

The use of Common Sense Applications in Teaching Engineering Economic Analysis

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Abstract

Engineering economic analysis plays a vital role in nearly all decisions made by engineers. The course is very important because most topics covered in it are used everyday in both our personal and professional lives. Unfortunately, the importance of this course is greatly undermined when students have difficulties in understanding the application of economic analysis to real life economic problems. This is in part due to the fact that students typically do not have the opportunity to apply the concepts learned in the classroom to common sense applications outside of the classroom. The purpose of this paper is to present two examples of these common sense applications in detail and show how these approaches can be used in other engineering schools.

Introduction

Engineering Economy is one of the basic engineering courses in an undergraduate engineering curriculum. At California State University, Northridge the general engineering student population is required to take only one course in economics which is taught within the college of Engineering. The class addresses the need for students to be able to design parts, systems, processes and products which are cost effective. The course is also very important for engineering students, because the underlying fundamental principles of engineering economy may be used in both their personal and professional lives.

Students taking the course come from a wide spectrum of engineering disciplines. The use of real world projects is one approach that can address the teaching of fundamental principles of engineering economy to students from this wide range of disciplines. Students take the course at an upper-division level which enables them to take advantage of life experiences and knowledge acquired from their earlier studies. It primarily focuses on how to make decisions regarding competing economic alternatives with varying costs and benefits over time. Unfortunately, the importance of this course is often undermined because students do not comprehend the course's applicability to their personal life. This is because students typically do not have the opportunity to apply the course concepts to a relatively complex "real-world" problem. Although examples are used in class, students have difficulties to determine the economic feasibility of an actual engineering solution. Thus, the subject matter becomes isolated and is not automatically applied when an engineer attempts to solve an engineering problem. This has also been experienced when students work on their senior design projects.

Use of common sense applications

As part of teaching engineering economy tools and their engineering applications, students at CSUN are exposed to two examples of common-sense applications such as investing in a private residence or investing in mutual funds. These projects are covered during several class discussions because many students have difficulty comprehending their importance. Exposing students to such common sense applications not only increases student interest in the subject matter but also enables them to implement engineering economy methods better during their engineering career.

Supportive Background

This point of view has also been addressed by several papers in the Engineering Economy Division at the ASEE National Conference. The main theme of these papers recommends that courses in Engineering Economy should focus more on engineering decision-making process than is currently emphasized in textbooks. Hartman¹ strongly supported the decision process in engineering economy courses. Wells² offered a different method of teaching engineering economy. His emphasis is on case studies which allow students to synthesize their learning while applying concepts to a realistic situation. Martinazzi and Lavelle³ strongly placed more emphasis on the personal finance aspects as this enhances the student motivation in learning the basic concepts.

Common Sense Applications and Other Purposes

Many topics of the engineering economy are found in the financial world. The concept of the time value of money is certainly financial and is utilized throughout our personal financial lives. With this in mind, the selected projects for the class have been chosen to address the applicability of the course material to students' everyday lives. The projects also serve several other purposes. First, the current criteria of the Accreditation Board for Engineering and Technology (ABET) requires that engineering programs demonstrate their graduates have the ability to "identify, formulate, and solve engineering problems", "understand the impact of engineering solutions in a global and societal context", and have the "ability to communicate in writing." This implies that an engineer must consider the economic impact of proposed engineering solutions and communicate his/her solution to others. ABET also requires students to develop an ability to work on multidisciplinary, diverse teams. This is addressed in the project by requiring students to work in teams of no more than three. Each team is required to submit their work for grading.

The faculty member teaching this class discusses the term project with students at the beginning of the semester. This typically occurs the first session of class. Students are told that they will have to perform a term project based on two typical common-sense applications including investing in a private residence or investing in mutual funds. Second, engineering economic analysis is one of the core engineering competencies addressed by the "Fundamentals in

Engineering” Exam. This exam is a required step in the process of earning the Professional Engineering (PE) license. The project requires students to formulate the analytical problem to be solved, calculate the rate of return, develop cash flows based on real data, apply present worth analysis and after ax analysis. Thorough understanding of these methods will enable them to successfully complete the economic portion of the FE exam. To fulfill these requirements, students are exposed to such common sense applications.

Mutual Funds Investment Project

This project shows students how to perform a before-ax rate of return analysis on an investment of their choice. Rate of return is the preferred technique in evaluating investment alternatives in most organizations.

The faculty member teaching this class briefly discusses the concept of a mutual fund with students at the beginning of the semester. This typically occurs the second week of class. Most students do not know the differences between a mutual fund, the stock market, the bond market, and certificates of deposit prior to taking this course. In addition to defining a mutual fund and how the mutual fund market works, the faculty member must also explain the information that a student must have in order to make a decision about a mutual fund. This includes the price of the fund, brokerage fees, management fee, and individual fund policies.

For investing in mutual funds project, students select one mutual fund from three different firms. They acquire information about the funds, their policies, their costs, etc. The third week of the semester students pretend to invest \$100,000 in three different mutual funds from three different companies. Students are required to submit an initial status report telling the faculty member which mutual funds were selected. The initial price per share, number of dollars invested, and number of shares purchased is to be included. Students are also required to identify fees and the fund policies in the report. The investment is then held by the student for ten weeks. During the ten week period students are required to record the daily price of their selected funds. At the end of the ten week period the student “sells” his or her investment. A final report on their mutual fund investments from each student is required.

The report must follow a specified format, which includes an abstract, description of purpose, statement of process, presentation and discussion of results, and appendices. The abstract serves to summarize their project including the funds chosen and the calculated rate of return on investment. The description of purpose is included to assure that the students understand the significance of the project. The statement of process then outlines in detail how they obtained information about the mutual funds and how that information was used in selecting a fund. This section would include a discussion of the investment strategy for each fund, the holding’s portfolio for each fund, the fund size (small, medium, large), and the risk factor associated with the fund (aggressive growth, growth, secure). The discussion of results includes the relative performance of the three funds. This includes a discussion of the change in share price of the mutual funds, whether a profit or loss was experienced and the actual before-tax rate of return on their initial investment as an annual percentage rate. The student must decide which investment is best based on their analysis. The appendices includes the project status report, the daily record of share prices, sample rate of return calculations (both over 10 weeks and as an annual percentage rate), and copies of the sources of information regarding fund policies and prices.

The mutual fund project contributes to students understanding of fundamental principles of engineering economy including development of cash flows, present worth analysis, and rate of return analysis. Students also experience the difficulties often encountered in acquiring accurate financial data in real life situations as they determine the costs associated with their investment. Most textbook problems simply present the data, which contrasts with working engineers who must find the data required to perform an analysis.

The authors believe that engineering students who understand the workings of the financial markets are better equipped to make sound engineering economic decisions in the real world where corporations must take the entire financial picture into consideration before investing in a particular application. For example, a company using bonds to generate capital for an investment not only have to look at the technical soundness of a project and cost of issuing the bonds, but must also look at the financial conditions of the market to assure the timely issuance of bonds is feasible. This type of project will help engineers in management positions deal with capital budgeting issues such as the estimated expenses regarding the issuance of bonds.

Private Residence Investment Project

Engineering students need to consider income taxes in their economy studies to ensure that they understand the impact of this important factor. Students are told that strategic investments involving new business and/or products must be evaluated on an after-tax basis. In after tax analysis a before-tax cash flow is determined, taxes are calculated, an after-tax cash flow is found, and finally the after-tax rate of return is computed. Taxable income is found by subtracting all deductions from gross income. After-tax rate of return can then be found by subtracting taxes from the before-tax cash flow. This project shows students how to perform an after-tax rate of return analysis on a real estate investment of their choice. The after-tax rate of return is the preferred technique in evaluating the affordability of a real estate investment.

The faculty member teaching the class discusses the actual costs involved in the purchase of a private residence. This typically occurs during the second week of the semester. Students must be informed about appraisal fee, inspection, points on the loan (if any), closing costs, escrow, property taxes, home owner association fees, insurance requirements, local regulations, maintenance, and deductibility of loan interest (and points) from federal income taxes. For investing in a private residence, students start by producing a project status report identifying a specific property which is currently on the market. The status report is due in week three of the semester. Students then acquire information, estimate costs, and generate a cash flow associated with investing in that residence.

It should be noted that investments made in residential property used for rental purposes must include a MACRS depreciation schedule. Based on their research, they are required to perform an after-tax analysis to determine the affordability of the residence. Students will determine the minimum income required to purchase the private residence that they have chosen. A final report on the project is then prepared.

The report for this project follows the same format as specified in the mutual fund investment project. The abstract identifies the property and summarizes the affordability of the investment.

The description of purpose assures the students understand the cost elements involved in the purchase of a private residence. This should assure that students understand the complexity of all of the cash flow elements in a real life situation. The statement of process outlines how the residence was found, its asking price, the method used to find the associated cost, how loan rates were shopped, and how the cash flow was determined for the analysis. This section must include the method used to estimate unknown costs such as utilities and maintenance. This is to assure that students are prepared to estimate cost elements for any engineering projects that they may encounter in the future. The final aspect of the process section is a discussion of the assumed income level and the associated tax bracket. The discussion of results section includes the outcome of the after tax analysis. Students use the results of the after tax analysis to determine the affordability of the property being studied. The appendices includes examples of calculations performed in the after tax analysis, the cash flow used in the analysis, and a copy of the status report.

Conclusion

The experience of the faculty teaching engineering economy at CSUN has been that the use of common sense, real life term projects has improved the comprehension of course materials. Faculty members who teach the course have observed improved performance by students on exams when they are asked to calculate rate of return. Student feedback obtained through end of semester course evaluations of the course and faculty teaching it has also indicated that these projects aid the student in comprehending course materials. Most texts include a variety of excellent examples and problems, however the nature of textbooks limits them to relatively simple problems that fail to show students the larger picture when it comes to economic analysis. The use of personal finances similar to those identified by Martinazzi and Lavelle³ has been found to increase interest in a subject that many students find dry and confusing. By using practical common sense problems, faculty is able to impress the applicability of engineering economy on the individual student.

Bibliography

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Biographies

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