Where is the Engineering in Engineering Economy?

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Abstract

Many of the basic tenets of engineering economy are founded in the finance world. The concept of the time value of money is certainly financial and students appreciate that they are learning tools that they can apply to their personal finances. Does typical coverage in an Engineering Economy course emphasize financial or engineering applications? This paper looks at three leading Engineering Economy textbooks and assesses the level of financial versus engineering applications within the chapters that are typically covered in a one-semester course. End of chapter problems are categorized according to the level of and type of engineering content. Summary information from the study should be helpful in determining the appropriate balance of engineering and finance coverage to meet curricular objectives.

Introduction

Successful teaching of engineering economy requires that, upon completion of the course, students are able to apply time value of money concepts in making engineering decisions. In order for students to reach a minimum level of competence, they must master the basics of techniques such as present worth, equivalency, and rate of return on an after-tax basis. They must also be able to apply correctly the techniques in an engineering decision-making context.

Engineering Economy textbooks typically use a mix of financial and engineering problems to help the students learn the basics of engineering economy. Financial examples, such as bank account savings, loans and bonds, are useful because they can be used to present time value of money concepts in a simplistic form. Problems using an engineering decision making context in real life tend to be more complex.

Arguments can be made that courses in Engineering Economy should provide more of an engineering decision-making focus than is currently emphasized in textbooks. In recent years several papers in the Engineering Economy Division at the ASEE National Conference have supported this view. Hartman[1] strongly supported re-emphasizing the decision process in engineering economy courses. Wells[2] proposed a revised approach for teaching engineering economy where "Case studies are used to teach the language and concepts of cost and the relationships between engineering decisions and economic performance of the firm." A two-course sequence with the second emphasizing applications in the engineering student's major was proposed by Mallik and Sarin.[3]

An alternate viewpoint is that by putting more emphasis on the personal finance aspects, student motivation in learning the basic concepts will be enhanced. Martinazzi and Lavelle[4] suggest that a series of exercises in personal finance be utilized in the first month of classes. The series focuses on personal planning issues such as purchasing automobiles or homes, investment

strategies and retirement planning. The authors promote use of these exercises to "heighten the student's awareness of the relevance of the course material to their life."

The textbook chosen exerts a major influence on course emphasis through the assortment of problems it supplies. To assess the level at which finance problems are used in engineering economy textbooks, three leading texts were reviewed.

Methodology

To determine the engineering emphasis of leading textbooks, the following steps were taken:

Selection of textbooks for inclusion in the study
Identification of chapters in the texts that are typically covered in a semester.
Identification of selected chapters as "core" or "expanded" material
Establish a classification scheme for the problems
Classify problems and count by problem type
Analysis of collected data

In an unpublished study conducted through the University of Pittsburgh, Needy et al. identified engineering economy textbooks in terms of usage among the 28 respondents to a survey.[5] The survey also included the number of respondents that covered each topic within a book. For our study, we selected the most recent editions of the top three textbooks in terms of usage: Engineering Economic Analysis, by Newnan and Lavelle,[6] Engineering Economy, by Degarmo, Sullivan, and Bontadelli,[7] and Engineering Economy, by Blank and Tarquin.[8] If the majority of the text adopters covered a certain chapter then we analyzed the problems provided at the end of the chapter in order to determine the type of problem/content that was available.

In addition to identifying commonly selected texts, University of Pittsburgh research also identified topical coverage in semester-long engineering economics classes. In a forthcoming paper in *The Engineering Economist*, details of the topical coverage will be presented.[9] The topics appear to be divisible into three distinct groupings: 1) Core material covered by at least 26 of the 28 respondents, 2) Expanded core material covered by at least a simple majority of the respondents and 3) Additional topics covered by less than half of the respondents. For our analysis, we divided the typical chapters covered into core and expanded core categories to allow us to analyze the engineering content in chapter problems for topics covered by all and for chapters covered less regularly. Table 1 shows the topics that fell these two categories. Table 2 provides summary information about the chapters reviewed in the textbooks.

Table 1. Core and Expanded Core topic areas

Core topics	Expanded Core topics	
Introductory material	Depreciation and depletion	Evaluating Multiple Alternatives
Benefit/cost rates	Sensitivity Analysis	
Interest rates	Replacement, Retirement and Breakeven analysis	After tax economic Analysis
Present worth		Uncertainty and Risk Analysis
Cash flows	Rate of Return	Decision Making
Equivalence relationships	Income Taxes	Geometric Gradients & Spreadsheets
	Inflation & Deflation	

Table 2. Summary of Book Chapters Reviewed

Text		Core Topic Coverage	Expanded Core Topic Coverage
Blank & Tarquin	Chapters Covered	1,2,3,4,5,6,9	7,8,10,13,14,15,16,19
	# of pages in Chapters covered	223	270
	# of problems reviewed	297	262
Newnan & Lavelle	Chapters Covered	1,2,3,4,5,6	7,7a,8,9,10,11,12,13
	# of pages in Chapters covered	218	294
	# of problems reviewed	313	343
Sullivan, Bontadelli &Wicks	Chapters Covered	1,2,3,4,11	5,6,7,10
	# of pages in Chapters covered	221	198
	# of problems reviewed	236	135

Chapter problems were classified as one of six types of problems. The categories, presented in Table 3, reflect a continuum of problem types from general skill type problems without a context to problems that require making an engineering decision using engineering economy techniques. For the three selected textbooks, a physical count was made of the end-of chapter problems that fall into each category. Problems that referred to previous problems counted as a new problem. Multi-part problems counted as only one problem. Note that the Sullivan text uses numerous multi-part problems. Direct comparisons of the numbers of problems in each text were therefore avoided. Percentages of the total numbers of problems in each category for each book were deemed more appropriate for comparison purposes.

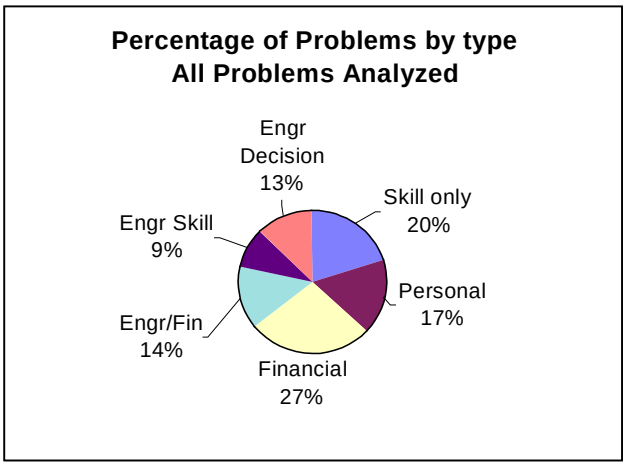
Table 3. Problem Classification Scheme

Problem Type	Description	Example
General Skill/ Content Reinforcement	Problems are strictly skill reinforcement questions without any other context. Basic definitions fit this category too.	Find the value of *P* for the cash flow diagram.
Personal	Problems are related to situations students encounter in daily life. These problems often contained the word "you".	Determine monthly payments on a 48 month $20,000 car loan with an interest rate of 9% .
Financial	Problems have a financial context without a personal or engineering focus.	What is the future equivalent of $1000 invested now at six percent interest compounded monthly for three years?
Financial applications in engineering settings	A financial problem set in an engineering situation, but without an engineering decision-making process. The problem would have the same financial solution if the situation were switched from an engineering application to a different context.	A project will cost $5000, the benefits at the end of the first year are estimated to be $100, increasing at a 10% uniform rate in subsequent years. Compute the benefit-cost ratio using as eight-year analysis period and a 10% interest rate.
Engineering Skill reinforcement	An engineering chapter skill reinforcement problem has an engineering context, but is strictly reinforcing a topic covered in the chapter without any decision-making required.	An asset for drilling was purchased for $50,000. What is the depreciation in year 5 using SOYD?
Engineering analysis and decision making	A problem that is given an engineering situation and some analysis and decision making are required to solve the problem.	You are responsible for determining the production rate for a new product. Analyze the data provided, identify the appropriate economic criterion, and make a recommendation.

Preliminary Study Findings

Preliminary analysis of the study data has been performed. An overall assessment was made of the types of problems found in the texts. We then compared the percentage of types of problems found in the different text books and compared the types of problems found in the core topic chapters and expanded core chapters.

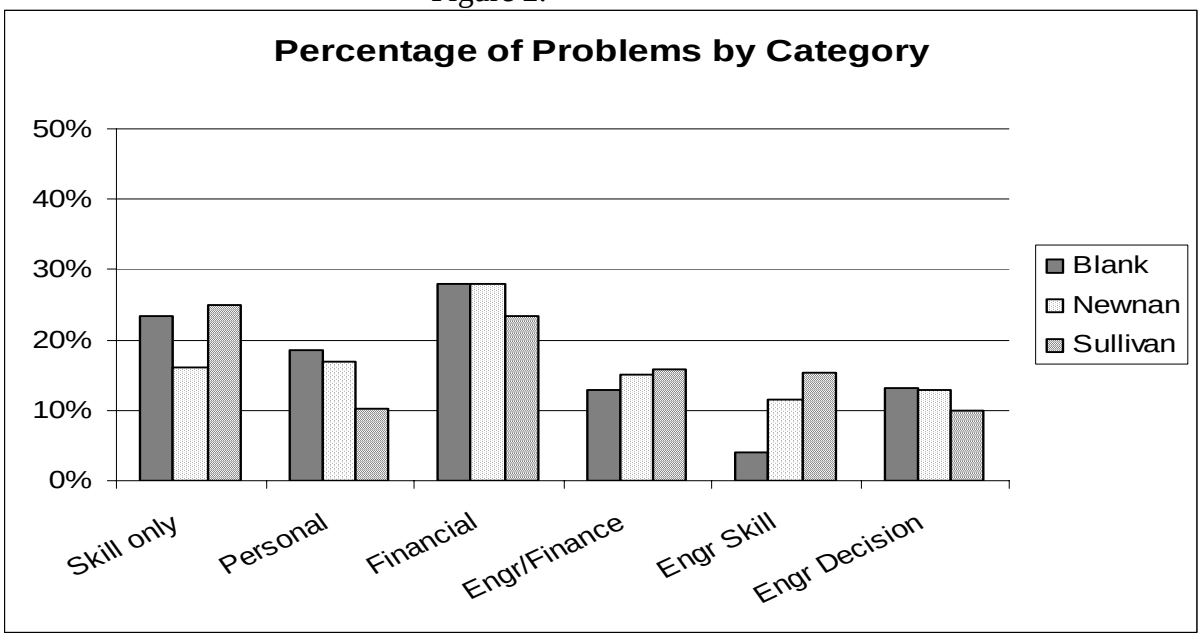
Figure 1.



Considering all problems reviewed from the three textbooks, the percentage of problems by category was determined as depicted in Figure 1. The largest single category at 27% was composed of financial problems without a personal or engineering context. Problems in which an engineering decision was to be made based on the economic analysis accounted for only 13% of the total problems. Note, however, that that the engineering decision problems tended to be lengthier and more complex than other types of problems.

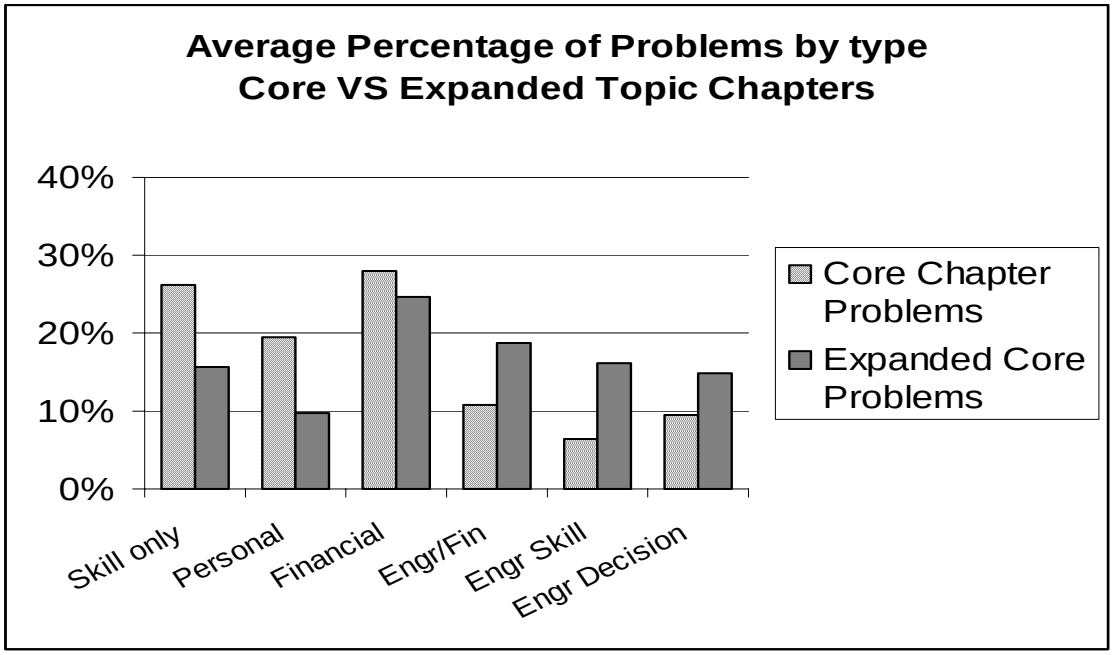
Comparison of the percentages of problems in the categories in the different textbooks is depicted in Figure 2. Overall, the texts do not appear to differ greatly relative to the types and percentages of problems included at the end of the chapters typically taught in a semester. The percentage of problems put in an engineering context (engineering financial, engineering skill or engineering decision making) ranged from 30% in Blank, to 40% and 41% for Newnan and Sullivan texts respectively.

Figure 2.



Most of the core topics were found in the early chapters and the expanded core concepts were found in the later chapters of these texts. As one would expect, more problems with engineering content were found in the later chapters of the expanded core topics than in the earlier chapters. Figure 3 depicts the average percentage by type of both core and expanded core topic chapters. The core topic chapters where basic theory is introduced tend to use more skill type, personal and financial problems. The expanded core topics show a greater percentage of the problems with engineering content. The average percentage of problems with an engineering context, including engineering finance, engineering skill and engineering decision-making was 27% in the core chapters, 50% in the expanded core chapters and 37% overall.

Figure 3.



Conclusions

How much engineering is in engineering economy? One might reasonably expect at least half of the chapter problems in an engineering economy text to be in an engineering context, but based strictly on a count of problems at the end of the chapters typically taught during a semester course using three leading Engineering Economy textbooks, only 37% of the chapter problems are presented in an engineering context. Since the majority of the engineering context problems come in the later chapters and topic coverage in these expanded core chapters ranges from 52-82 percent, this average may actually be overstating the percentage of problems that are in an engineering context. . In reality, an instructor only assigns a portion of the end-of-chapter problems, so faculty who rely on chapter problems to provide the main engineering exposure must make a conscious effort to select problems with an engineering context. Even though half the problems in the advanced core chapters are in an engineering context, only about 15% actually involve engineering decisions. While it is possible to use supplemental cases or projects, if textbooks contained more problems in an engineering context, and particularly more

problems emphasizing engineering decisions, students would benefit because it is likely that they would have more opportunities to practice engineering decision-making in the context of an engineering economy course. Unless authors and instructors make an effort to increase emphasis on engineering applications through problem selection, students completing engineering economy courses will still lack the skills they need to apply economic principles to many engineering decisions.

Bibliography

1. Hartman, J.C., "Engineering Economy: Suggestions to Update a Stagnant Course Curriculum," *American Society for Engineering Education Annual Conference Proceedings*, 1998.

2. Wells, W.E., "Economics for Engineers: An Integrated Approach," *American Society for Engineering Education Annual Conference Proceedings*, 1998.

3. Mallik, A.K., and S. Sarin, "Engineering Economy: A Two-Step Approach to Energy and Environmental Strategies," *American Society for Engineering Education Annual Conference Proceedings*, 1996.

4. Martinazzi, R., and J.P. Lavelle, "Facilitating Student Learning in Engineering Economy Classes Through Context: "Making Horses Thirsty While You Lead Them to Water"," *American Society for Engineering Education Annual Conference Proceedings*, 1999.

5. Needy, K.L., J.P. Lavelle, H. Nachtmann, and T.G. Eschenbach, "Empirically Analyzing Engineering Economy Pedagogy: Current Data and Longitudinal Analysis," unpublished, January 1998.

6. Newnan, D.G., and J.P. Lavelle, *Engineering Economic Analysis*, *Seventh Edition*, Engineering Press, 1998.

7. Sullivan, W.G., J.A. Bontadelli, and E.M. Wicks, *Engineering Economy*, *Eleventh Edition*, Prentice Hall, 1999.

8. Blank, L.T. and A.J. Tarquin, *Engineering Economy*, *Fourth Edition*, McGraw-Hill, 1998.

9. Needy, K.L., J.P. Lavelle, H. Nachtmann, and T.G. Eschenbach, "An Empirical Analysis of Engineering Economy Pedagogy," accepted for publication *The Engineering Economist*.

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