To the Graduate Council:

I am submitting herewith a thesis written by Stephanie Slagle Thompson entitled "The Engineering Management Online Handbook: An Evaluation of Content." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Industrial Engineering.

Gregory SedrickMajor Professor

_____

We have read this thesis
and recommend its acceptance:

Denise Jackson

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George Garrison

_____

Accepted for the Council:

Carolyn R. Hodges, Vice Provost and Dean
of the Graduate School

_____

(Original signatures are on file with official student records.)

The Engineering Management Online Handbook:

An Evaluation of Content

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Stephanie Slagle Thompson

May 2008

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I wish to thank all those who helped me complete my Master of Science degree in Industrial Engineering. I would like to thank all of my undergraduate professors. It is not until you get into the “real” world that you realize how relevant and thorough those classes really were. In addition to all of my graduate school professors, I would also like to thank my thesis advisor and graduate professor, Dr. Greg Sedrick. Without his enthusiasm for Engineering Management and this topic, I would not have succeeded. I would also like to thank my father, Fredrick J. Slagle, for encouraging me to “try” the field of engineering and knowing it would be a good fit for me.

Abstract

The purpose of this study was to gather a detailed understanding and encompassing list of topics for an Engineering Management Online Handbook. To better understand the profession of Engineering Management, the history of the profession is discussed. Although an Engineering Management Handbook currently exists on the World Wide Web, this study incorporates surveys of practicing engineers and current literature research. General perceptions and comments were collected from practicing engineers about the current state of the Handbook as it exists at the website of the American Society for Engineering Management (www.ASEM.org). It seems as though the main contributors currently are professors associated with the American Society for Engineering Management. Of the 26 topics listed on the Table of Contents, only a handful contains relevant links that have been updated in the past year. Corresponding handbooks were studied and reviewed for gaps or new philosophies and tools. Topics were analyzed and compared to the Engineering Management Body of Knowledge. Recommendations and an encompassing list of topics are provided.

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List of Abbreviations

ASEM	American Society for Engineering Management
BoK	Book of Knowledge
EM	Engineering Management

Introduction

What is engineering management? *Webster's Dictionary* defines engineering as "the practical application of science and mathematics, as in the design and construction of machines, vehicles, structures, roads, and systems." Management is defined as "the act or process of managing; the persons controlling and directing an enterprise." In his book *Managing Engineering and Technology*, Daniel Babcock gives his definition of an engineering manager:

> The engineer manager is distinguished from other managers because he (or she) possesses both an ability to apply engineering principles and a skill in organizing and directing people and projects. He is uniquely qualified for two types of jobs: the management of technical functions (such as design or production) in almost any enterprise, or the management of broader functions (such as marketing or top management) in a high-technology enterprise (14).

According to the U.S. Department of Labor, in 2006, there were 1.5 million engineers employed. Those engineers and their projects are all managed in some form by an "engineering manager." Some of these engineering managers manage solely from experience, but others go through formal training courses, such as a graduate degree or certification course. Whether they know it or not, there is an Engineering Management Handbook available online through the American Society for Engineering Management's webpage (www.ASEM.org). To fully appreciate the Engineering Management concept and Handbook, one must realize the rich history of engineering management. This paper will attempt to gather a detailed understanding and an encompassing list of topics for an update to the online Engineering Management Handbook. Several questions must be

asked when updating the Engineering Management Handbook. How can all aspects of Engineering Management be identified, researched, defined, and included in an Engineering Management Handbook that will be used to assist an engineering manager with the most current philosophies, tools, and techniques? Where are the gaps in the current handbook, specifically with contributors, users, and articles?

History of Engineering Management

The history of the combination of engineering and management can be traced back to 1913 at the Massachusetts Institute of Technology (MIT). According to the web site of Institute Archives, an ad hoc committee of the Alumni Council in 1913 studied and issued a report in favor of a program "specially designed to train men to be competent managers of businesses that have much to do with engineering problems;" thus the Alfred P. Sloan School of Management began in 1914 as Course XV, Engineering Administration, within the Department of Economics and Statistics. In 1930, Course XV became an independent department and was named the Department of Business and Engineering Administration. In 1931 a special program was started for graduate studies in the fundamentals of management and decision making, aimed at young, competitive managers. It was in 1950 that a member of the MIT class of 1895, Alfred P. Sloan, Jr. made a gift of over 5 million dollars to establish a School of Industrial Management (SIM). According to the Archives, "Sloan sought to correlate the complex problems of management in modern technical industry with science, engineering, and research." At the time, Sloan was the Chairman of General Motors (www.gm.com). Throughout the next couple of decades, the school developed short executive and master's programs and expanded in research. In 1981 a Joint Master's Program in the Management of Technology was started by a joint faculty committee from the Sloan school and the School of Engineering. "The objective was to prepare candidates for more senior roles in industry and

government, where they would generate and manage technology-based endeavors." The Alfred P. Sloan School of Management is now the model for many programs in Engineering Management.

One of these programs was established in 1967 at the University of Missouri, Rolla, by Bernard R. Sarchet. In a March 2000 *Engineering Management Journal,* Dan Babcock describes how Sarchet came to the university. He writes, "An alumni survey was conducted by then Chancellor Meri Baker about the quality of engineering education that alumni received." The article states that "the consensus was they had acquired fine technical skills, but were weak in the humanities and the social and management skills needed for their careers." The Chancellor then obtained a grant for a graduate program in engineering administration and hired Sarchet to run it. Sarchet was a chemical engineer with management experience who always regretted the lack of training in management and human relations that he received in school. While at the school, Sarchet led a bachelor's program, evening classes, and strengthened the content of the engineering management department. It was in the mid-1970s that Sarchet felt there should be a national organization that dealt with the problems of managing technology. According to the article, he met with 20 leading engineering managers who started the American Society for Engineering Management in late 1979. The next fall the society held its first annual meeting and membership quickly grew to 800 members.

History of the Engineering Management Online Handbook

It was at the 1995 American Society for Engineering Management Annual Conference that Dr. Gregory Sedrick, ASEM member and then professor in the College of Engineering Computer Science at the University of Tennessee, Chattanooga, suggested the idea for a “virtual” engineering management handbook, using the Internet as a medium. As said by the ASEM website, “this virtual EM (Engineering Management) handbook was envisioned to place a variety of EM resources at the ready disposal of practicing engineering managers, engineering management researchers, policy makers, and analysts.” It was presented that the handbook would consist of “how-to” methodologies, suggestions of software to solve problems, tools of interest, best practices, research, etc. The website, www.asem.org, cites the reasons as to why the Society should take the lead on the handbook:

1) The need for a resource tailored to EM practitioners and other users of EM information;
2) To express ASEM’s position in matters involving engineering management and to achieve recognition as THE subject matter expert in the field of engineering management;
3) To further advance ASEM influence on policy and processes in the field of engineering management; and
4) To have control over handbook content and content evolution.

According to the ASEM web site, an Oversight Committee for the virtual handbook was formed in March 1996. Comprised mainly of ASEM members, the

purpose of the committee is to provide long-term sponsorship for the EM

Handbook project. The current Committee members are listed below:

- Dr. Larry Richards, School of Management and Aviation Science, Bridgewater State College
- Dr. Greg Sedrick, College of Engineering and Computer Science, University of Tennessee at Chattanooga
- Dr. Henry Wiebe, University of Missouri at Rolla
- Dr. Donald Merino, Wesley J. Howe School of Technology Management, Stevens Institute of Technology
- Dr. Rick Chambers, Sierra Nevada Corporation

Currently, the Purpose Statement for the Engineering Management Handbook is

listed under Publications on the ASEM web page. It states:

"The Engineering Management Handbook provides engineering management practitioners, researchers, policy makers, and analysts with a singular, easy-to-navigate web site through which continuously updated, peer reviewed information and tools can be readily accessed and easily utilized. The EM Handbook will further provide a medium thought which users, subject matter contributors, and subject matter experts can communicate on items of mutual interests."

Current State

The content of the Handbook can be found by visiting the website, www.ASEM.org, clicking on Publications in the upper right hand corner, then clicking on EM Handbook in the left hand corner. As stated on the web site, the list of topics for the Table of Contents was generated by work performed by Dr. Sedrick's graduate students at the University of Tennessee, Chattanooga. The Table of Contents is listed below:

- Applied Operations Research/Production and Operations Management
- Artificial Intelligence/Human Learning
- CIM/CAE/CAD
- Cost Estimation
- Environmental Management
- Engineering Economy
- Ethical Issues
- Information Systems Management
- Innovation and Creativity
- Knowledge Management
- Legal Issues
- Logistics Management
- Management of Technology and Technical Professionals
- Organizational Design
- Product (Hardware/Software) Design and Development
- Product (Hardware/Software) Testing
- Productivity and Performance Measurement
- Project Management
- Quality Assurance
- Reliability and Maintainability
- Research and Development
- Risk Management
- Sensitivity Analysis
- Systems Engineering
- Technical Marketing
- Generic Useful Resources

On the web site, under the Table of Contents, the user can click on each one of the above topics, which will take them to all of the submissions/subtopics concerning that main topic.

For example, if an engineering manager wanted to research how other engineering managers handled managing technical professionals, the manager could search the World Wide Web. If they used www.google.com and typed in Engineering Management Handbook, the first link would take them to current Handbook. Figure 1, below, is what would appear. For this particular topic, Management of Technology and Technical Professionals, there are no subtopics listed, relevant articles, tools, or lessons learned. It does list a subject matter expert, Elias G. Carayannis, Ph.D, MBA, BScEE. It was last updated on January 11, 2000. This is the case when linking to all of the subjects listed on the table of contents. Although most of the updates occurred around the year 2000, the online Handbook is a work in progress with submission welcome to anyone. A link to Dr. Don Merino's e-mail is listed on the home page of the handbook.

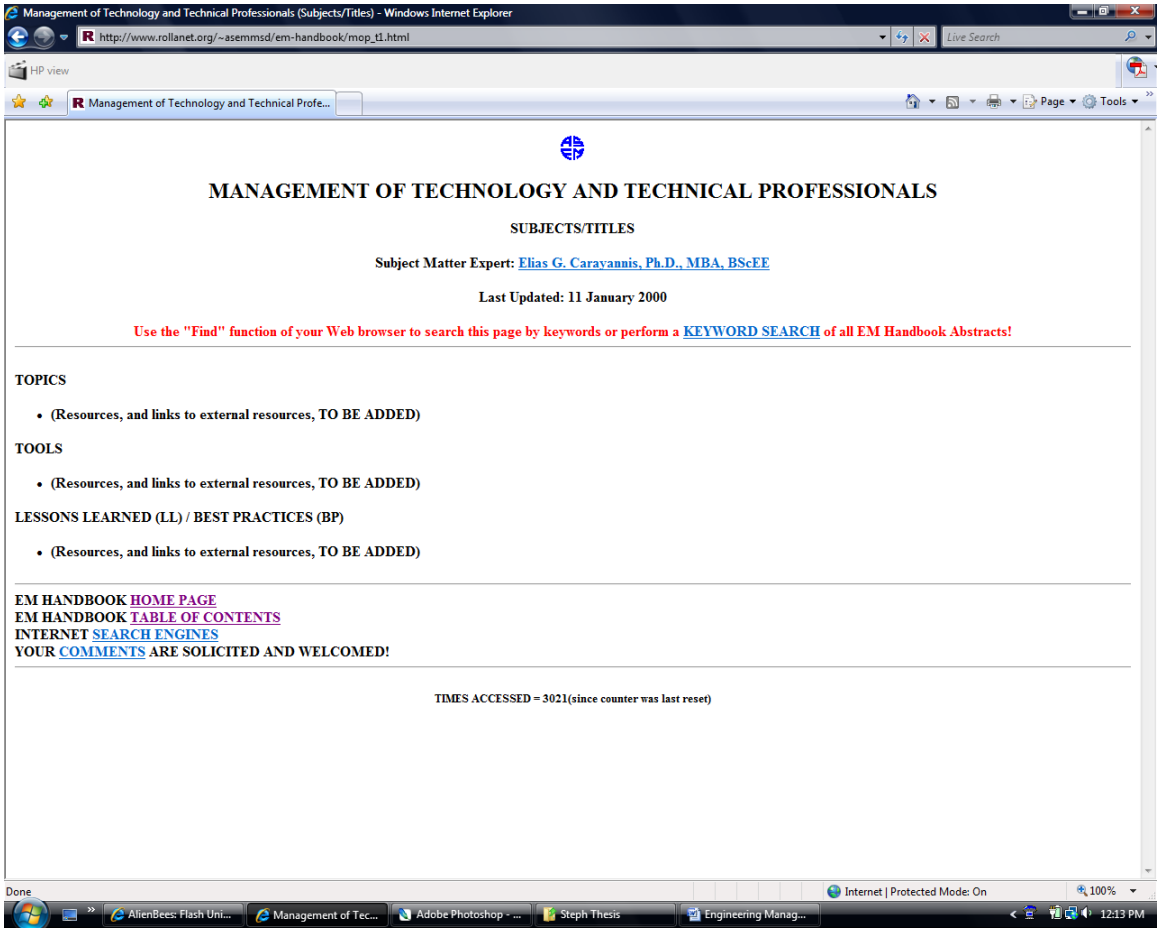


Figure 1. Screen Shot of Current Online Handbook for Management of Technology and Technical Professionals.

Research

Current Topics

One way to get a better understanding of what is important to engineers in the field of Engineering Management is to analyze the most recent topics of capstone/thesis papers at the University Of Tennessee Department Of Industrial Engineering. A total of 418 paper topics were sorted by topic, according the Table of Contents' topics on ASEM's web page. Some topics were added to accommodate a large grouping of papers that otherwise did not fit into a heading. The topics of Business Planning, Design of Experiments, Planning and Scheduling, and the miscellaneous category were added. The authors of these papers vary in experience, such as practicing engineer, graduate student working towards PhD, etc. The years that the papers were written also vary from 1978 to 2003.

Although the Figure 2 shows that the largest topic studied was the miscellaneous category, this category mainly consists of projects and papers related to specifics companies. Figure 2 gives a perspective on engineering management research at a current level and shows that students are most interested in topics such as Organizational Design and Culture, Quality Assurance, and Project Management. The students' research also did not include topics such as: Ethical Issues, Knowledge Management, Legal Issues, Product (Hardware / Software) Testing, Reliability and Maintainability, and Sensitivity Analysis. This research indicates that some Engineering

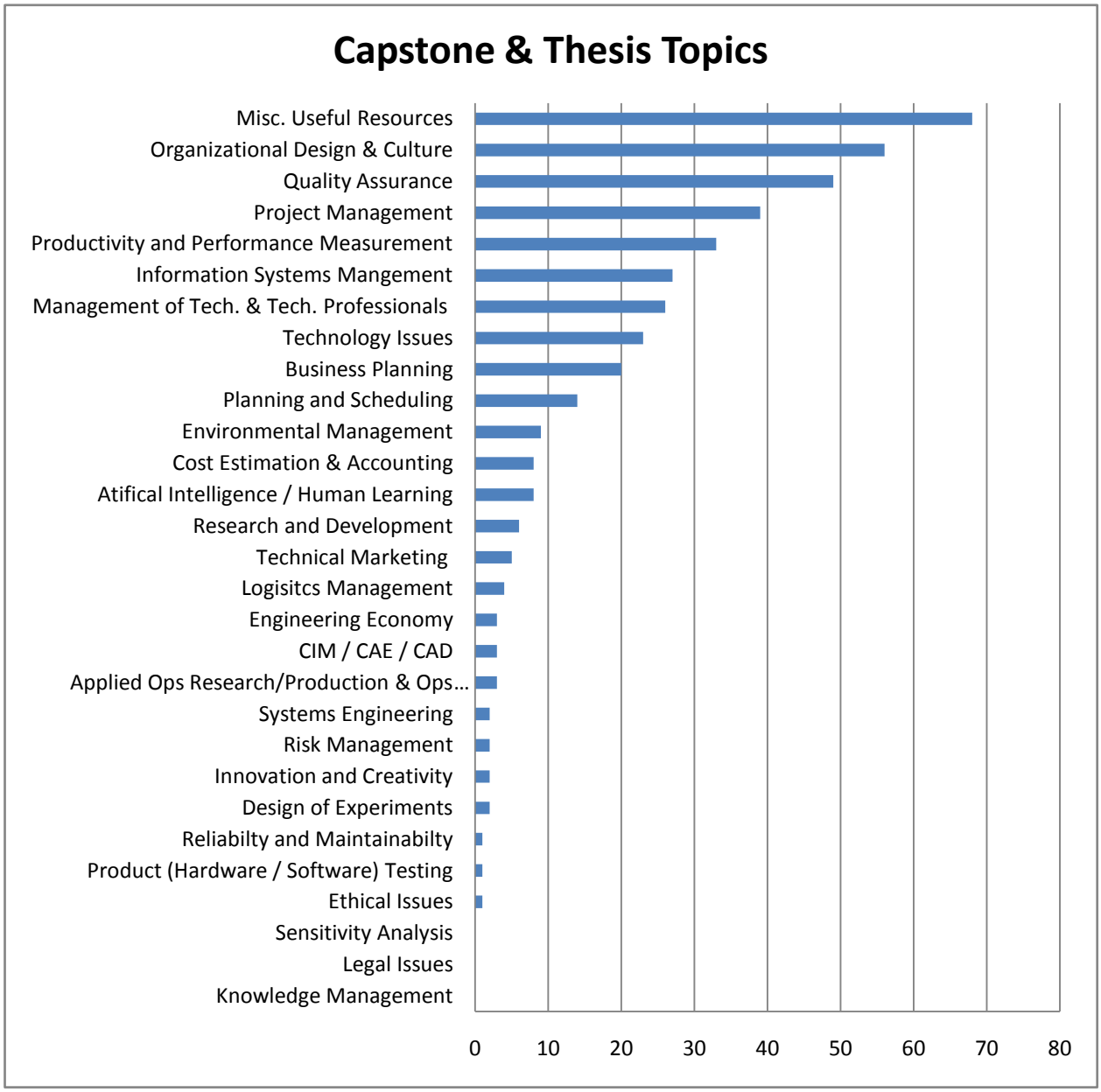


Figure 2. Capstone and Thesis Topics

Management topics are either unavailable/too difficult to research or not applicable to the students' current interests. In the conclusions portion of this paper, Table 7 shows a summary of the capstone and thesis topics compared to other literature searches.

Body of Knowledge

Another useful tool to aid in the further definition of an Engineering Management online handbook is the Engineering Management Body of Knowledge (EM BoK). Also produced from the American Society for Engineering Management, the Body of Knowledge lists general topics and subject matter experts. Version 1.0 was published in September 1, 2007, with the understanding that corrections will be included in version 1.1 to be issued sometime after the ASEM annual meeting in November 2007. The Book of Knowledge lists 13 headings:

- Organizational Behavior
- Management Theory
- Statistics
- Operations Research
- Simulation
- Systems Engineering
- Accounting for Engineers
- Engineering Economics
- Project Management
- Capstone
- Engineering Management
- Operations Management
- Quality Management

The Body of Knowledge was arranged by Dr. Donald N. Merino, PhD, PE at the Stevens Institute of Technology. He writes that it builds on the existing EM BoK embedded in EM undergraduate programs that are ABET (Accreditation Board

for Engineering and Technology) accredited and EM graduate programs that are ASEM certified (Conference Proceedings, 2007). On page 2 of his conference proceedings, Dr. Merino writes that this EM BoK has been developed by EM faculty based on industry/advisory board input; whereas another approach would have used an industry survey as the primary basis.

Although the Engineering Management Book of Knowledge and the Engineering Management Handbook are similar, they also have their differences. One of those differences is the missions of each medium. Dr. Merino notes, "An EM BoK is the first step to developing an EM certification, EM Handbook, and training efforts that give Professional Development Hours (PDHs.)" (Conference Proceedings 2007). He feels that the Book of Knowledge should be more geared towards a certification in Engineering Management and ensuring continuity in the teachings of Engineering Management. The mission of the Handbook is more to assist the student, professor, and practicing engineer with a variety of abstracts and subject matter experts all in one location. The qualifications of the subject matter experts (SMEs) are also different. According to the Conference Proceedings, the SMEs for the Book of Knowledge must have:

- ✓ PhD in the subject field
- ✓ Professor or at least Associate Professor Level
- ✓ Tenure Status
- ✓ Refereed articles in the field
- ✓ Text (s) in the field
- ✓ Funded research in the field
- ✓ Practical experience at the executive level

With the online Handbook, those who are listed as subject matter experts were determined by the Oversight Committee and may have the same qualifications

as above, but not necessarily. Also, to be an author for the Handbook, all an author has to do is submit to the committee and be approved, regardless of education level or experience; although, it is up to the discretion of the committee. One of the main similarities in both the Body of Knowledge and the Handbook is the realization that both are "living" articles. Dr. Merino states that there are at least two areas for future research. "The first involves updating the EM BoK over time. As mentioned in previous papers, EM is a relatively new and evolving discipline. EM will change over time and there needs to be a continuing commitment to update the EM BoK." (Conference Proceedings 2007) The online Handbook also realizes this by posting the option online to submit suggestions, papers, and questions. In the conclusions portion of this paper, Table 7 shows a summary of the Engineering Management Book of Knowledge topics compared to other literature searches.

Other Handbooks

A literature search of other "handbooks" was performed to analyze the contents and possibly benchmark other handbooks that are currently in use. One that appears to be popular is the *Technology Management Handbook* by Richard C. Dorf. Although more detailed than the current online Engineering Management Handbook, the overall content is similar. Dorf's Table of Contents follows:

1. The Technology Manager and the Modern Context Entrepreneurship and New Ventures
2. Science and Technology Policy
3. Innovation and Change
4. Knowledge for the Technology Manager Economics
5. Statistics

6. Accounting
7. Organizations
8. Tools for the Technology Manager Finance
9. Decision and Simulation Methods
10. Legal Issues
11. Information Systems
12. Managing the Business Function Marketing of Technical Products
13. Production and Manufacturing
14. Product Management
15. Project Management
16. Strategy of the Firm Business Strategy
17. Strategic Action
18. Core Relationships for the Technology Manager Human Resources
19. Personal Issues
20. Reliability and Maintainability
21. Safety and Human Factors
22. Global Business Management International Business

Dorf's *Technology Management Handbook* includes very relevant topics to today's engineering manager. Another handbook that was analyzed is the *Handbook of Industrial Engineering*, edited by Gavriel Salvendy. Even though this handbook was printed in 1982, the handbook shows that the core concepts of Industrial Engineering have not really changed, but evolved. The *Handbook of Industrial Engineering* includes contributions from professors and practicing engineers. In the foreword, D.C. Burnham, Retired Chairman of the Board, Westinghouse Electric Corporation, writes, "The *Handbook* should be valuable to industrial engineers and other engineers, as well as to all levels of mangers." The Table of Contents follows:

1. Industrial Engineering Function
2. Organization and Job Design
3. Methods Engineering
4. Performance Measurement and Control of Operation
5. Evaluation, Appraisal, and Management of Human Resources
6. Ergonomics/Human Factors
7. Manufacturing Engineering

8. Quality Assurance
9. Engineering Economy
10. Facilities Design
11. Planning and Control
12. Computers and Information Processing Systems
13. Quantitative Methodologies for Industrial Engineers
14. Optimization in Industrial Engineering

This handbook is obviously geared more toward the key concepts of industrial engineering. Each section under the table of contents contains anywhere from five to fourteen articles written by practicing engineers or professors. The handbook does not contain many articles related specifically to the management field; and since it is 26 years old, the handbook is not up to date in the technology field.

In 2001, Salvendy also edited an updated version of the *Handbook of Industrial Engineering*, which focuses more on the technology aspect. The *Handbook of Industrial Engineering: Technology and Operations Management* in its third edition is slightly more concise and updated than the early version in 1982. It contains entire sections dedicated to management and technology. This version is organized in similar fashion to Salvendy's 1982 version. Each topic listed on the table of contents contains articles written by professors and practicing engineers. The topics and subtopics listed in his table of contents are found below:

1. Industrial Engineering Function and Skills
    a. Full Potential Utilization of Industrial and Systems Engineering in Organizations
    b. Enterprise Concept: Business Modeling Analysis and Design
2. Technology
    a. Information Technology

    b. Manufacturing and Production Systems
    c. Service Systems
3. Performance Improvement Management
    a. Organization and Work Design
    b. Human Factors and Ergonomics
4. Management, Planning, Design, and Control
    a. Project Management
    b. Product Planning
    c. Manpower Resource Planning
    d. Systems and Facilities Design
    e. Planning and Control
    f. Quality
    g. Supply Chain Management and Logistics
5. Methods for Decision Making
    a. Probabilistic Models and Statistics
    b. Economic Evaluation
    c. Computer Simulation
    d. Optimization

The table of contents in Salvendy's *Handbook of Industrial Engineering: Technology and Operations Management 3rd Edition* includes the core topics of Industrial Engineering, but does not really address the management of technical professionals. In the conclusions portion of this paper, Table 7 shows a summary of these handbook topics compared to other literature searches.

Engineering Management Survey 2004

One way of understanding how an online handbook would benefit its users is to ask the users. A survey is a way to accomplish this. Similar to research performed in 1995 to establish the Table of Contents for the online Handbook, a survey of 55 subject matter experts was conducted in 2004 by Dr. Greg Sedrick and the University of Tennessee. The survey asked the managers to rank the core competencies listed in the survey as how they related to the field of engineering management. The competencies were split into five major categories: Management, Financial, Human Factors, Quality, and Technical. Each competency had several subtopics listed under each core competency. Each manager was asked to rank these with a rank of 1-5, with 5 being the most important competency to the field of engineering management. The results can be interpreted to also show the most important topics, which should be displayed on the table of contents for an online Engineering Management Handbook. Table 1 below shows the competencies that were surveyed.

The first core competency questioned in the survey was Management. Figure 3 below shows how the subtopics were ranked. The remaining core competencies, Financial, Human Factors, Quality, and Technical are shown in Figures 4-7 with their corresponding ranked subtopics.

Table 1. Topics from 2004 Survey

Core Competency	Subtopics
1) Management	Engineering Mgmt.
	Project Mgmt.
	Strategic Management
	Marketing Management
	Leadership Skills
	Decision Making and Analysis
	Technology Transfer
	Acquisition Logistics
	System Integration
	Communication
	Handling Employee Problems
2) Financial	Engineering Economy
	Financial Management
	Accounting
	Enterprise Integration
	Value Management and Analysis
	Product Development
	New Venture Formation
	Risk Management
3) Human Factors	Legal and Ethical Perspectives
	Labor Relations
	Managing Change
	Management of Technology
	Safety Issues
	Organizational Behavior
	Conflict Resolution/People Skills
	Diversity Issues
	Quality Assurance
	Accountability
4) Quality	Quality Control
	Process and Product Reliability
	Probability and Statistics
	Performance Benchmarking

Table 2 continued. Topics from 2004 Surve

Core Competency	Subtopics
4) Quality, cont.	Production and Inventory Systems
	Lean Systems
	Six Sigma
5) Technical	Analytical methods
	Life Cycle Engineering
	Optimization Methods
	Systems Analysis
	Product Development
	Facilities Planning
	Simulation Studies
	Information Systems
	Database Management

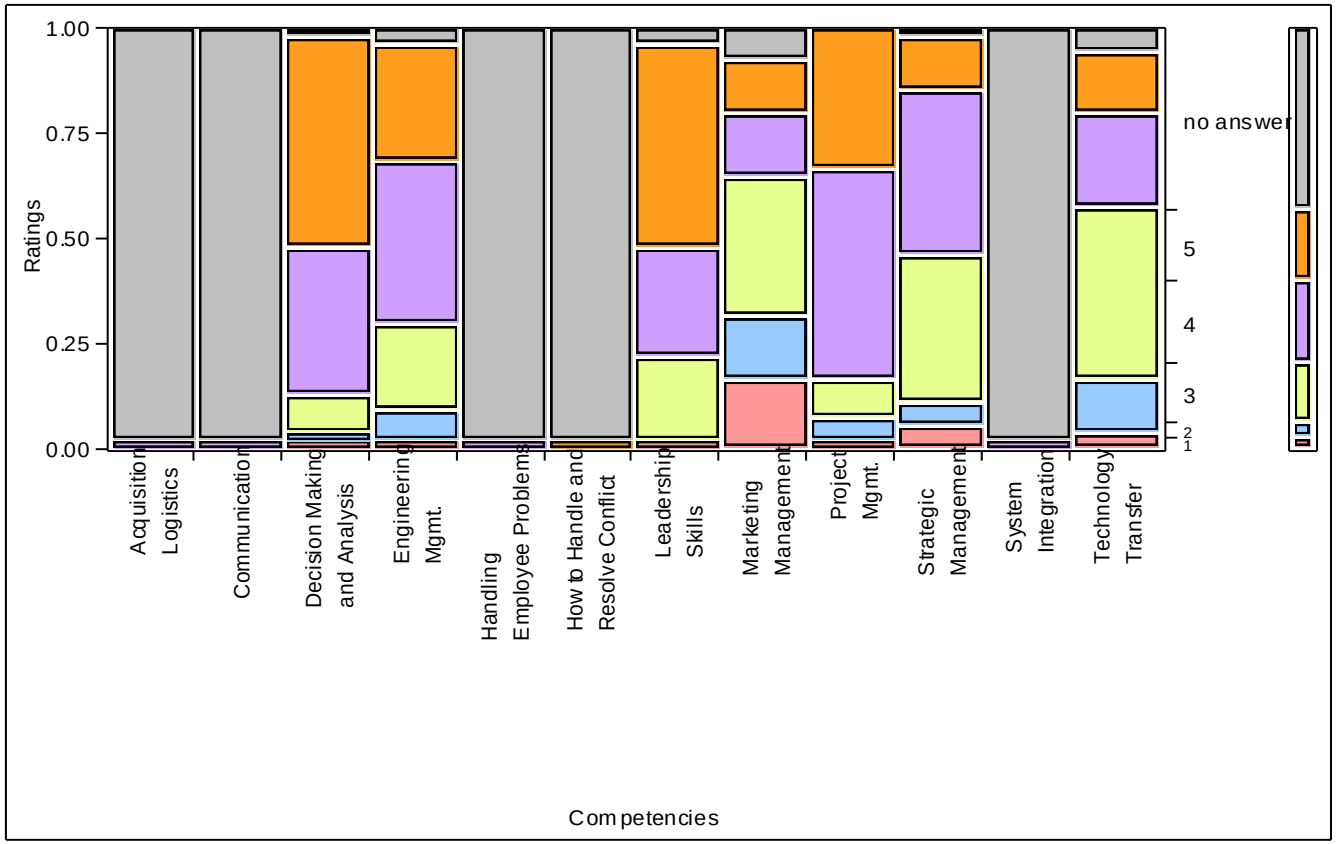


Figure 3. Management Competencies

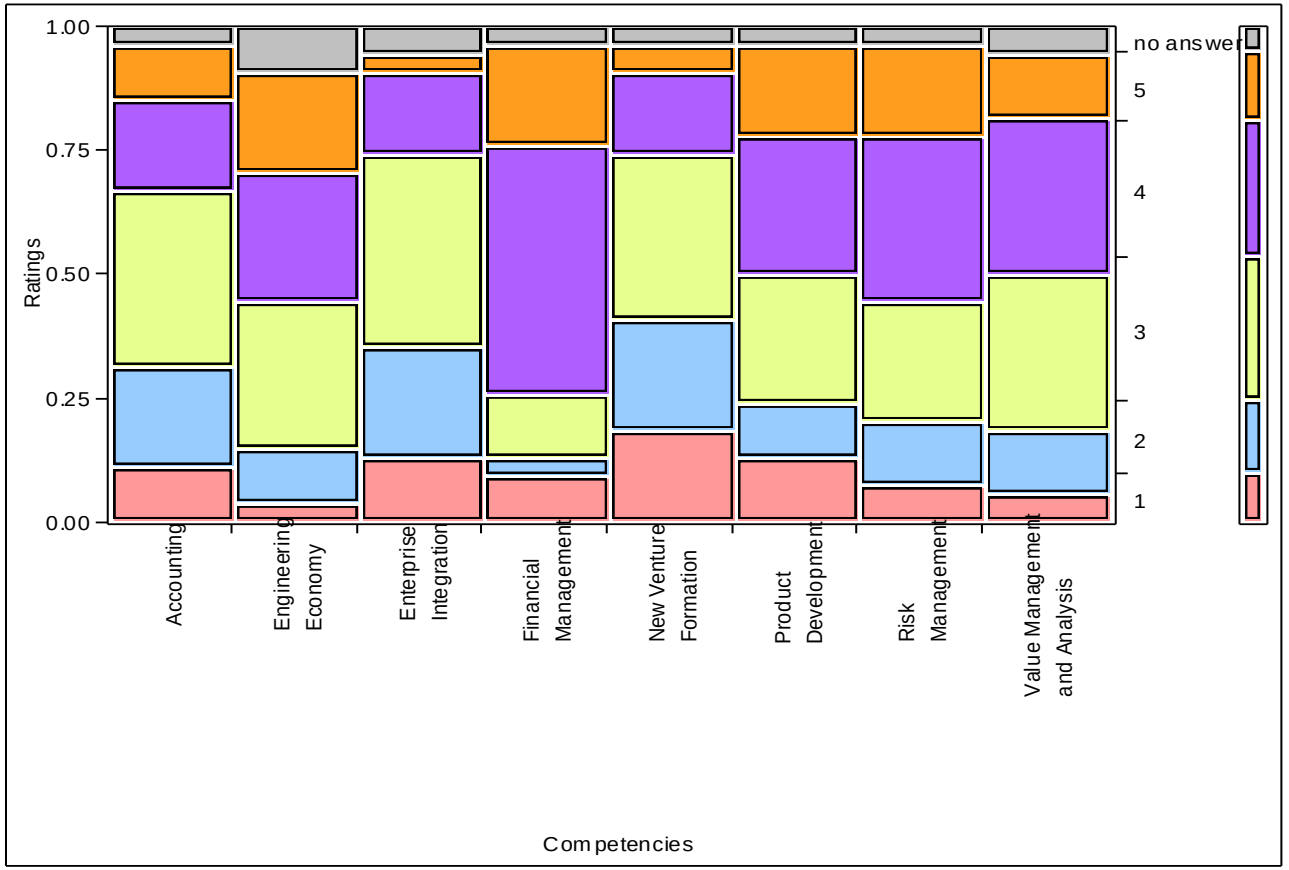


Figure 4. Financial Competencies

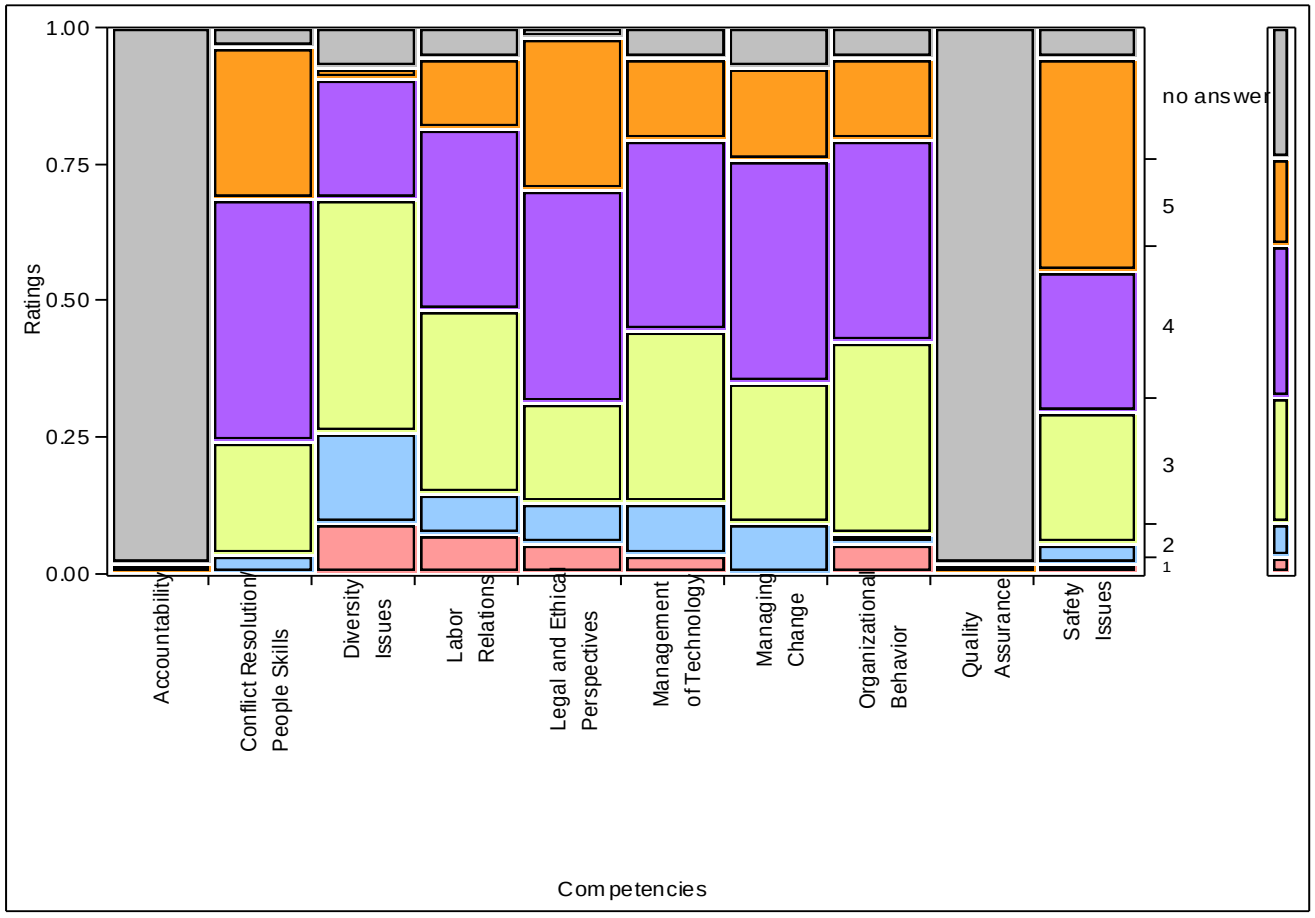


Figure 5. Human Factors Competencies

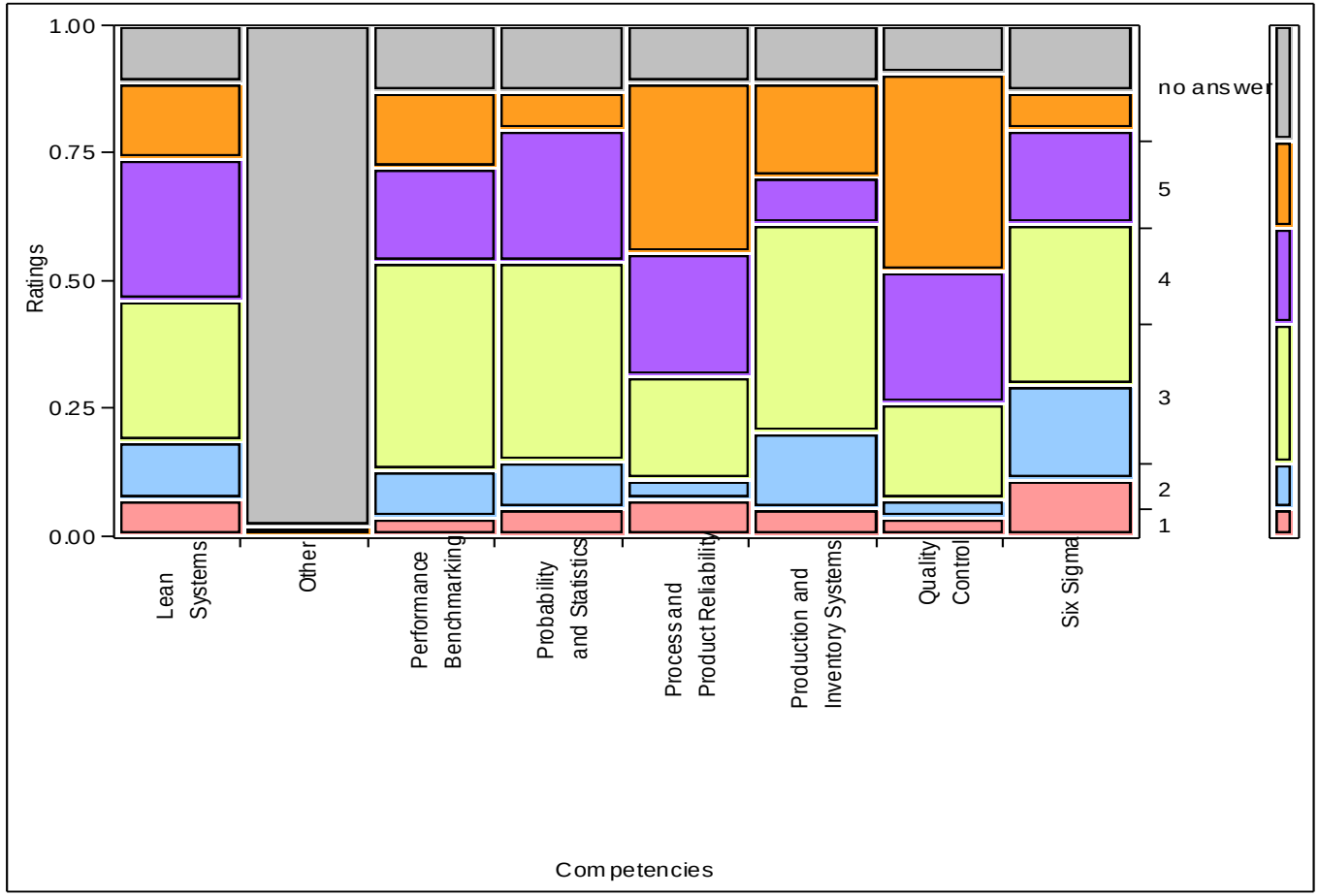


Figure 6. Quality Competencies

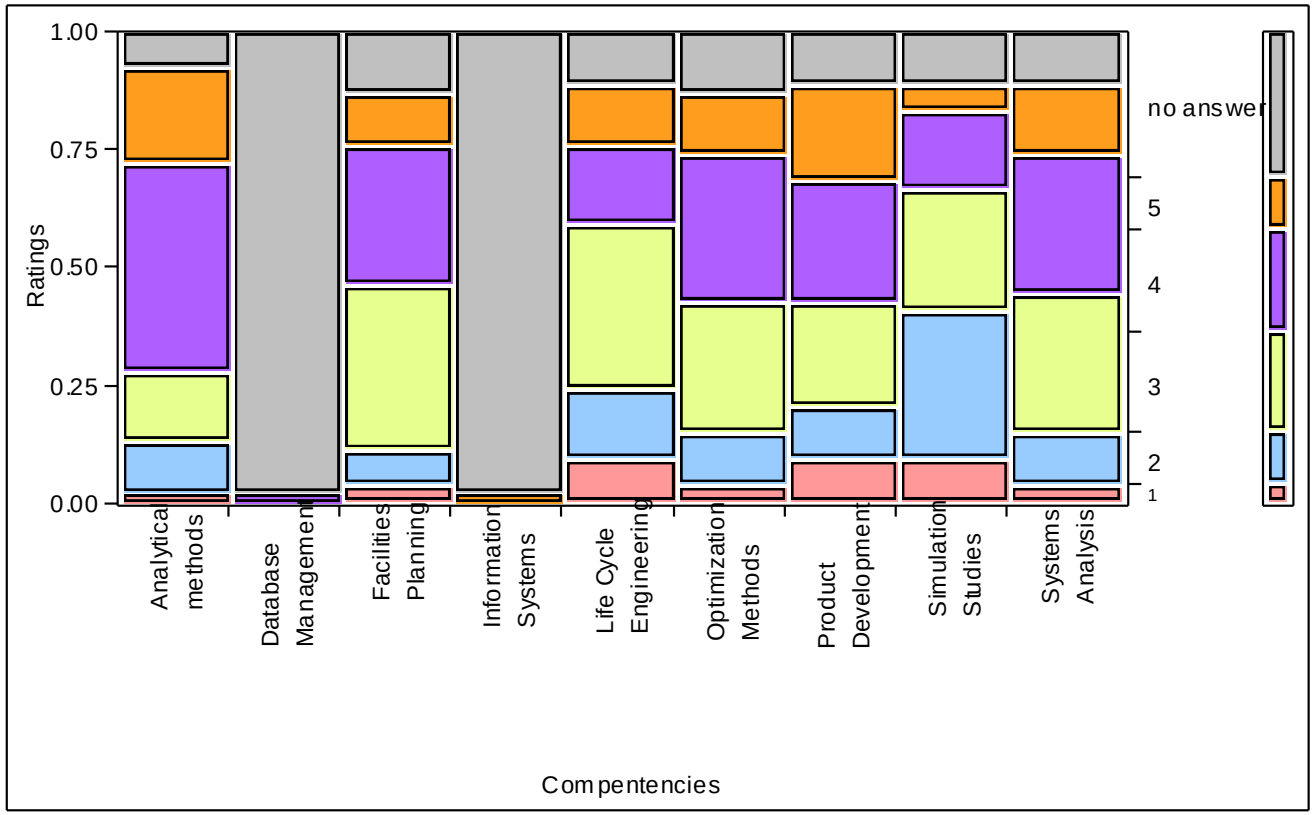


Figure 7. Technical Competencies

Several conclusions can be made from the figures:

1) Management

- ✓ As shown from the table, the managers ranked decision making and analysis and leadership skills as the top competencies in management.

2) Financial

- ✓ Of the subtopics under the financial competency, several ranked as most important: engineering economy, financial management, product development, and risk management. The subtopics of new venture formation and enterprise integration received the least rankings of a 5.

3) Human Factors

- ✓ Under the competency of Human Factors, Safety Issues earned the most important ranking. Conflict Resolution/People Skills and Legal and Ethical Perspectives were also ranked fairly high. Most notably, the subtopics of accountability and quality assurance received little to no answers.

4) Quality

- ✓ The subtopics of Quality Control and Process and Product Reliability received the most votes of a number five ranking under the core competency of Quality.

5) Technical

- ✓ The highest ranked Technical subtopics were analytical methods and product development.

Obviously, all of the highest ranked topics should be compared to the current Table of Contents and addressed in the online Engineering

Management Handbook, if the topic is not already listed. It is important to analyze the survey in another way by looking at the average ranking of each topic. This will assist in determining exactly what issues engineering managers are dealing with in today's world and what the managers might need to reference in the online handbook.

For the management competency, Table 2 shows the average ranking of each of the subtopics as well as the average ranking of the core competency. For the financial competency, Table 3 shows the average ranking of each of the subtopics as well as the average ranking of the core competency. For the human factors competency, Table 4 shows the average ranking of each of the subtopics as well as the average ranking of the core competency. For the quality competency, Table 5 shows the average ranking of each of the subtopics as well as the average ranking of the core competency. For the technical competency, Table 6 shows the average ranking of each of the subtopics as well as the average ranking of the core competency.

A list of all the topics, regardless of core competency that received an average ranking of 4 or 5 are as follows: information systems, database management, quality control, conflict resolution/people skills, quality assurance, safety issues, communication, decision making/analysis, how to handle and resolve conflicts, leadership skills, and project management. The responses in the survey are beneficial when determining the contents of the online handbook. In the conclusions portion of this paper, Table 8 shows a summary of this survey's topics compared to other survey results.

Table 3. Average Ranking of Management Topics

Average of Ratings	
Competencies	Total
Acquisition Logistics	4.0
Communication	4.0
Decision Making and Analysis	4.3
Engineering Mgmt.	3.9
Handling Employee Problems	4.0
How to Handle and Resolve Conflict	5.0
Leadership Skills	4.2
Marketing Management	2.9
Project Mgmt.	4.1
Strategic Management	3.5
System Integration	4.0
Technology Transfer	3.3
Grand Total	3.8

Table 4. Average Ranking of Financial Topics

Average of Ratings	
Competencies	Total
Accounting	3.0
Engineering Economy	3.5
Enterprise Integration	2.7
Financial Management	3.7
New Venture Formation	2.7
Product Development	3.3
Risk Management	3.4
Value Management and Analysis	3.4
Grand Total	3.2

Table 5. Average Ranking of Human Factors Topics

Average of Ratings	
Competencies	Total
Accountability	5.0
Conflict Resolution/People Skills	4.0
Diversity Issues	2.9
Labor Relations	3.4
Legal and Ethical Perspectives	3.8
Management of Technology	3.5
Managing Change	3.7
Organizational Behavior	3.6
Quality Assurance	5.0
Safety Issues	4.0
Grand Total	3.6

Table 6. Average Ranking of Quality Topics

Average of Ratings	
Competencies	Total
Lean Systems	3.4
Other	5.0
Performance Benchmarking	3.4
Probability and Statistics	3.2
Process and Product Reliability	3.8
Production and Inventory Systems	3.2
Quality Control	4.0
Six Sigma	2.9
Grand Total	3.4

Table 7. Average Ranking of Technical Topics

Average of Ratings	
Compentencies	Total
Analytical methods	3.8
Database Management	4.0
Facilities Planning	3.4
Information Systems	5.0
Life Cycle Engineering	3.1
Optimization Methods	3.4
Product Development	3.4
Simulation Studies	2.8
Systems Analysis	3.5
Grand Total	3.3

Table 8. Literature Search Summary Table

Topics					
Accounting for Engineers		X	X		
Applied OR/Production and Operations Mgmt.	X	X		X	X
Artificial Intelligence/Human Learning	X				
Business Planning (1)	X		X		
CAE/CAD/CIM	X				
Capstone (2)		X			
Cost Estimation	X				
Design of Experiments (1)	X				
Engineering Economy	X	X	X	X	X
Engineering Management (2)		X			
Environmental Management	X				
Ethical Issues	X				
Facilities Design (4)				X	X
Generic Useful Resources	X				
Human Factors (3)			X	X	X
Industrial Engineering Function (4)				X	X
Information Systems Management	X		X		
Innovation and Creativity	X		X		
Knowledge Management					
Legal Issues			X		
Logistics Management	X				X
Mgmt. of Tech. and Tech. Professionals	X		X	X	
Management Theory (2)		X			
Organizational Behavior (2)		X			
Organizational Design	X			X	X
Planning and Scheduling (1)	X			X	X
Product (Hardware/Software) Design&Development	X		X		X
Product (Hardware/Software) Testing	X				
Production and Manufacturing (3)			X	X	X
Productivity&Performance Measurement	X			X	X
Project Management	X	X	X		X
Quality Assurance	X	X		X	X
Reliability and Maintainability	X		X		
Research and Development	X				
Risk Management	X				
Sensitivity Analysis					
Simulation (2)			X		X
Statistics (2)		X	X		X
Systems Engineering	X	X		X	
Technical Marketing	X		X		
Technology (5)					X
	Capstone & Thesis Topics	EM Book of Knowledge	Tech. Management Handbook (Dorf)	Handbook of Industrial Engineering (1982)	Handbook of Indust.Eng.: Tech. & Oper. Mgmt.

(1) Topic was added from Capstone Research.
(2) Topic was added from EM Book of Knowledge.
(3) Topic was added from Technology Mgmt. Handbook.
(4) Topic was added from 1982 Handbook of Industrial Engineering.
(5) Topic was added from Handbook of Industrial Engineering: Technology & Operations Mgmt.

Graduate Study Survey 2007

A survey was also completed for the purpose of this paper and other graduate work at the University of Tennessee, Knoxville. The survey can be found in Appendix A. The purpose of this survey was to gather data from students, faculty and engineers about their familiarity and/or use of an Engineering Management Handbook. The survey was distributed to two different groups: employees at the Y-12 National Security Complex and a distribution list from the American Society for Engineering Management. They will be referred to Survey 1a and Survey 1b, respectively. Figures 8 and 9 display the demographics of the survey responses. The majority of responses from both surveys (70% or greater) had not heard of the Online Engineering Management Handbook and had never visited the site. One response on Survey 1a reported, “Good structure, thorough topical listing, but lack of content in some key areas.” Another quote about the current state of the Handbook said, “The Handbook looks like a great resource for a wide array of subjects in industry.” In order to get an idea of what field or subject in Engineering Management is important to those who responded to the survey, a question on the survey asked those who responded to list the subjects in the current Table of Contents for their top five. Figure 10 and Figure 11 show the response to this question from Survey 1a and Survey 1b, respectively. In the conclusions portion of this paper, Table 8 shows a summary of these surveys’ topics compared to other survey results.

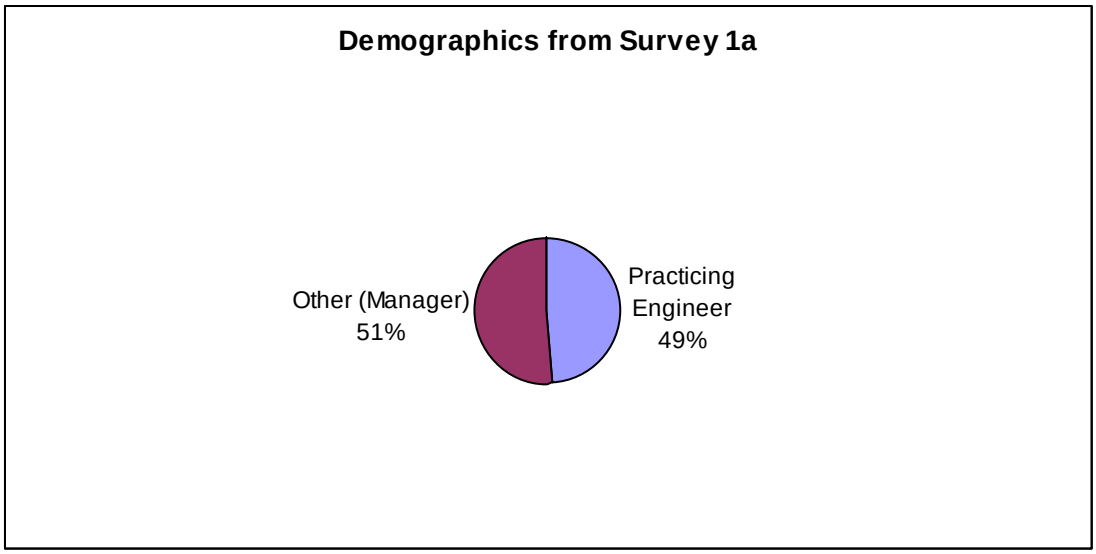


Figure 8. Demographics from Survey 1a

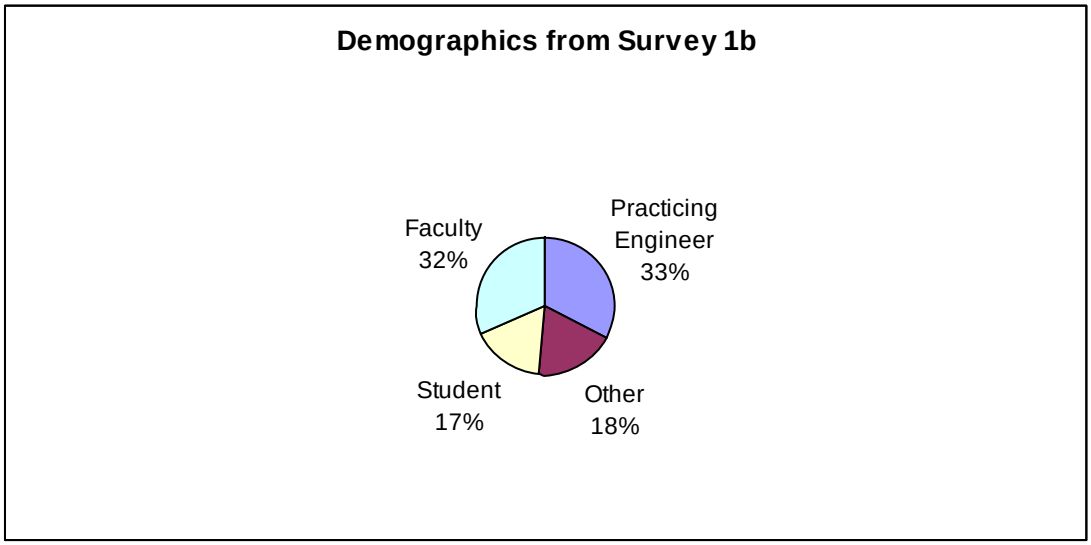


Figure 9. Demographics from Survey 1b

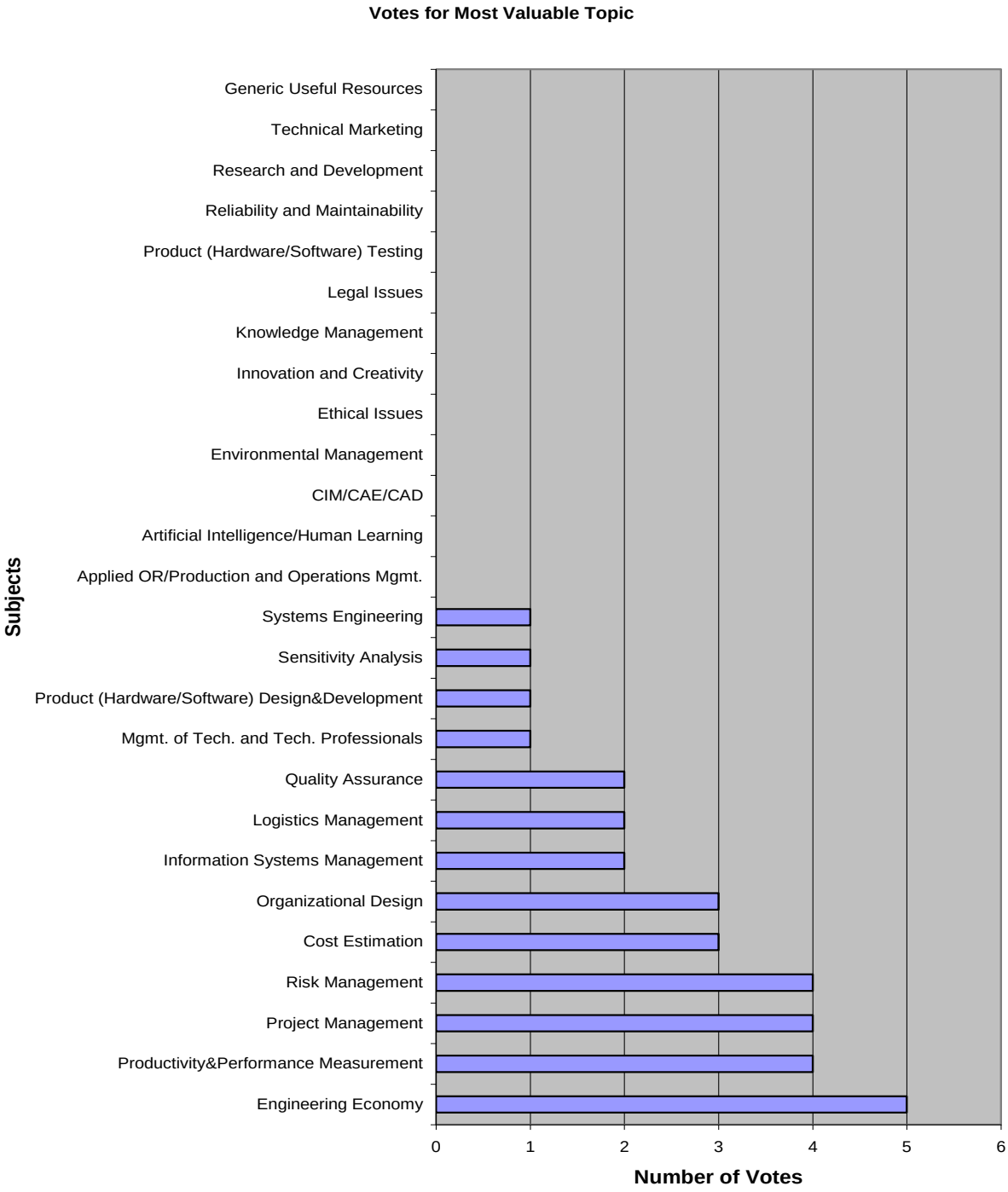


Figure 10. Top 5 Topics from Survey 1a

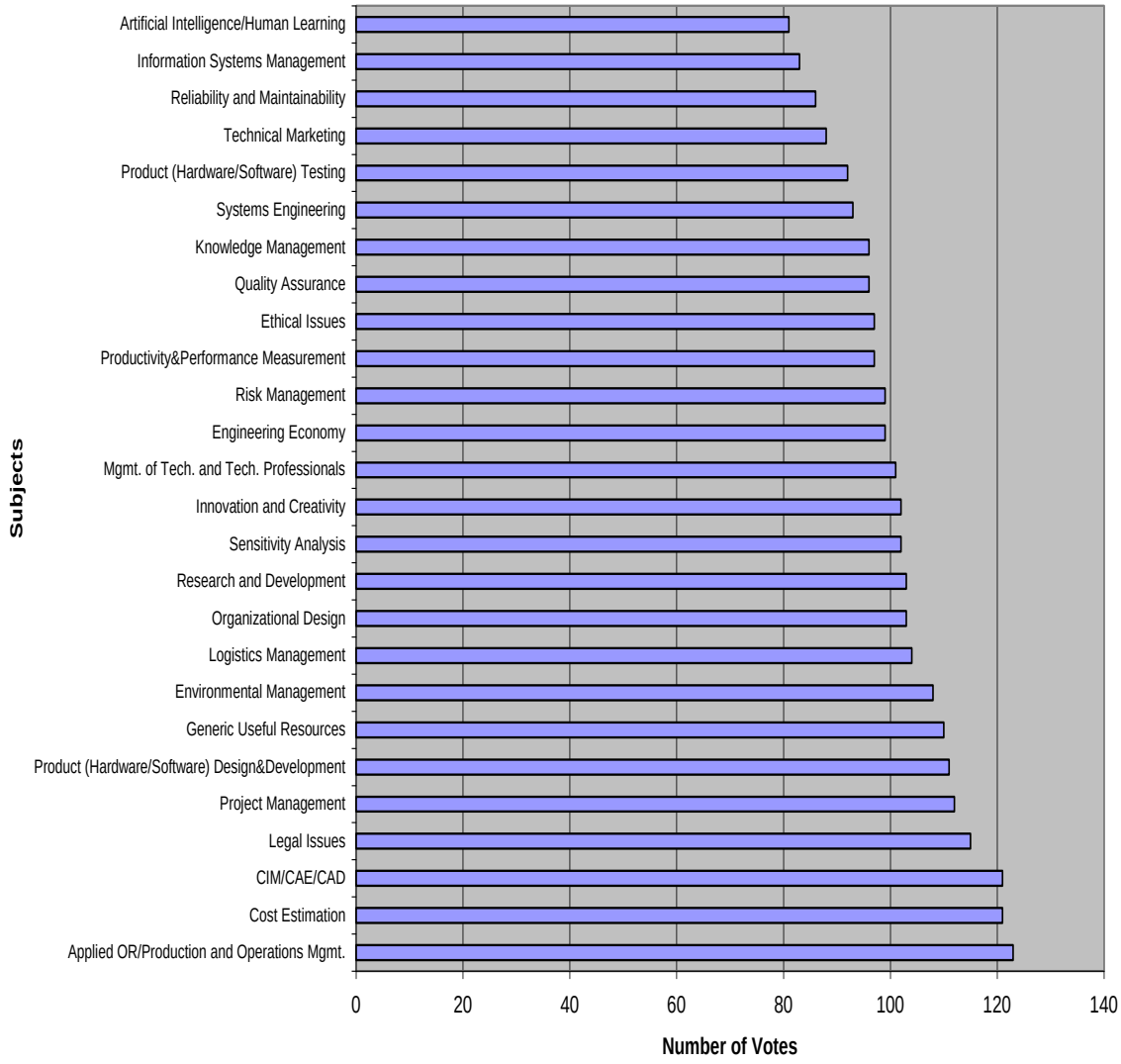


Figure 11. Top 5 Topics from Survey 1b

Conclusion

The research shows common topics in each of the surveys and previously published research. A summary of topics covered in the literature search is shown on Table 8. A summary of topics covered in the surveys is shown on Table 9. The lists of topics in the summary tables are from the current table of contents on the American Society for Engineering Management website. Topics were added to the list by the literature search. If the literature shown on the bottom of the table contained that topic, an “X” is placed in that column. For the Survey summary table, if the topic received a “vote” as a popular topic, an “X” is placed in the corresponding column. These summary tables give an overall view of what topics are relevant in today’s Engineering Management world. For example, the topic of Capstone only appeared in the Engineering Management Book of Knowledge. This does not mean that the topic is not important; the “popularity” of the topic would just not warrant its own heading in the updated table of contents. “Popularity” in this case is defined as the number of surveyors who picked that topic as one of the top five in the current table of contents in the online handbook. For example, a topic, like Project Management, which appeared in every search field except for one, would warrant its own heading in the new table of contents.

Table 9. Survey Summary Table

Topics			
Accounting for Engineers	X		X
Applied OR/Production and Operations Mgmt.			X
Artificial Intelligence/Human Learning			X
Business Planning (1)			
CAE/CAD/CIM			X
Capstone (2)			
Cost Estimation		X	X
Design of Experiments (1)			
Engineering Economy	X	X	X
Engineering Management (2)	X		
Environmental Management			X
Ethical Issues			X
Facilities Design (4)	X		
Generic Useful Resources			X
Human Factors (3)	X		
Industrial Engineering Function (4)			
Information Systems Management	X	X	X
Innovation and Creativity			X
Knowledge Management	X		X
Legal Issues	X		X
Logistics Management	X	X	X
Mgmt. of Tech. and Tech. Professionals	X	X	X
Management Theory (2)			
Organizational Behavior (2)	X		
Organizational Design		X	X
Planning and Scheduling (1)			
Product (Hardware/Software) Design&Development	X	X	X
Product (Hardware/Software) Testing			X
Production and Manufacturing (3)	X		
Productivity&Performance Measurement	X	X	X
Project Management	X	X	X
Quality Assurance	X	X	X
Reliability and Maintainability	X		X
Research and Development			X
Risk Management		X	X
Sensitivity Analysis		X	X
Simulation (2)	X		
Statistics (2)	X		
Systems Engineering	X	X	X
Technical Marketing	X		X
Technology (5)	X		
	2004 Survey	2007 Y-12 Survey	2007 ASEM Survey

(1) Topic was added from Capstone Research.
(2) Topic was added from EM Book of Knowledge.
(3) Topic was added from Technology Mgmt. Handbook.
(4) Topic was added from 1982 Handbook of Industrial Engineering.
(5) Topic was added from Handbook of Industrial Engineering: Technology & Operations Mgmt.

Based upon this literature search and the surveys, a complete and updated table of contents for the Engineering Management Handbook can be found below.

1) Engineering Economy
2) Financial Management
3) Information Systems
4) EM Knowledge Management
5) Management of Technical Professionals
6) Operations Research
7) Organizational Design
8) Product Design and Development
9) Productivity and Performance Measurement
10) Project Management
11) Quality
12) Research and Development
13) Risk Management
14) Generic Useful Resources

The recommended new Table of Contents condenses the topics from 26 topics to 14 topics. Topics were eliminated or consumed under other topics due to current research and surveys. These new topics should make it easier for the user to find what they are looking for. In addition to assisting the user, the American Society for Engineering Management will hopefully be able to assign one subject matter expert who could then find their own “delegates” to update that portion of the Handbook. Further research is recommended to establish a

more in depth subtopic listing under each of the new headings. For example, under the Engineering Economy section, a link could be established to the Association for the Advancement of Cost Engineering (www.aacei.org). This website has links for sample problems and a link to the Cost Engineering Magazine. Links like this for each heading under the new Table of Contents is recommended.

One major section that results from the survey confirmed to be missing is "what it takes to be an engineering manager." Survey results show that practicing engineers would like to see career paths, critical skills, and personal attributes that is takes to be an engineering manager. Not currently in the Table of Contents on the online Handbook, this section would most likely fit under Knowledge Management. Of course every corporation would have a different path with different qualifications of what the necessary experience is to become an engineering manager. In *Managing Engineering and Technology*, Daniel Babcock and Lucy Morse define three types of critical skills that all managers need: technical, interpersonal, and conceptual skills (11). There are also personal attributes that can be incorporated into the critical skills listed above. Good interpersonal skills are personal attributes that a good engineering manger must have. Several of these personal attributes include communication and leadership skills. Although there a techniques for teaching these types of skills, engineering managers must possess these traits in some form before they become managers.

Engineering Management is a relatively new and evolving field of study. More and more literature is becoming available on this topic. An online Engineering Management Handbook is a crucial tool to making this research available and accessible to those who use it. A more thorough, yet simplified table of contents assists the users to quickly find and use this valuable information.

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Appendix

University of Tennessee Graduate Studies Survey

The Engineering Management Handbook

The purpose of this survey is to gather anonymous data from students, faculty, and engineers about their familiarity and/or use of an Engineering Management Handbook. The data collected will be incorporated into a graduate studies thesis.

Please check the appropriate box. Are you a:

☐Full-Time Student ☐Faculty ☐Practicing Engineer

☐Other_____

If you are in Industry, do you manage:

☐ People ☐ Projects ☐ Neither

Approximate number of people or size of project (budgeted dollars, etc.)

_____

Have you ever heard of an Engineering Management Handbook?

☐ Yes ☐ No

If yes, have you ever tried to access the online version through the ASEM website?

☐ Yes ☐ No

Would you be interested in using an Engineering Management Handbook?

☐ Yes ☐ No

What is your impression of the EM Handbook in its current state? (The EM Handbook can be found under the Publications tab at www.ASEM.org.)

_____

_____

_____

Of the subjects listed in the Table of Contents in the current Handbook which five (5) do find the most valuable and feel warrant the most attention for immediate update?

_____

_____

_____

The Handbook has been brought up-to-date (in book format) in respect to the contents of each of the sections. What other features would you like to see included in a Body of Knowledge if an on-line version were offered?

For example, links to software applications that solve complex formulas related to the subjects, a question/answer area, BLOG, etc. Please provide your input and feel free to think outside of the box.

_____
_____
_____
_____
_____

For the area (or areas) you find most important, what specific types of information, articles, and papers would you like to see included in the Body of Knowledge?

_____
_____
_____

Educators and Practioners Only: Would you be willing to participate in a panel to determine if new material is worthy to be added to each area in the Table of Contents? This would require you to provide information on your background in Engineering Management and show strength through publications and/or certifications in each area for which you are reviewing submissions.

☐ Yes ☐ No

Would you be willing to submit articles, papers, tools that you have written or find valuable for review by such a panel?

☐ Yes ☐ No

Additional Comments:

_____
_____
_____

Vita

Stephanie Ann Slagle Thompson was born in Knoxville, TN, on December 21, 1980. She was raised in Farragut, TN where she attended elementary and middle school. She graduated from Farragut High School in 1999. From there, she went to the University of Tennessee, Knoxville, and received a Bachelor of Science in Industrial Engineering in 2003. In 2004, she married Brennan Thompson. She received her Masters degree in Industrial Engineering at the University of Tennessee, Knoxville in 2008. She currently works at the Y-12 National Security Complex.