



Engineering Economy

A Networking Community of the Institute of Industrial Engineers

Spring 2002

Engineering Education – Effectiveness of Virtual Class Rooms

A Virtual Classroom Experiment For Teaching the Economic Principles of Engineering Design

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Abstract:

The objective of this project was to conduct and report on experiments to determine whether industrial case studies, web-based course materials, and communication enhanced by the Internet can improve the proficiency of student learning in engineering economy.

Overview:

This paper reports on a project whose focus has been to create and evaluate the effectiveness of a virtual classroom for teaching the economics of engineering design. This project has been a collaborative effort between two universities, Virginia Tech and the University of Massachusetts at Amherst, and industry, GE Industrial Systems. The motivation behind this project was that as decision-makers, engineers must be knowledgeable and competent in multiple aspects of design. A major challenge is to increase student competency in the economic elements that are such a critical part of the engineering process.

The intent of the virtual classroom project was to develop and assess new materials and methods that would go beyond the "traditional" analytical approach to teaching the subject wherein considerable attention is paid to teaching the mechanics of techniques to an approach that engages students with more active learning. As part of two experiments to assess the effectiveness of a virtual classroom, various electronic materials were developed and include six modules. The first five modules are topical in content with examples, quizzes, and frequently asked questions. These modules include:

- ▶ The Business/Engineering Environment
- ▶ Principles of Design and Systems Analysis
- ▶ Cost Estimating Techniques
- ▶ Time Value of Money and Comparison of Alternatives
- ▶ Consideration of Risk and Uncertainty.

The sixth module, Current Industrial Problems, includes resources that enable student teams to
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Director's Message

by John Dukovich
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Networking Community

We all carry around "tool kits" that we use to help us do our jobs. Our tool kits might include spreadsheet templates that we've developed and perfected over the years, reference books, favorite Internet sites that keep us apprised of the latest in our areas of interest, calculators, charting materials, simulation programs, and even peer groups that will give us feedback on our ideas. Those tool kits change over the years - we add more items, discard those that aren't so effective, and maybe borrow some tools temporarily to handle an infrequent crisis.

As we prepare for this year's Industrial Engineering Research Conference (IERC) and anticipate the many papers that are planned to be submitted in the Engineering Economy Division (EED) sessions, it occurred to me that the IERC may be the most tangible benefit that many of us receive from our IIE membership. The IERC provides us the opportunity to network with our peers, to participate in presentations of the latest research in our field, and to learn from each other. The IERC is one of the tools that we have come to rely upon to help sharpen our knowledge and to keep us current. We will distribute one more newsletter before the IERC, summarizing the papers that are to be presented in the EED sessions. (For those of you presenting papers, please remember the upcoming deadlines, mentioned later in this newsletter!)

However, there are other tools provided by the EED that provide continuous networking opportunities throughout the year. One of which is this newsletter. Hopefully, as you read this newsletter it helps keep you informed of the events happening in EED. You can also participate in the newsletter by submitting an article, a suggestion, or just provide information such as interesting Internet sites to share with other EED members.

Another tool available for networking is the online discussion forum hosted on the IIE Webpage. Look for the "Discussion Center" on the IIE Website. Once you log in, you will find discussion areas for EED and the other networking communities. This is a great way for us to share ideas, ask questions, and develop professional relationships that will benefit all of us. So please take a look at this tool and put it to use.

At the IERC, we will be holding our annual EED business meeting at 12:30 p.m. on Sunday, May 19th. At this meeting we will present the Wellington Award to the 2002 winner.

Additionally, we will discuss opportunities and directions for the EED. We are also looking for someone to become our next newsletter editor. (We have a progressive responsibility system that starts at newsletter editor and leads to program chair, and ultimately to EED director.) If you are interested in the experience of becoming directly involved with EED, please consider being our next newsletter editor. At the very least, I encourage you to come to IERC to gain the other benefits mentioned above and to enrich us with your participation - add to our tool kit. I look forward to seeing you in Orlando in May!

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work with industry on open-ended real problems. Industry partners interacted with students through e-mail, a message board, and recorded audio/video of classroom guest lectures directly related to industry problems. Guidance in project management, teaming, and other resources related to projects are also included. The capacity for posting university specific information such as syllabi, announcements, et cetera, is also provided.

Results and Conclusions:

In the first experiment, it was found that the industry problems resulted in significant improvements in student learning (as measured by the composite score in the course) at the $\alpha = 0.05$ level. In the second experiment, the Internet supported course materials were assessed to determine whether learning was affected. Although students in the Internet supported course had higher scores (and grades) than students in the control group, this difference in learning was not significant at the $\alpha = 0.05$ level. Overall, the experiments yielded important insights about how students learn in a team based setting and in a course heavily supplemented with Internet usage. Refer to the web site located at http://mielsvr2.ecs.umass.edu/virtual_econ/ for additional information

As envisioned, the virtual classroom will remain an open resource on the web that can be used by any university in teaching engineering economics. It is also anticipated that it will serve as a continuing resource that students can return to regularly throughout their education and serve as a resource for practicing professionals. Farther reaching, this research is an integral part of a longer-term and broader vision to build an undergraduate "National Technological University" (NTU) for selected core courses in the engineering curriculum. It is anticipated that through computer-based learning methods utilized at the undergraduate level, higher quality core engineering courses can be offered to more students in a very cost-effective manner.

Please forward any questions or comments regarding this article to William G. Sullivan (bills@vt.edu) or Janis P. Terpenny (terpenny@ecs.umass.edu)

Important Dates and Times to Remember:

Monday, May 20th, 12:30-2:00 p.m.
Engineering Economy Networking
Community Meeting



Monday, May 20th, 4:00-5:00 p.m.
Engineering Economist Board
Meeting

Engineering Education - Real Option Courses

Real options is one of the most widely discussed concepts and techniques in finance at business schools around the world. It is also gaining acceptance in Industrial Engineering programs in number of universities. Academics in both business and engineering schools are excited about this new valuation and strategic planning approach. They are incorporating this topic into their existing courses and even developing new courses primarily devoted to real options and financial engineering. In this issue, we highlight a new course in Financial Engineering developed by IE Professors Leyuan Shi and Harriet Nembhard, which covers valuation of real options.

" Business managers often base important manufacturing decisions on the traditional

net present value analysis. However, for many high-risk or highly uncertain projects they often hesitate to chance a big loss- especially in today's volatile markets. Uncertainty may offer advantages if they know how to manipulate them. How to do it is to be prepared for uncertainty by keeping a variety of alternatives available - a concept of real options theory " says IE Associate Professor Leyuan Shi. The theory forms one of the cornerstones of a hot new area called financial engineering, which combines engineering skills with economics, business, finance, computer sciences, math and statistics" says IE Assistant Professor Harriet Nembhard. The course is offered during spring in the College of Engineering at University of Wisconsin Madison.

Course Summary:

IE 691 (01) Financial Engineering in Manufacturing Enterprise Systems

The course addresses design, planning and control of operations in manufacturing enterprises, from shop floors to the associated procurement and distribution of supply chains. The course covers:

- ◆ Financial markets and options basics
- ◆ Monte Carlo simulation in financial applications
- ◆ Cost models for manufacturing activities
- ◆ Valuation of real options

More information on this course can be obtained by contacting Leyuan Shi (leyuan@engr.wisc.edu) and Harriet Nembhard (hbnem@engr.wisc.edu)

Real Options - List of Recently Published Books

Getting started on real options can be a challenge to the engineering economics community especially as the concepts draws heavily from financial option pricing theory. Listed below are the recent textbooks published in the real options area. Out of the first four textbooks - the one by Copeland & Antikarov and the other by Amram and Kulatilaka are written with a practitioner audience in mind. The remaining books are edited volumes of articles written by primarily academics.

- ◆ *Investment Science* by David Luenberger
- ◆ *Investment under Uncertainty* by Avinash Dixit and Bob Pindyck
- ◆ *Real Options: Managing Strategic Investment in an Uncertain World* by Martha Amram and Nalin Kulatilaka
- ◆ *Real Options: A Practitioner's Guide* by Tom Copeland and Vladimir Antikarov
- ◆ *Real Options: Managerial Flexibility and Strategy in Resource Allocation* by Lenos Trigeorgis
- ◆ *Real Options: Evaluating Corporate Investment Opportunities in a Dynamic World* edited by Howell, Stark, Newton, Paxson, Cavus, Pereira and Patel
- ◆ *Real Options in Capital Investments: Models, Strategies and Applications* edited by Lenos Trigeorgis
- ◆ *Project Flexibility, Agency and Competition* edited by Brennan and Trigeorgis
- ◆ *Real Options and Investment Under Uncertainty: Classic Readings and Recent Contributions* edited by Schwartz and Trigeorgis
- ◆ *Real Options Applications* edited by Alberto Micalizzi and Lenos Trigeorgis
- ◆ *Real Options and Business Strategy: Applications to Decision Making* edited by Lenos Trigeorgis
- ◆ *The New Investment Theory of Real Options and its Implications for Telecommunications Economics* edited by James Alleman and Eli Noam
- ◆ *Game Choices: The Intersection of Game Theory and Real Options*, edited by Steven Grenadier

2002 Wellington Award — Call for Nominations

The Wellington Award recognizes outstanding contributions to the field of Engineering Economy. The award is named for Arthur M. Wellington, author of *The Economic Theory of Railroad Location*, published in 1887. The EED presents the Award annually at each Industrial Engineering Research Conference (IERC).

We are now collecting nominations for the year 2002 Wellington Award. If you would like to nominate someone, please contact [William Sullivan at bills@vt.edu](mailto:William.Sullivan@bills@vt.edu) (other contact information is located toward the final pages of this newsletter). **The deadline for submission is March 31, 2002.**

The selection panel determines eligibility of nominees. Criteria used in evaluation include original contributions to the profession, recognition of service to the profession, and application of engineering economy methods and practices.

The New Discussion Center for EED Members

The EED ListServ was retired in December 2001. In its place is an online forum where EED members can hold discussions, pose questions, and provide information to peers. Additionally, members can view discussions taking place in other networking communities.

If you haven't done so already, please go to www.iienet.org, click on "Discussion Center" and sign in with your member number. Then you will be able to gain all of the benefits available through the EED and other networking discussions.

Call for Web Page Editor

We're still looking for one! Joe Hartman has been designing and maintaining the EED Webpage for several years... he's done an excellent job, but he's ready to pass the baton (he's *really* ready)! Additionally, IIE is striving to migrate all division pages onto the IIE server, which will provide opportunities for revising the page contents and layout. If any of you are interested and have some Web experience, please send e-mail to the newsletter editor at herathh@unbc.ca. Also, if you have any ideas on how to improve the page, please send those comments to herathh@unbc.ca. The current EED Webpage can be viewed at <http://www.lehigh.edu/~jch6/eedhome.html>.

The Engineering Economist

The Engineering Economist is a journal sponsored by the Institute of Industrial Engineers and the American Society for Engineering Education. This quarterly refereed journal is the *only* publication devoted to the field of capital investment analysis and related topics in the private and public sectors. Articles on such topics as capital budgeting, project evaluation, equipment replacement analysis, and economic design are regularly featured.

For a subscription (\$20 for members, \$27 for non-members) to the journal, contact Member and Customer Service at 770.449.0460 or email cs@iienet.org

Or, download the faxable subscription form at: <http://solutions.iienet.org/forms/subsc.htm>

To submit an article for publication, please mail four copies of the article to Dr. Chan S. Park, Editor, The Engineering Economist, Department of Industrial Engineering, Auburn University, Auburn, AL 36849-5346

Editor's Message

by Dr. Hemantha Herath
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Newsletter Editor

This is our second newsletter. We have devoted this newsletter primarily to issues in Engineering Education. I would like to thank John, Bill and Harriet for their contributions. I have also included a list of recent real option textbooks for interested IE practitioners and researchers. As always, I would very much welcome any contribution to the newsletter. I hope you find this issue interesting and informative.

Engineering Economy Leadership Directory

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Annual IIE Conference and Exhibition

Orlando, Florida, May 19-22 2002

Hilton in Walt Disney World Resort

Early Registration Cut-off: April 1

Book hotel rooms by April 24

IE Research Conference - May 19-21

IIE Solutions Conference - May 20-22

Discover cost-effective solutions and cutting-edge research at the most respected industrial engineering event of the year, the IIE Annual Conference. Experience a world-class educational opportunity featuring dual forums devoted to covering all aspects of industrial engineering. No other industrial engineering event gives you a more comprehensive overview of current developments and scholarly research than the IIE Annual Conference.

Features of attendance:

- 175+ plus education sessions with new interactive workshops
- Over 300 dynamic presenters representing industry and research
- Fascinating presenters on the IIE keynote podium
- Informative exhibits showcasing the latest products and developments
- Earn continuing education credit hours for education sessions
- Experience the magic and warmth of the South

IIE Research Conference Track Topics:

- Methods Analysis
- Engineering Education
- Housing Applications
- Manufacturing Systems
- Engineering Economy
- Military and Space Applications
- Supply Chain Management
- Modeling & Simulation
- Quality & Reliability Engineering
- Logistics & Scheduling
- Manufacturing & Design
- Engineering Management
- Production & Inventory Control
- Human Factors
- Operations Research
- Computers & Information Systems
- Facilities

Presenter deadlines:

- Final paper — due March 26, 2002
- Speaker registration form — due April 5, 2002
- Audio visual form — due April 13, 2002
- Hotel information — due April 24, 2002

New for 2002 - Millennium Membership

How to Attract and Keep Members in the New Marketplace -- a special motivational workshop for all IIE members and leaders

Sunday, May 19, 2002
1:00 - 5:00 p.m.
Hilton at Walt Disney World
Salon IV of the Grand Ballroom

The importance of membership recruitment and retention to IIE's success won't change in the new century -- but the members and potential members will! How well we deal with this new generation of members and prospects to determine, if and how much, we can grow. Join this fun, interactive workshop to learn about ways to attract and keep members in the new marketplace!

This specially designed half-day session will focus on ways to:

- * Identify the "new marketplace"
- * Use technology to recruit and retain members
- * Enhance our professional image
- * Understand the need to create a membership experience

For information regarding the session tracks for the IERC go to <http://fie.engrng.pitt.edu/iie2002/ierc/matrix1.htm>. For general information, for both the IERC and Solutions Conferences go to

Foundations of Engineering Economy. 1.1 Engineering Economics: Description and Role in Decision Making. 1.2 Performing an Engineering Economy Study 1.3 Professional Ethics and Economic Decisions 1.4 Interest Rate and Rate of Return 1.5 Terminology and Symbols 1.6 Cash Flows: Estimation and Diagramming 1.7 Economic Equivalence 1.8 Simple and Compound Interest 1.9 Minimum Attractive Rate of Return 1.10 Introduction to Spreadsheet Use. For the application of engineering economics in the practice of civil engineering see Engineering economics (Civil Engineering). Engineering economics, previously known as engineering economy, is a subset of economics concerned with the use and "...application of economic principles" in the analysis of engineering decisions. As a discipline, it is focused on the branch of economics known as microeconomics in that it studies the behavior of individuals and firms in making decisions regarding the Engineering Economy. It deals with the concepts and techniques of analysis useful in evaluating the worth of systems, products, and services in relation to their costs. 2. Engineering Economy. It is used to answer many different questions Which engineering projects are worthwhile? Has the civil engineer shown that constructing a new road is worth developing? Which engineering projects should have a higher priority? Uniform Series Payment Problems - Fundamentals of Engineering Economics (Part 1). EngineerInTrainingExam.com. EngineerInTrainingExam.com. 6. Uniform Series Payment Problems - Fundamentals of Engineering Economics (Part 2). EngineerInTrainingExam.com. Continuous Compounding - Fundamentals of Engineering Economics. EngineerInTrainingExam.com. EngineerInTrainingExam.com. 10. Non-Annual Compounding - Fundamentals of Engineering Economics. Engineering Economics in Civil Engineering, also known generally as engineering economics, or alternatively engineering economy, is a subset of economics, more specifically, microeconomics. It is defined as a "guide for the economic selection among technically feasible alternatives for the purpose of a rational allocation of scarce resources." Its goal is to guide entities, private or public, that are confronted with the fundamental problem of economics.