Enhancing the Educational Process Through a Supplemental Reading Initiative

Stanley F. Bullington and Allen G. Greenwood

Abstract

The Department of Industrial Engineering at Mississippi State University uses supplemental reading materials in a number of its courses. The books used in each class are intended to support the objectives of the class and to reinforce the more "traditional" material presented in the course. Furthermore, supplemental reading materials can be used to directly address five of the eleven specific skills required in the ABET 2000 Criteria. Also, the supplemental reading initiative addresses feedback from employers and industrial advisors regarding the need for enhanced communications skills and general business awareness, and provides a potentially powerful marketing tool for our graduates by demonstrating that they have been exposed to reading material that many prospective employers view as being fundamental. This paper discusses our experiences with the use of supplemental reading materials. We make some suggestions on appropriate books, discuss several methods for incorporating the use of the materials into classes, and share some anecdotal results of the initiative.

Introduction

The Department of Industrial Engineering at Mississippi State University (MSU) launched a Supplemental Reading Initiative (SRI) in 1998. The SRI involves the use of supplemental reading books in most of the courses offered by the department. This paper describes the objectives of the SRI, discusses various implementation issues such as suggestions on appropriate books (for industrial engineering, and for other engineering disciplines) and different methods for covering the supplemental reading material in courses, and shares some anecdotal results of the initiative.

Objectives of the Supplemental Reading Initiative

The SRI is intended to help achieve the following objectives: (1) reinforce the "traditional" materials presented in each course, thereby contributing to the achievement of course objectives and, ultimately, departmental program objectives, (2) directly address ABET Criteria 2000 skills requirements, (3) respond to the needs of employers of our graduates, and (4) increase the likelihood that our graduates will achieve professional success. Each of these objectives will be briefly discussed below. The "Results" section will also address our observations regarding the achievement of these objectives.

Reinforce Course Material and Meet Course and Program Objectives

As noted below in the "Implementation Issues" section, supplemental books are generally chosen so that they directly address the topic of the specific course. They might serve to expand on themes covered in the course textbook (e.g., using a supplemental book to present the ideas of Drucker or Deming in an Engineering Management or Quality Management course), or perhaps to present alternative ideas to those covered in the course textbook (e.g., using a supplemental book to examine the Toyota Production System or the Theory of Constraints in a Production Control course where the textbook focuses on more traditional methods).

The supplemental reading materials can serve to promote active learning by increasing student interest and enhancing class discussion. The supplemental reading books are generally more "interesting" and less "dry" than the course textbooks, which can serve to make the entire course more meaningful, and thereby increase the degree to which the course and program objectives are achieved.

Table 1 shows the MSU Industrial Engineering undergraduate program objectives. The sections in bold show elements of the objectives that we believe are directly addressed by the SRI.

1. The Department of Industrial Engineering strives to provide **excellence in instruction** in its undergraduate courses in industrial engineering, using **advanced teaching methods** and technologies in classrooms, laboratories, and other educational settings.
2. The Department of Industrial Engineering strives to ready its students for a **lifelong pursuit of learning**.
3. The Department of Industrial Engineering expects its graduates to be well versed in industrial engineering theory, know how to apply that theory, and to **be capable of functioning effectively in a broad range of organizations.**
4. The Department of Industrial Engineering expects its students to **master important professional skills**, **including communication**, economics, physical and social science, mathematics and statistics.
5. The Department of Industrial Engineering expects its students to interact cooperatively in **professional situations** with individuals having different cultures, training, education, and interests.
6. The Department of Industrial Engineering expects its students to **think independently**, to **critically examine ideas**, and to **make discerning professional judgments**, whether intellectual, ethical, or aesthetic.
7. The Department of Industrial Engineering expects to graduate **professionally mature, responsible, and informed citizens.**

Table 1. MSU Industrial Engineering Undergraduate Program Objectives [Mississippi State University]

Address ABET 2000 Skills Requirements

For most undergraduate engineering programs, it is imperative that ABET accreditation criteria be appropriately addressed. Table 2 presents the eleven skills requirements outlined in Criterion 3 of the ABET Engineering Criteria 2000 [Engineering Accreditation Commission, p.32]. The sections in bold show ABET requirements that we believe are directly addressed by the SRI. It should be noted that the specific requirements addressed by the SRI (i.e., requirements f, g, h, i, j) are among the "softer" requirements, which are often those that are most difficult for engineering programs to effectively demonstrate and assess.

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an **understanding of professional and ethical responsibility**
(g) an **ability to communicate effectively**
(h) the **broad education necessary to understand the impact of engineering solutions in a global and societal context**
(i) a **recognition of the need for, and an ability to engage in life-long learning**
(j) a **knowledge of contemporary issues**
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Table 2. ABET EC2000 Criterion 3 Skills Requirements

Respond to the Needs of Employers

There is abundant evidence that employers consistently rate communications skills and general business knowledge among the most important desired attributes for new engineers [Aldridge; Bullington, et al; Lang, et al; Wheeler and McDonald]. Employers also consistently rate these areas as among those in which new engineers are least prepared [Babcock; Meier et al]. The formal courses in composition, speech, technical writing, etc., which are common in undergraduate engineering curricula, have apparently not been adequate in themselves in meeting this long-standing need of industry. In response to this, many engineering programs have developed innovative approaches to incorporating communication-enhancing experiences into engineering courses [Hendricks and Pappas; Sharp, et al; Wheeler and McDonald]. In our opinion, the SRI approach can serve to complement these efforts by emphasizing **reading**, which is something that we find many of our students do all too infrequently. Furthermore, many of our implementation approaches (see "Implementation Issues" section below) use writing and/or class discussion to determine how well the students have grasped the reading material.

Contribute to Professional Success of Graduates

The ultimate goal of any engineering department, and of ABET, is to help produce graduates who are equipped to succeed professionally. By addressing departmental program objectives, the requirements of the ABET Criteria, and the needs of prospective employers of our graduates, we feel that the SRI can help to achieve this primary objective. More specifically, many of the supplemental books introduce students to real-world examples and cases, which can help better prepare them for situations they will face during their professional careers.

Implementation Issues

Two critical implementation issues are the selection of supplemental reading books, and the selection of methods for covering the supplemental reading material in courses. The two subsections that follow present what we have done at MSU. In the third subsection, we present a few suggestions for books that might be appropriate for other engineering disciplines.

Books Used in MSU IE Courses

Table 3 lists the MSU courses in which supplemental reading books have been used, as well as the books used in each of those courses. Although we may never require supplemental reading in all of our courses, the number of courses involved in the SRI is currently increasing. The book list is viewed as a dynamic one, with instructors and technical area committees making periodic adjustments as needed.

IE 1911 – Introduction to Industrial Engineering	*How to Win Friends and Influence People*, Dale Carnegie
IE 3123 – Work Analysis and Design	*The Principles of Scientific Management*, F.W. Taylor
IE 3323 – Manufacturing Processes	*Modern Approaches to Manufacturing Improvement: The Shingo System*, Alan Robinson (editor)
IE 3913 – Engineering Economy I	*Making the Most of Your Money*, Jane Bryant Quinn
IE 3921 – Industrial Engineering Projects	*Presentations Plus*, David A. Peoples
IE 4333 – Production Control Systems I	*The Goal*, Eliyahu M. Goldratt and Jeff Cox
IE 4353 – Materials Handling	*Modern Approaches to Manufacturing Improvement: The Shingo System*, Alan Robinson (editor)
IE 4513 – Engineering Administration	*Peter Drucker on the Profession of Management*
IE 4533 – Project Management	*Critical Chain*, Eliyahu M. Goldratt
IE 4573 – Process Improvement Engineering	*The Deming Management Method*, Mary Walton
IE 4653 – Industrial Quality Control I	*Zen and the Art of Motorcycle Maintenance*, R.M. Pirsig
IE 4773 – Systems Simulation I	*Serious Play: How the World's Best Companies Simulate to Innovate*, Michael Schrage
IE 4990 – Logistics Engineering	*Direct from Dell: Strategies that Revolutionized an Industry*, Michael Dell
IE 8333 – Production Control Systems II	*The Goal*, Eliyahu M. Goldratt and J. Cox
IE 8373 – Computer Integrated Manufacturing	*Necessary But Not Sufficient*, Eliyahu M. Goldratt, et al
IE 8583 – Enterprise Systems Engineering	*Mission Critical*, Thomas H. Davenport

Table 3. Supplemental Reading Books Used in MSU Industrial Engineering Courses (See Reference List)

Methods for Covering Supplemental Reading Material

The IE faculty at MSU have used a variety of methods for covering the supplemental reading material. The method of coverage is left up to the individual faculty member, and depends largely on faculty preference and on how "full" of traditional material the course already is. Methods we have used are briefly described below. This list of methods is, of course, merely representative of the possibilities.

Daily Discussion: Everyone reads the book on the same schedule. Several minutes at the beginning or end of each class is devoted to discussion of the assigned reading.

Daily (or "pop") Quiz: Everyone reads the book on the same schedule. Brief daily or "pop" quizzes are given on the assigned reading.

Interactive Quiz: Everyone reads the book on the same schedule. An interactive quiz is conducted in class (prepared in advance by the instructor; completed in class by the whole class in a discussion mode.

Student "Nuggets" and Questions: Students are asked to identify a few key points (i.e., "nuggets") and questions on each assigned section. These could be turned in and reviewed by the instructor (in which case the reading could be carried out at each individual's own pace), or used as the basis for daily discussions.

Written Reports/Summaries: These could take many forms, including "book reports" covering the entire book, or summaries of each assigned section. This method could be used even if no class time was devoted to discussion of the supplemental book (e.g., in a very "full" course).

"Fair Game" on Exams: Important points on the supplemental reading material could be included in the regular class exams. (NOTE: This will be unpopular with students unless these "important points" are woven into the lectures, or identified in some other way!)

Honor System or Optional: Students are required to read the book on their honor, or the supplemental reading book is suggested, but optional. Although some of our faculty members have used this method, we do not recommend it.

Combination of Methods: The possibilities for combining methods are endless. As an example, one of the authors taught the IE 4773 – Systems Simulation I course in the Fall 2000 semester. The supplemental reading book was *Serious Play: How the World's Best Companies Simulate to Innovate* [Schrage]. The following five-part supplemental assignment was due near the end of the semester:

(1) Provide a one-page summary of the book.

(2) For each chapter, identify one to three "nuggets" – the most interesting and/or most important things in the chapter. Each nugget must be expressed in complete and quality sentences. If quotes are used, reference them.

(3) Select the "top two" most important nuggets from (2). Describe each one in detail, approximately one paragraph, including the significance and relevance of the nugget and why you believe it to be so important.

(4) Discuss how the material that you have learned in this course contributes to an environment of "serious play" and innovation. Be prepared to discuss this in class, also.

(5) Discuss how reading *Serious Play* would help you utilize discrete-event simulation in an organization. Be prepared to discuss this in class, also.

Note that this assignment has (1) virtually ensured that each student will read the supplemental book, (2) allowed each student to read the book at his/her own pace, (3) forced the students to synthesize what they have read in each chapter, and for the book as a whole, (4) forced the students to write, (5) forced the students to relate the supplemental reading to what they have learned in the rest of the course, (6) forced the student to participate in discussion of the book during one class period at the end of the semester, and (7) used relatively little class time.

Some Book Suggestions for Other Engineering Disciplines

It is fairly easy to identify appropriate supplemental reading books. Although it is sometimes difficult to identify a book with a close link to a particular course (and this might be even more difficult in some engineering disciplines than in others), our experience has been that it is likely to be more difficult to select from among several appropriate titles. You will note that several of the books we use (see Table 3) are just as suitable for other engineering disciplines as they are for IE. We present the following list of titles merely to stimulate thought among our colleagues from other disciplines:

- *The Soul of a New Machine*, Tracy Kidder, Back Bay Books, 2000 (reprint)
- *Augustine's Laws*, 6th Edition, Norman R. Augustine, American Institute of Aeronautics and Astronautics, 1997
- *Inside NASA: High Technology and Organizational Change in the U.S. Space Program*, Howard E. McCurdy, Johns Hopkins University Press, 1994
- *The Mars Pathfinder Approach to "Faster-Better-Cheaper"*, Price Pritchett and Brian Muirhead, Pritchett and Associates, 1998
- *A Brief History of Flight: From Balloons to Mach 3 and Beyond*, T.A. Heppenheimer, John Wiley and Sons, 2000
- *Skunk Works: A Personal Memoir of My Years at Lockheed*, Ben R. Rich and Leo Janos, Little Brown and Company, 1996
- *The Machine that Changed the World: The Story of Lean Production*, James P. Womack, Daniel T. Jones, and Daniel Roos, Harper Collins, 1991
- *Design Paradigms: Case Histories of Error and Judgment in Engineering*, Henry Petroski, Cambridge University Press, 1994
- *Remaking the World: Adventures in Engineering*, Henry Petroski, Vintage Books, 1999
- *The Innovators: The Engineering Pioneers Who Made America Modern*, David P. Billington, John Wiley and Sons, 1996
- *Systematic Innovation: An Introduction to TRIZ (Theory of Inventive Problem Solving)*, John Terninko, Alla Zusman, and Boris Zlotin, St. Lucie Press, 1998
- *The New Rational Manager*, Charles H. Kepner and Benjamin B. Tregoe, Princeton Research Press, 1997
- *Principle-Centered Leadership*, Stephen R. Covey, Simon and Schuster, 1990

Results

The SRI has been underway for just over two years. Reaction to the program has generally been favorable from faculty, students, prospective employers, and our departmental Industrial Advisory Group. The number of faculty members participating, and the number of courses involved, are increasing. Although some students have strong preferences regarding particular books and implementation methods, student reaction has been generally quite positive (as evidenced in informal discussions with faculty members, and in written comments on student evaluations of teaching). There is some evidence that a "culture of reading" is developing among students (e.g., student requests for faculty recommendations for further outside reading materials for semester breaks and co-op terms). Students have received favorable comments regarding SRI books from prospective employers during interviews. Recent alumni have sent messages to faculty members to recommend books for inclusion in the SRI program. The department featured the SRI program in its favorable ABET (EC2000) visit in Fall, 1999, as evidence of achievement of EC 2000 requirements. We believe that this anecdotal evidence indicates that the objectives of the initiative are being met.

Summary and Conclusions

The Supplemental Reading Initiative in the MSU Department of Industrial Engineering is intended to achieve several important educational objectives. These include some of the "soft" objectives (enhanced communications skills, ability to engage in life-long learning, increased understanding of the business side of engineering work, etc.) that are generally recognized as being of critical importance, but that are also traditionally difficult for engineering programs to address. We believe this approach holds promise for any engineering program, and that there is a great deal of flexibility in tailoring such a program to meet the needs of particular schools, disciplines, and courses. Our early anecdotal evidence is promising, and we look forward to continuing the development of this initiative in the future.

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Stanley F. Bullington, Ph.D., P.E.

Dr. Bullington is a professor in the Department of Industrial Engineering at Mississippi State University. He received his B.I.E. and Ph.D. degrees in industrial engineering from Auburn University, and his M.S.I.E. degree from Purdue University. He worked as a systems engineer for TRW Defense Systems, and served as a Malcolm Baldrige National Quality Award Examiner in 1999 and 2000. His areas of academic interest include management systems engineering, quality management, production control, and logistics.

Allen G. Greenwood, Ph.D., P.E.

Dr. Greenwood is an associate professor in the Department of Industrial Engineering at Mississippi State University. He received his B.S. and M.S. degrees in industrial engineering from North Carolina State University and the University of Tennessee, respectively. He received his Ph.D. in management science from Virginia Tech. He has served on the faculty at Virginia Tech, Northeastern University, and the American University of Armenia, and has ten years of industry experience as an engineer and manager in the synthetic fiber and defense industries. His areas of academic interest include management systems engineering, cost estimation and analysis, project management, and simulation optimization.