffmann, Paul and William Peterson, "Assignment of Importance to Engineering Economy Topics by Master of Engineering Management Students", *2002 ASEE Annual Conference and Exposition Proceedings*, American Society for Engineering Education (June 16 – 19, 2002), Session 1339 (CD-ROM).
2. Keating, Charles, David Dryer, Andres Sousa-Poza, William Peterson, and Robert Safford, "Systemic Issues in Asynchronous Delivery of Graduate Engineering Management Programs", *2002 ASEE Annual Conference and Exposition Proceedings*, American Society for Engineering Education (June 16 – 19, 2002), Session 3242 (CD-ROM).
3. Kauffmann, Paul, Resit Unal, Andres Sousa-Poza, and William Peterson, "A Study of Financial Analysis Expectations and Practices in the Engineering Management Workplace", *2001 ASEE Annual Conference Proceedings*, American Society for Engineering Education (June 24 – 27, 2001), Session 2542 (CD-ROM).

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