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Path Forward to Design and Implement an On-going Engineering Management Handbook

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To the Graduate Council:

I am submitting herewith a thesis written by Robert B. Kring entitled "Path Forward to Design and Implement an On-going Engineering Management Handbook." 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.

<div align="right">Greg Sedrick, Major Professor</div>

We have read this thesis and recommend its acceptance:

Denise Jackson, George Garrison

<div align="right">Accepted for the Council:
Dixie L. Thompson</div>

<div align="right">Vice Provost and Dean of the Graduate School</div>

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

To the Graduate Council:

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Major Professor

We have read this thesis
and recommend its acceptance:

<u>Denise Jackson</u>

<u>George Garrison</u>

Accepted for the Council:

<u>Carolyn R. Hodges</u>

Vice Provost and
Dean of the Graduate School

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PATH FORWARD TO DESIGN AND IMPLEMENT AN ON-GOING ENGINEERING MANAGEMENT HANDBOOK

A Thesis Presented for
the Master of Science Degree

The University of Tennessee, Knoxville

Robert Byron Kring
May 2008

Abstract

The purpose of this thesis was to determine a path forward to design and implement an on-going Engineering Management Handbook. A review was performed to establish a definition of Engineering Management, the history of Engineering Management, how this history has impacted the Body of Knowledge in Engineering Management over the years, and the current state of the Engineering Management Handbook. Two surveys were performed to discover how users perceive the Handbook. It was found that there was a desire for a useful on-line EM Handbook. This research allows for decisions to be made in the future as the Handbook is updated by showing what subjects and features are most important to users, as well as the need for structure development from the beginning. The features and structure of the Handbook are proposed, along with submission guidelines. The functionality is presented through a series of examples to illustrate the use of the new Engineering Management Handbook.

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Abbreviations

EM	Engineering Management
BOK	Body of Knowledge
ASEM	American Society of Engineering Management

Chapter I

Introduction and General Information

Research Questions

This thesis will answer the primary research question: What is path forward to design and implement a current Engineering Management Handbook? Other research questions to be examined include:

- What is one definition of Engineering Management?

- What is the history of Engineering Management?

- How has this history impacted the BOK over the years?

- What is the current state of the EM Handbook?

- How do users perceive the Handbook?

- Determine the features and structure of the Handbook.

- What should be the submission guidelines for the Handbook?

- How would the new system of providing the Handbook function?

    The methodology that will be utilized to seek answers to these research questions is as follows:

- Research the history of EM.

- Provide a definition of Engineering Management.

- Study the origins of the BOK including creation of first Handbook by ASEM.

- Determine current state of the Handbook.

- Survey students, faculty, and practicing engineers.

- Formulate the content/features to be included for each subject in the Handbook.

- Establish submission guidelines for new additions to the Handbook.

- Provide a plan of design and implementation for an on-line Handbook.

- Provide examples on the use of the Handbook.

Chapter II

Literature Review

What is one definition of Engineering Management?

There has been much discussion throughout the years as to what truly defines Engineering Management. By many, Engineering Management is seen as the next logical step for engineering graduates with the pursuit of management positions in their professional careers. "Engineering management is the academic discipline which blends management expertise and engineering know-how to produce effective managers of technically educated/trained human resources, materials, financial resources, and technological assets to plan and achieve strategic organizational objectives" (Baker 1988). "The engineering 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 (or She) 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*" (Babcock, 1996).

What is the history of Engineering Management?

The concept of Engineering Management was born from a long-developed program at the Massachusetts Institute of Technology. The initial program Course XV, Engineering Administration began in 1914. It was "specially designed to train men to be competent managers of businesses that have much to do with engineering problems."

The program developed over the years to include a master's degree in management. In 1930 Course XV became an independent department. In 1938, with full funding from the Alfred P. Sloan Foundation, the program was formally named MIT Sloan Fellowship Program for Executive Development at MIT. This is when the Industrial Management field of study was born, later to be known as Engineering Management (mitsloan.mit.edu). The modern-day concepts of engineering management and academic programs have evolved from the mid-1960s (Baker, 1988). This coincides with a period of growth in the program at MIT.

Since this time many other schools have added programs in Engineering Management. One of the most notable is the University of Missouri at Rolla.   As of December 2007 there were five undergraduate degree programs accredited in the United States in Engineering Management (www.abet.org). There are also numerous graduate degree programs across the US.

How has this history impacted the Body of Knowledge over the years?

To gain insight on what has shaped the Engineering Management Body of Knowledge we need to look no further than *IEEE Transactions on Engineering Management*. An article titled <u>50 Years of Engineering Management Through the Lens of IEEE</u> Transactions, by Allen & Sosa (2004), discusses how tracing the frequency of occurrence of various topics contained in the pages of *Transactions* provides an interesting history of the field called Engineering or Technology Management. The authors researched the Tables of Contents from 1954 to 2004 and recorded all titles, authors, authors' affiliations, etc. into a spreadsheet. After this task was completed each

paper was categorized into one of eleven topical categories. These categories included Human Resources & Staffing; Strategy & Policy; Product Development, Project Management & Technical Problem Solving; Marketing; Organizational & Program Management; Technology Transfer, Technical Communication & University/Industry Relations; Organizational Structure & Issues; Planning & Control, Project Selection & Mathematical Modeling; Entrepreneurship & New Ventures; Manufacturing, CAD/CAM & Supply Chain Management; and Other.

Most of the topics are fairly evenly distributed among these categories. The two outliers noted by the authors were Marketing and Entrepreneurship & New Ventures. Entrepreneurship & New Ventures is an area that has not received much scholarly attention until recently, so its low percentage is not surprising when considering the fifty year span of articles. The low proportion of papers on Marketing was somewhat surprising to the authors, but this was attributed to the fact that most researchers into marketing issues probably find other outlets for their writings, such as business journals. The situation could also reflect the lack of concern by engineers for marketing issues in the early years of Engineering Management.

By looking back in time to subjects that have been important to the study of Engineering Management we are able to begin to understand the formation the Body of Knowledge. In order to recognize the impact of each topic or subset of topics the authors studied the number of submissions per decade. A brief explanation of their findings is below.

Planning and Control, Project Selection, and Mathematical Modeling are related in that they rely on more quantitative methods of investigation. These topics have the

highest occurrence rate of any in *Transactions* over the last fifty years. It is interesting to note that there was an early growth rate in the 1960s followed by a gradual decline to a steady lower level. This is explained by the fact that the 1960s are seen as the heyday of operations research. There was great faith in the potential contribution of quantitative methods. This reliance has been tempered with experience and over time for many engineering managers. There is, however, some resurgence in interest as old issues are being revisited using tools and theories developed in other fields.

Manufacturing, CAD/CAM, and Supply Chain Management were almost entirely absent from *Transactions* in the first three decades of publication. The 1980s brought a crisis in American manufacturing, especially with foreign competition. Japanese manufacturing strategies and techniques took center stage, and American universities revived programs in manufacturing engineering, government agencies provided support for manufacturing related research, and investigators published the results. This initial response developed into a long term commitment to manufacturing and to the relationship between manufacturing and product development.

The attention given to *Human Resources and Staffing* was at its highest in the early years of study. In the early years of *Transactions* many of the authors were from industry and government, which lends credence to the fact that these are vitally important topics to engineering managers. As authorship of articles shifted to academic sources the number of articles has decreased, which may show that not enough consideration has been given to the study of these fields in the engineering management arena.

Organizational Structure and Issues have been important to *Transactions* and to the engineering management field since the inception of both. Early submissions of

papers were made by managers, active or retired, who communicated their experience-based wisdom. The authors describe them as being quasi-theoretical in nature. As with *Human Resources and Staffing* the nature of paper submissions changed. This came as a result of wide adoption of various forms of matrix organizations. Contributors from academia gathered data and tested these earlier "theories" and practices empirically. Along with this change came a decrease in the number of submissions; however this trend has in recent years made an upturn which is viewed as a positive sign of greater attention being given to this field of study.

The emphasis on *Organizational and Major Program Management* has throughout the entire fifty years focused on documenting the experience of managing large scale complex system projects. The change to technology-based organizations and globalization has made the study of this field all the more important.

The material related to *Product Development and Project Management* covers a wide range of topics. However, its roots are in the study of engineers solving technical problems related to new product (and process) development and managing complex processes. This is the essence of Engineering Management, so it should come as no surprise that paper submissions have remained steady over the last four decades.

Technology Transfer, Technical Communications, and University/Industry Relations burst onto the stage in the 1970s. Industry and government were overwhelmed with the "information explosion." There was so much information being published in scientific journals that many were worried how to contain it. However, studies showed that engineers did not rely on this written word as much as was previously believed. In the 1990s and 2000s as downsizing began to occur interest grew again, especially in the

area of knowledge management. As seasoned employees left a company they took with them the knowledge gained over the many years of service. This continues to be an important and popular research area that interests academia and professional engineers.

Strategy and Policy has received increased emphasis of late with many business schools. The authors expected to see an increase over time in the number of papers related to this field, but for the most part the content has been consistent. The subjects have seen somewhat of an increase in last decade.

What is the current state of the EM Handbook?

The paper just discussed from *IEEE Transactions on Engineering Management* illustrated at a high-level the subjects that have been important to Engineering Management since its inception. In 1995, the American Society of Engineering Management decided to make the list of topics official. At the ASEM Annual Conference held during September of that year in Washington, D.C., an idea was presented for using the Internet as an information resource and distribution medium for what was referred to as a "virtual engineering management (EM) handbook." This virtual EM handbook, once developed, was envisioned to place a variety of EM "resources" at the ready disposal of practicing engineering managers, engineering management researchers, policy makers, and analysts (www.asem.org). Also presented at the 1995 ASEM Annual Conference was the status of prior work performed by graduate students at the University of Tennessee at Chattanooga and the Southern Methodist University. Their collective output resulted in a preliminary listing of potential EM handbook subjects that served as input for the virtual EM Handbook Table of Contents which is

listed below. This would be the first time that the Body of Knowledge would be agreed

upon and placed in handbook form (www.asem.org).

- 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

The following reasons were cited for why ASEM should take the lead in

developing a virtual EM 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 (www.asem.org).

With the groundwork laid the Handbook was created with the hopes of having the following resources for each of the topics: principles, best practices, 'how to' methodologies, lessons learned, and specialized problem-solving software tools of interest to users. Over the next five years items were added and updated for each of the subjects in the table of contents. However, by the year 2000 interest in the site even among ASEM members had waned, and no updates have been performed on the Handbook since January 11, 2000 (www.asem.org).

The idea of an Engineering Management Handbook was revisited by ASEM in 2007. For this iteration it was decided to produce the handbook in hardcopy format. The list of topics was condensed to include fifty percent less topics than the original Handbook, from twenty-six to thirteen. The complete list is below.

- ORGANIZATIONAL BEHAVIOR
- MANAGEMENT THEORY
- STATISTICS
- OPERATIONS RESEARCH
- SIMULATION
- SYSTEMS ENGINEERING
- ACCOUNTING FOR ENGINEERS
- ENGINEERING ECONOMICS
- PROJECT MANAGEMENT
- CAPSTONE
- ENGINEERING MANAGEMENT
- OPERATIONS MANAGEMENT
- QUALITY MANAGEMENT

This change may seem rather extreme, but in actuality much of the content from the original Handbook can be placed under an appropriate heading in the new Handbook. There do seem to be some omissions, intentional or not, that were made when updating

the Handbook. Topics such as Artificial Intelligence/Human Learning; Environmental Management; Ethical Issues; Information Systems Management; Innovation and Creativity; Legal Issues, Product Design, Development, and Testing; and Research and Development do not easily correspond to one of the new content headings.

It is important to understand what contents should be included as the Handbook is revised once again and a new system is devised to create an on-line Handbook. It is logical to assume that a "wholesale" update cannot occur for every topic in a short period of time. It must be determined what subjects are most important to potential users of the Handbook, so that updates can be made on topics that are of most interest or necessity.

Summary

Up to this point the focus has been on the past, i.e., the history of Engineering Management and the Engineering Management Handbook itself. The present, and more importantly the future of the EM Handbook are now to be the focus. The current state of the Handbook must be discovered, along with a detailed plan for the future.

Chapter III

Methodology

How do users perceive the Handbook?

Two surveys were used to determine what subjects were most important to be updated, the use rate of the current on-line Handbook, the interest in the Handbook, what new features should be added, and finally to discover how much interest there was from educators and practicing engineers in participating as a submitter or subject matter expert. The first survey was conducted by the University of Tennessee Chattanooga when that school was analyzing which subjects to focus on in a new distance learning Engineering Management program. It had a total of fifty-four responses. Respondents were asked to rate a list of competencies from 1-5, with the importance level being low at 1 and high at 5 in the study of Engineering Management. The forty-four competencies selected were divided under 5 headings: Management, Financial, Human Factors, Quality, and Technical. The second survey was conducted specifically for this thesis paper. It had a total of five hundred and twenty-three responses from a broad spectrum of people interested in Engineering Management.

An interview was also conducted with Dr. Greg Sedrick, currently Program Director of the University of Tennessee Engineering Management Program to examine his views of the Handbook. Dr. Sedrick proposed the original online Handbook to ASEM and led the original topical research. It was felt that he would be able to provide both a historical and current perspective on the professional needs of the Handbook. It

was especially important to understand what guidelines had been set during the creation

of the Handbook and his perception of its current state.

Chapter IV

Findings

How do users perceive the Handbook?

The first survey results presented are those from the survey conducted by the University of Tennessee, Chattanooga. Figure 1, below, shows the top five competencies with the greatest sum of ratings, i.e., adding the weights given by each participant for a specific competency. In order to determine how this affects the eventual update to the online Handbook it must be understood where these competencies fall in the current list of thirteen subject areas. The one that is easiest to associate then is Project Management, since this is one of the major items addressed in the current handbook. The others, however, would be listed as sub-topics under a major heading. The other four competencies could apply to Project Management, Engineering Management, Management Theory, or Organizational Behavior.

Figure 2 shows the top five competencies that were rated at the top score of 5. Again, we see Decision Making and Analysis, Leadership Skills, and Safety Issues. But we have also added Process and Product Reliability and Quality Control. In regards to major items addressed in the current Handbook, Operations Management and Quality Control should be added to the list.

The final set of data, Figure 3, provided is much like the last. Each shows the top five competencies by rating. Along with what has been learned from the previous charts and with these charts, a course can be set in updating the Handbook in an online format.
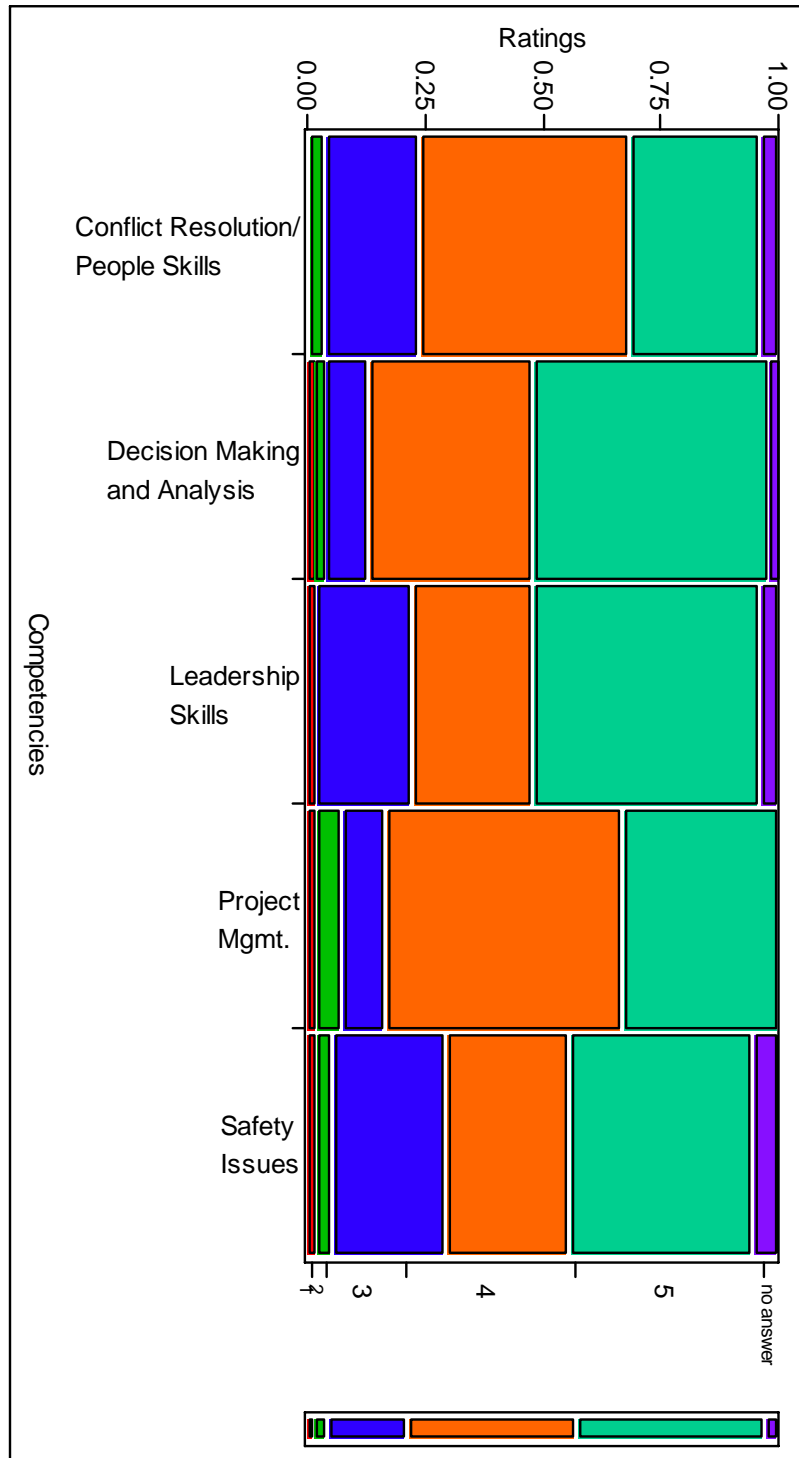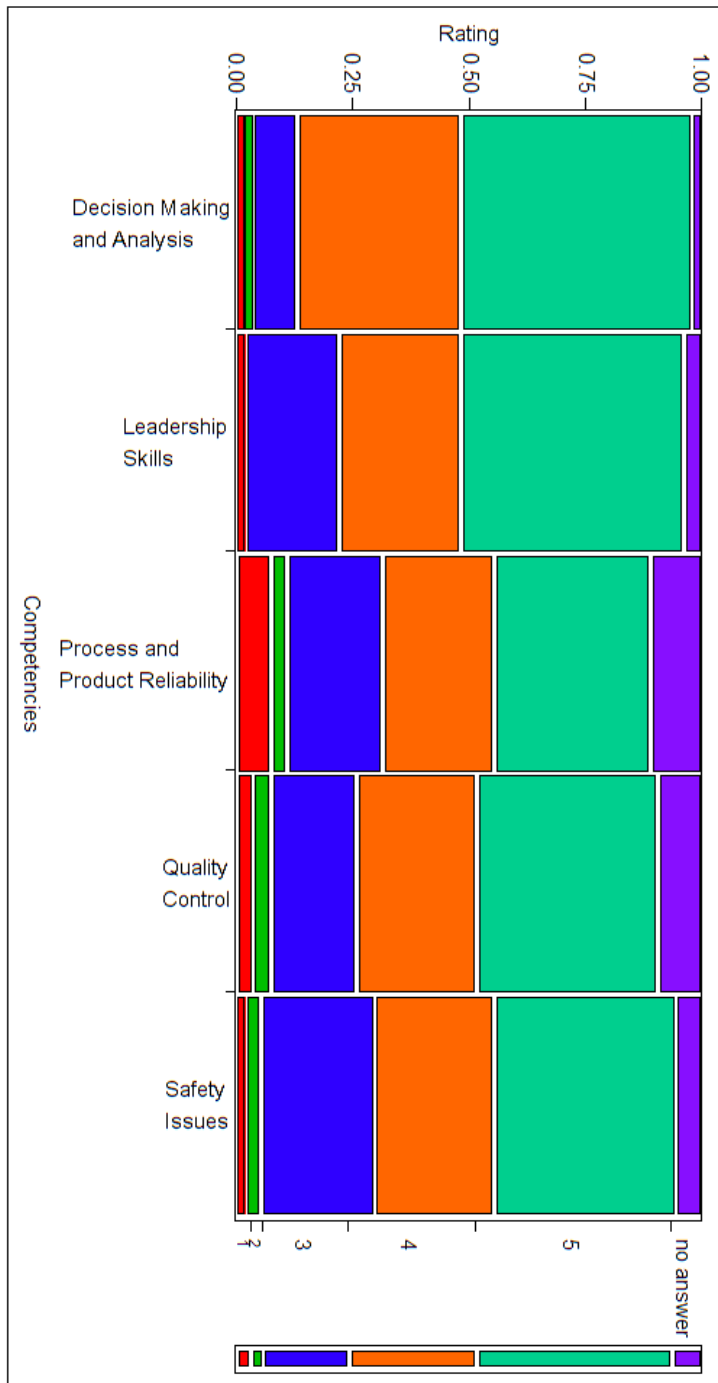
Figure 1 - Top 5 Competencies with Greatest Sum of Ratings

Figure 2 - Top 5 Competencies with Greatest Sum of Ratings

Top Competencies Rated 5	
Decision Making Analysis	27
Leadership Skills	26
Quality Control	21
Safety Issues	21
Process and Product Reliability	18

Top Competencies Rated 4	
Project Management	27
Financial Management	27
Conflict Resolution/People Skills	24
Analytical Methods	24
Managing Change	22

Top Competencies Rated 3	
Diversity Issues	23
Technology Transfer	22
Performance Benchmarking	22
Production and Inventory Systems	22
Probability and Statistics	21

Top Competencies Rated 2	
Simulation Studies	17
New Venture Formation	12
Enterprise Integration	12
Accounting	11
Six Sigma	10

Top Competencies Rated 1	
New Venture Formation	10
Marketing Management	9
Enterprise Integration	7
Product Development-Financial	7
Accounting	6

Figure 3 - Top Competencies by Rating

It can be gleaned from the results which topics should be addressed at the onset of the project and which could be delayed, with the understanding that there is not infinite time available at the beginning and some topics will be updated later than others.

As a final point, it is interesting to note that 98% of survey respondents did not rate the following competencies: Acquisition Logistics, Communication, Database Management, Handling Employee Problems, System Integration, Accountability, How to Handle and Resolve Conflict, Information Systems, and Quality Assurance. It is difficult to determine how to handle this situation. There appears to be two choices. The topics should not be included in the Handbook, either as subjects or sub-topics, due to the fact that there is little interest. Or conversely, the topics are not well understood and therefore valued, so more information should be provided in the Handbook. This however, would be a decision for those determining the content of the Handbook and should not affect its initial update in online form.

A second survey was compiled and sent to a five hundred and twenty-three full-time students, faculty, and practicing engineers; there was also an allowance made for those who felt they did not fit into any of the categories listed and space for explanation. The complete survey can be found in the Appendix. The responses shed light on some of the key questions related to the development of an online handbook. Selected results are also graphically presented in the figures below.

The first questions of the survey addressed demographics of the respondents. Thirty-three percent were practicing engineers, thirty-two percent were faculty, seventeen percent were full-time students, and eighteen percent did not feel that they fit into any of the categories and selected "other." When asked about the number of people or size of

project managed, approximately 67% of the respondents answered with zero for either category. This is explained by the percentage of people that responded as faculty, full-time students, and other. Approximately 16% of the respondents answered that they managed people, with an average of 263 people and a median of 278 people. This number ranged from 4 to 476 people. Approximately 18% of the respondents answered that they managed money, with an average of $19.34M and a median of $14.45M. The average is higher due to one outlier of $295M. The survey group appears to be an appropriate cross-section for interest in an Engineering Management Handbook.

It is interesting to note that only 31% of the respondents had heard of the Engineering Handbook. Of those who had heard of the Handbook only 15% answered "Yes" to having ever accessed it. An answer of "No" was given for 16% of the respondents, and 69% provided no answer. If we assume that those that did not answer had also never accessed the site the percentage is increased to 85%. The survey also asked whether there was interest in using the Handbook. This was nearly a 50-50 split. One should keep in mind that the survey respondents were only able to view the current Handbook, which has not been updated in nearly a decade. With this in mind respondents were asked their opinion of the current state of the Handbook on ASEM.org. Only 20% responded that it is fine as it is. Nearly 37% said that the Handbook at least needs updating or further needs to be trashed and started over. Twenty-two percent said that the Handbook is irrelevant to the needs of the respondents. This is an important statistic, and should bring awareness to the need to change. When we combine these three categories we see that nearly 59% of respondents would potentially find the Handbook more valuable if it were brought up-to-date and made more useful.

To better gage the results discussed in the previous section the data was separated by the type of respondent, i.e., Full-time students, Faculty, Practicing Engineers, and Other. The results were relatively even for the question, "Have you ever heard of an Engineering Management Handbook?" Approximately 32% of Students, 33% of Faculty, 30% of Practicing Engineers, and 26% of others had heard of the Engineering Management Handbook. When asked if they had ever accessed the Handbook before 62% of Full-Time Students responded that they had. The results for the other three groups were in the 45% range. Another question addressed if there was interest in using the Handbook. The responses for Full-time Students, Practicing Engineers, and others hovered around the 50% mark. It is most interesting to see that only 13% of Faculty said they had an interest in using the EM Handbook. Finally, the data on the respondents' impression of the Handbook was analyzed. A majority of Full-time students felt the Handbook needed to be updated. Similarly, the majority of Practicing Engineers felt the Handbook was irrelevant to their needs. This shows a need for the Handbook to evolve since these two groups showed the most interest in using the Engineering Management Handbook.

The next section of the survey addressed issues related to this change in the Handbook. Respondents were asked to assess which five topics currently found on the ASEM.org website Handbook they found most valuable and warranted the most attention during an update. The top five choices in weighted order were Applied Operations Research/Production and Operations Management, Cost Estimation, Legal Issues, Project Management, and Product (Hardware/Software) Design and Development. Similar to the survey presented earlier, this should assist in setting priorities as an update is performed.

The final section of the survey was presented to gage respondents' interest in being an integral part of updating the Handbook. When asked nearly 50% said they were willing to participate in a panel to determine if new material is worthy to be added to each area in the Table of Contents. They were informed that this would require them to provide information on their background in Engineering Management and show strength through publications and/or certifications in each area for which they would review submissions. Finally it was asked if they would be willing to submit articles, papers, or tools that they have written or find valuable for review by the panel described earlier. Thirty-two percent responded that they would be willing to do this.

The results for this second survey are presented graphically in Figures 4-9 in the order that they were discussed. This survey exhibits the need to recapture interest in the Engineering Management Handbook. The need is present for those in Engineering Management related positions whether it be students, faculty, or engineer practitioners. Both potential users and participants seem ready and willing for this change to occur.
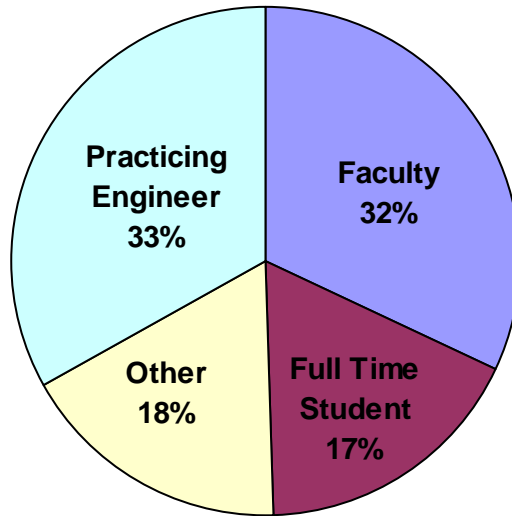
Figure 4 – Titles of Respondents
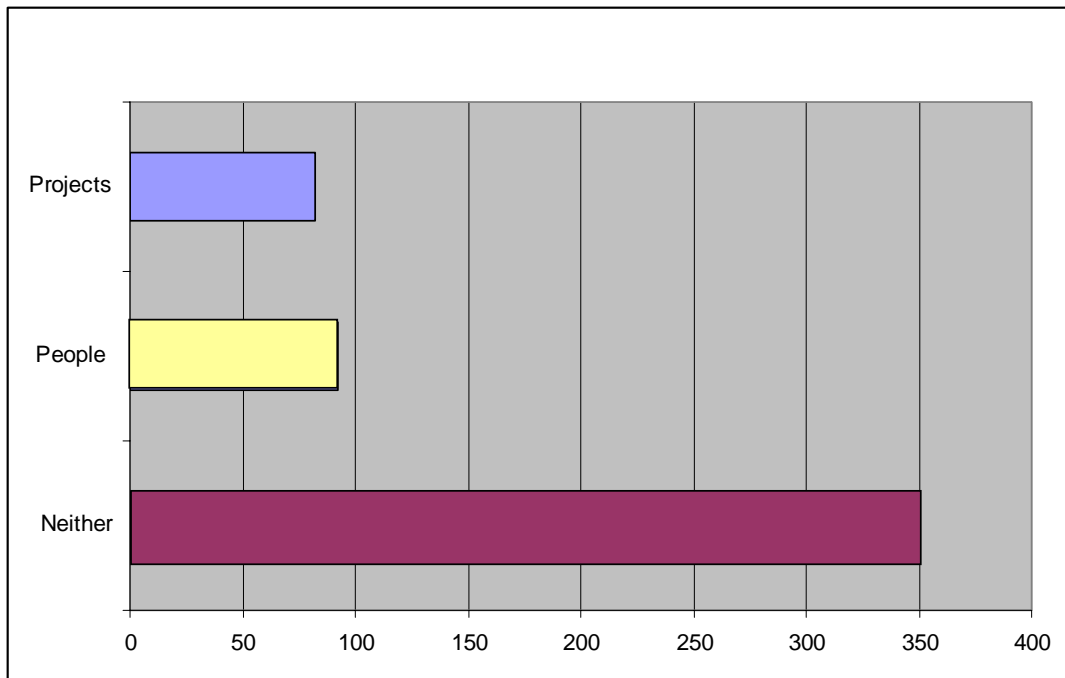
Figure 5 – In Industry, Who or What is Managed.
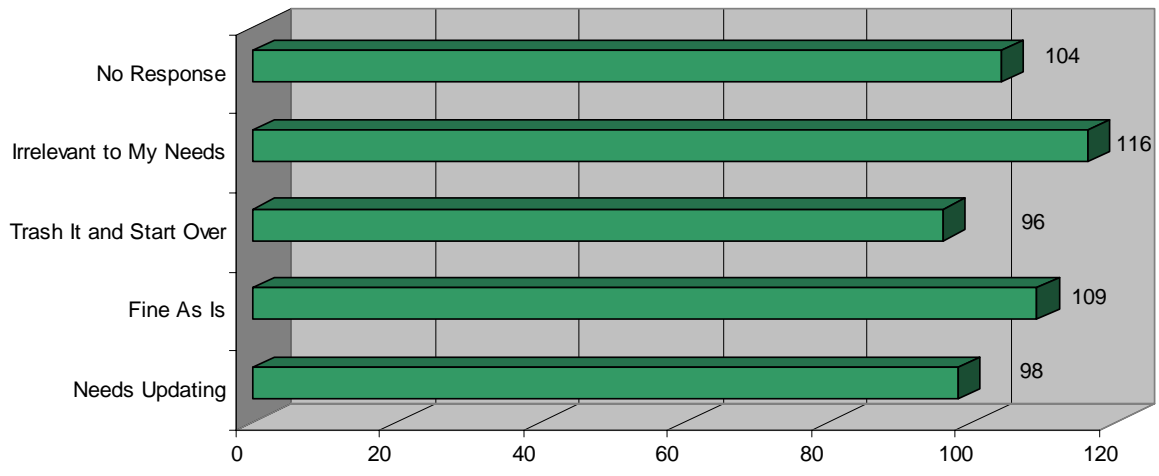
Figure 6 – Impression of EM Handbook in Current State

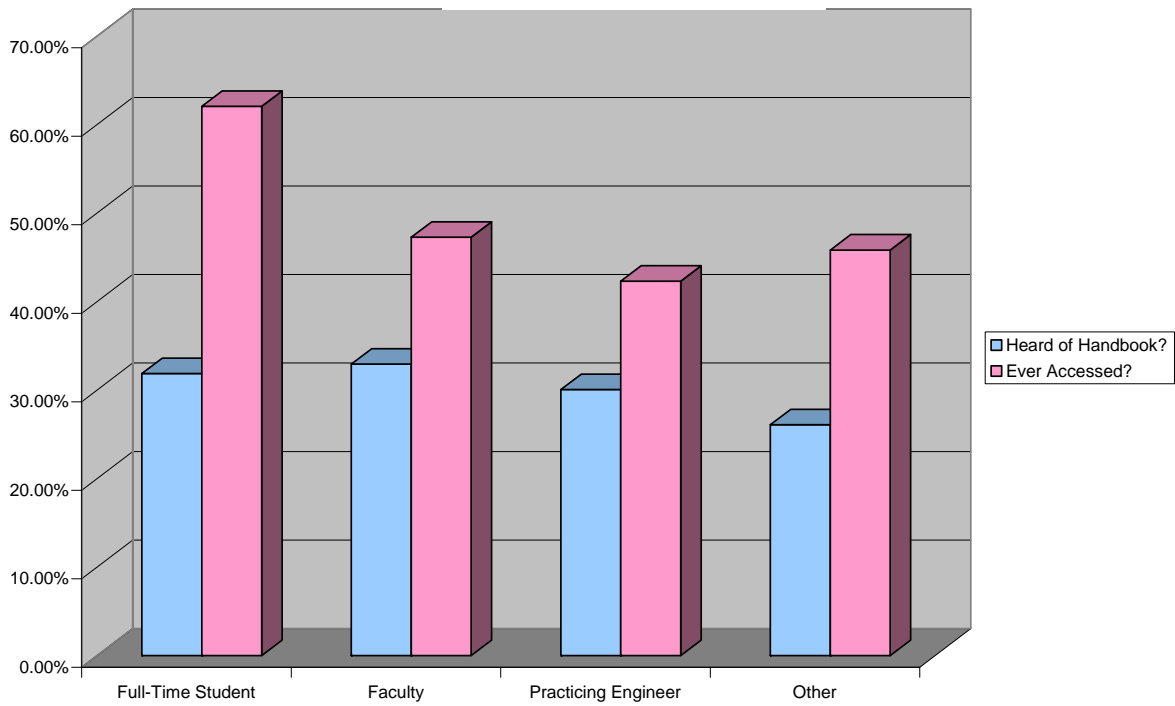**Figure 7 – Handbook Usage by Group**
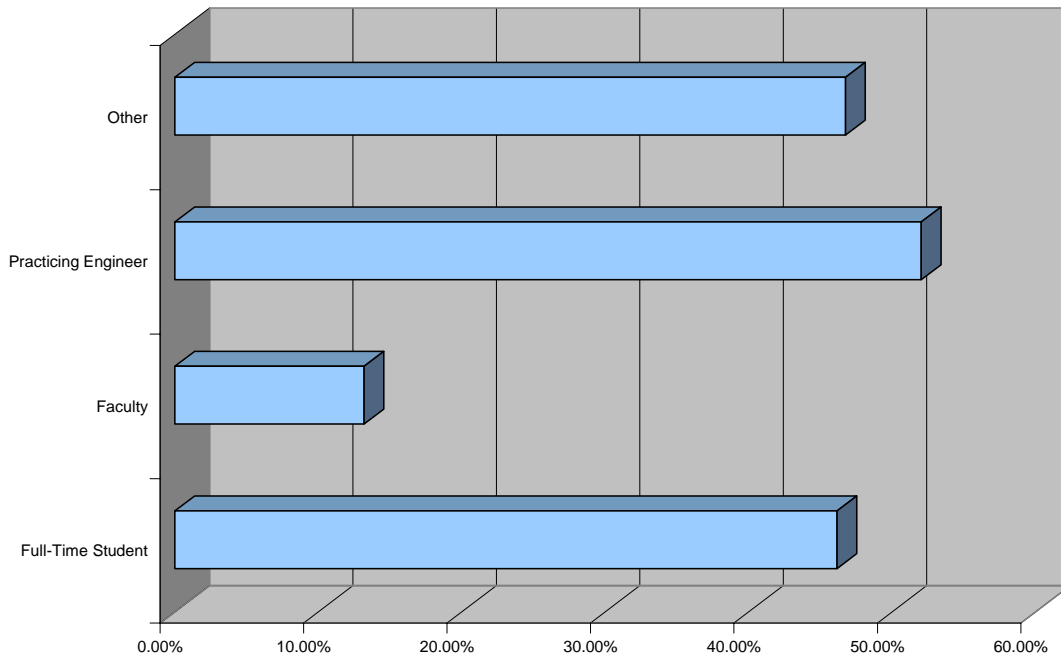
Figure 8 – Handbook Interest by Group
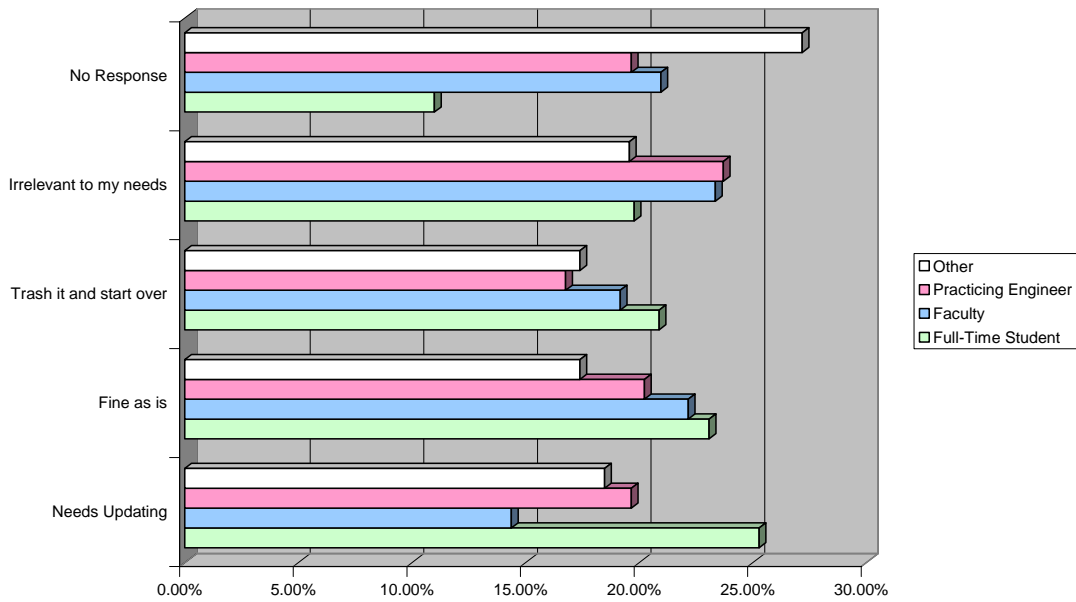
Figure 9 – Impression of Handbook by Group

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An interview with Dr. Greg Sedrick was performed in early January of 2008 and follow-up questions were asked on February 14, 2008. It was learned that the Handbook itself had simply evolved over time. No formal guidelines had been set for what it included or how it was structured. With the information gathered from the surveys along with this testimony the next step is to formulate features and structure of the Handbook.

Chapter V

Results and Discussion

Determine the features and structure of the Handbook

The projected online format of the Handbook lends itself to almost limitless possibilities of content. However, in order to be relevant and useful the amount of content must not be overwhelming, must be managed and be easily accessible, and must be useful to a high percentage of users. The idea is not to create a vast dumping ground of information, but to construct an online Handbook that can be "the source" of information pertaining to Engineering Management.

Below is a suggested list of contents/features to be included:

- History and Background

- General Information

- Theory/Opinion/Insight

- Current Issues or Industry Uses

- Tools

- Streaming Video

- Ask the Expert(s)

- Frequently Asked Questions

- Links to Google Books

- General Discussion Board

- E-mailed updates

History and Background – This section would have articles, papers, etc. (for ease of writing and reading these will be called pieces hence forth) that discuss the history of each subject. This would include pieces written about key figures in the creation or study of the subject.

General Information – This section would include pieces such as "What is …?" with the subject area filled in. Pieces that define the topic being addressed or provide the basis of the subject would be included here.

Theory/Opinion/Insight – This section would be reserved for pieces that clearly have a bias or have ideas or concepts that are not generally accepted by the approved Subject Matter Experts (SMEs – to be discussed later). Pieces on new theories or models for the subject would be in this section. This section would require review on a periodic basis to ensure significance. This is especially true as some opinion and theory becomes accepted by a majority and would then be found in *History and Background* or *General Information*.

Current Issues or Industry Uses – This section would by and large include pieces written and submitted by practicing engineers. Allowances would be made for faculty with strong ties to current issues or industry through research work they perform. This section would also require review for determination of relevance, probably more often than the section above.

Tools – The content of this section would be somewhat broader and varied than that in the sections above. Applications for solving problems related the subject would be found in this section. Many of these applications exist on-line, so links would be provided for the user. An example of a tool such as this will be provided in the Use of

the Handbook section of this paper. Information on useful software packages and "How To" guides would also be found in this section.

Streaming Video – Streaming video is becoming commonplace on the internet and with its users. The popularity of sites such as YouTube illustrates this fact. In March of 2004 ASEM discussed creating a certification for Engineering Management. Included in this discussion was the use of video clips provided by subject matter experts. Video clips such as these would be provided in streaming format. The video clips would encompass sub-topics within a subject area. Another source of video clips could be universities with ASEM affiliations. Many are now using online courses for their master's programs. Short clips from classes discussing sub-topics could be edited from the full class videos for inclusion in the Handbook with the approval or at the direction of the SME's for that section.

Ask the Expert(s) Section – The title of this area of the Handbook is self explanatory. This would be a tool for anyone to submit a question to be answered by the agreed upon SME's for each subject area. This feature would give ASEM insight into what subject areas or topics are missing. In order to be useful the questions would need to be answered in less than one month's time, with allowances made for holidays and special events like the ASEM annual conference.

Frequently Asked Questions – This section would build upon the content in "Ask the Expert(s)" section. Questions deemed relevant to a wide audience in Engineering Management would be listed with both the question and the provided answer. This feature would also reduce redundancy in the type of questions being asked. Answers to

questions would obviously be timelier for the user, since the wait time decreases from approximately one month to instantly.

*Links to **Google Books***, *etc.* – Google Books is an online resource that allows users to quickly search and find books related to topics that interest them. When a search is initiated on a specific topic the search engine returns results for related books. At a minimum basic bibliographic information is provided and in some cases full books are provided in PDF. There are also links to online libraries/stores where books can be borrowed or purchased. The SME's for each subject area would search Google Books for books that add value to their section. Links would be provided with a brief explanation of why the book is being recommended.

General Discussion Board – a discussion board would also be included on the website for the Handbook. Those seeking information and those with information would interact in an informal environment, therefore answers to questions in this area would not necessarily be provided by the approved SME's. General discussions about topics would also occur in this area. Posts on the board could be a first step in getting an article or idea included in the handbook by allowing users to "test the water" so to speak with Handbook users before making the request to the SME's. The discussion board would require that users register with ASEM with name and e-mail address at a minimum and enter a validation code to discourage comment spam on the site.

E-mailed Updates – users of the Handbook would have the option of registering with ASEM. When updates to the site occurred, system generated e-mails would be sent to users. Users would have the option to receive updates for only those subject areas that

interested them. This feature would also remind users to keep using the site and show that it is dynamic and always changing and growing to meet the needs to its users.

What should be the submission guidelines for the Handbook?

In order to ensure that the Handbook has the most up-to-date and relevant information, a list of guidelines and procedures would need to be implemented. Submissions include contents and features listed above, such as articles, papers, tools, and streaming videos. A review of submission guidelines for Wikipedia was performed, since the mission of the site is similar to that of the new EM Handbook: Information sharing (http://en.wikipedia.org/wiki/Wikipedia:Your_first_article). Wikipedia focuses on three main areas for submissions: Search Wikipedia first, gather references, and the neutrality of submissions. The first two Wikipedia guidelines were integrated into the submission guidelines of the Handbook. The third, however, was too limiting in the area of Theory/Opinion/Insight and Current Issues/Industry Issues.   In these two areas neutrality cannot be expected. In the other subject areas, such as General Information, the SME's would be responsible for ensuring the submission was not biased. Final determination would be made by the panel. Below are the guidelines for submission.

- Each time a submission is proposed the submitter would be asked to verify that a thorough search of the Handbook has been performed to ensure that the new submission does not duplicate information already contained in the Handbook.

- Each submission would be reviewed by a panel of Subject Matter Experts (SME's) determined by the ASEM Oversight Committee to have authority to review in each subject area. For instance, an educator or practitioner specializing

in Organizational Behavior would submit their name and information for consideration as a reviewer of possible new additions to the Handbook. Once a core group for each subject is established this group would have reviewing authority for each section and might also assist the committee in finding other reviewers in the field.

- Each submission must apply to at least one of the content areas of the Handbook. Submissions that apply to multiple areas would be included so long as each group of SME's approves its use in a section.

- Each submission that relies on others research must include citations. Sources will be verified by the panel of SME's. Submissions that contain incomplete citations and/or do not cite reliable sources will not be included in the handbook.

- Papers and articles with information removed for proprietary reasons would not be accepted, since the lack of certain information could hinder its usefulness to a broad audience.

- Promotional information or advertising of specific products would not be included. For example, under the Quality Management or Statistics sections links to the Minitab website would not be included. However, a paper or article on the unbiased usefulness, capabilities, and application of the software in industry would be included. Papers or articles that compare such applications and give unbiased assessments would also be included. Again, judgment will fall with the group of SME's.

Figure 10 gives a representation of how the Submission page in the Handbook would appear. Figure 11 is a flow chart that illustrates how the entire process would work.

Submission Page

Below you can upload a file for submission to the EM Handbook. Please note that we can only accept Microsoft Word and PDF files at this time. If you are submitting a tool, streaming video link, or a Google Book link, please place these in a Word or PDF file for review by our panel of SME's. Also, please review the submission guidelines below.

After your upload is complete you will be asked to enter contact information, so that we can contact you if there are issues with your submission.

Upload File

Note that the following illegal filename characters will be removed from uploaded files:\ / : " ? " " < > |

File: [   ] [Browse...]

[Upload] [Cancel]

- Verify that you have thoroughly searched the Handbook to ensure that your submission does not duplicate information already contained in the Handbook.
- Each submission will be reviewed by a panel of Subject Matter Experts (SME's) determined by the ASEM Oversight Committee to have authority to review in each subject area.
- Each submission that relies on others research must include citations. Sources will be verified by the panel of SME's. Submissions that contain incomplete citations and/or do not cite reliable sources will not be included in the handbook.
- Papers and articles with information removed for proprietary reasons will not be accepted, since the lack of certain information could hinder its usefulness to a broad audience.
- Promotional information or advertising of specific products will not be included. However, a paper or article on the unbiased usefulness, capabilities, and application of the software in industry would be included. Papers or articles that compare such applications and give unbiased assessments would also be included. Again, judgment will fall with the group of SME's.

Figure 10 - EM Handbook Submission Page
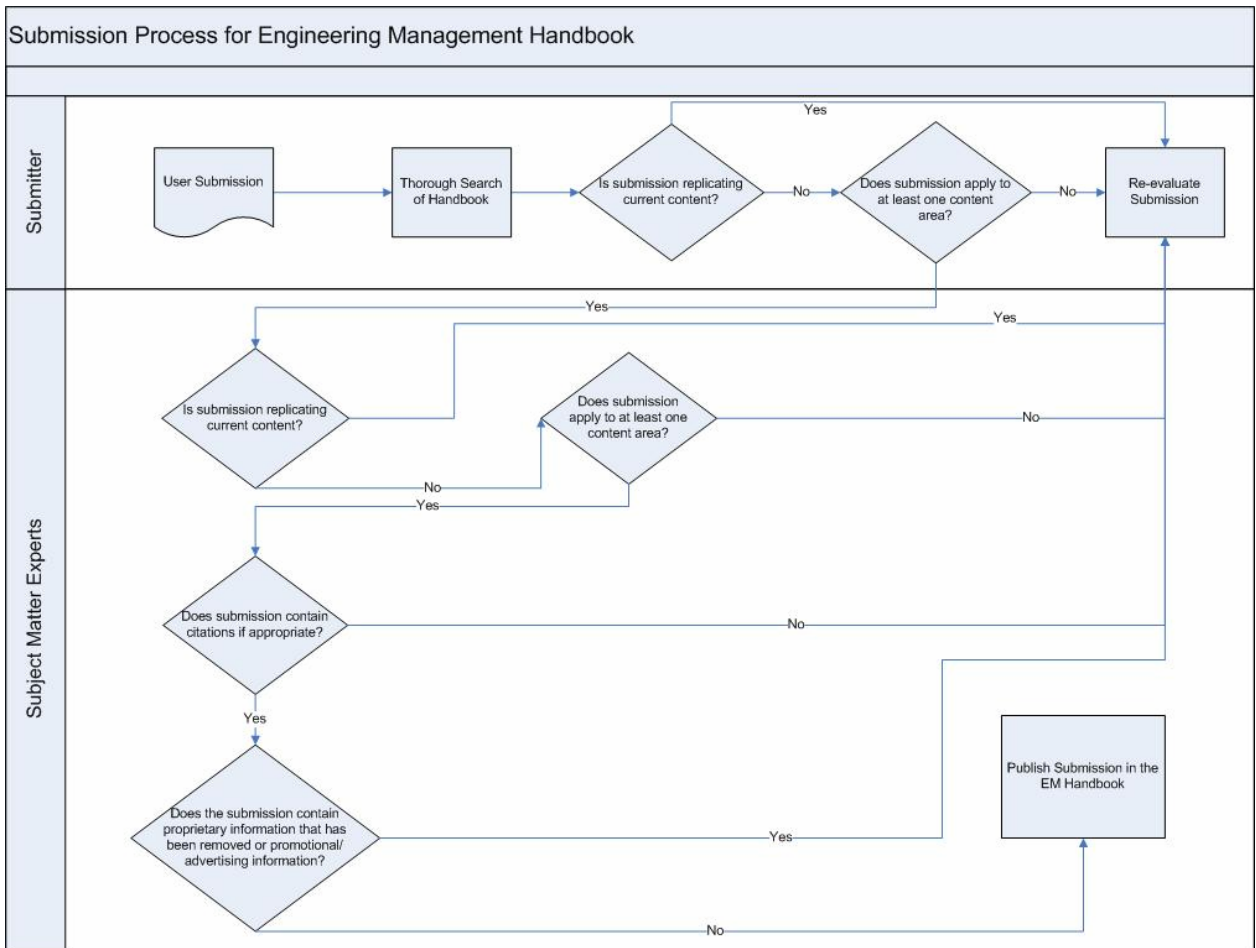
Figure 11 – Submission Process Flow Chart

How would the new system of providing the Handbook function?

There are many factors to consider when designing and implementing an on-line Handbook. First, the overall layout must be established. Then issues about the design require attention. Finally, features and functionality have to be discussed.

The layout of the Handbook could appear much like a book, but in on-line form. A standard webpage design could also be used initially and updated to fit the taste of ASEM. The start page will provide information on the Handbook and provide navigation options. Links here will include the Table of Contents, Ask the Expert, Frequently Asked Questions, General Discussion Board, Register, Submissions, and an About page.

The core navigation for the user will take place on the Table of Contents page. The Table of Contents as agreed upon by ASEM will be listed in a logical order, possibly alphabetical. When a subject is selected the user will be taken to a page with sub-topics listed, along with the high level subject. The contents/features of the handbook will be linked from these pages.

A link to "Ask the Expert" would appear on the start page and on each subsequent page. This allows the user to exercise this option when other options are not effective for them. Before allowing a user to ask a question the site should ask the user if they have attempted to find the answer under "Frequently Asked Questions." If the answer is no, the user would be redirected to that portion of the site. If the answer is yes, the user would be redirected to the "Ask the Expert" page.

The "Frequently Asked Questions" page would have a drill down feature. If selected from the start page or redirected from "Ask the Expert" the user would be directed to the highest level of the page. From there the user could drill down into

subject specific and then topic specific questions. If linked from a subject or sub-topic page the FAQ page would begin in that particular drilled-down state.

The General Discussion Board would also appear on the start page and each subsequent page. In order to attract users to its use, the most recent three to five discussion topics should be listed on the start page with the link. This would show the user that the site is active, useful, and relevant. This feature should not appear if no discussions have taken place in greater than two weeks. Registration would be required to use the General Discussion Board.

The Register link would allow users to register with the site by providing information. Registration would be required to submit information to the site, but would also be used for e-mailed updates and collecting personal and professional information. Each user would be asked to set up a profile with items such as a user name, password, and valid e-mail address being required. Optional fields would include items such as whether the user is a student, faculty member, or practicing engineer. Users would also decide whether they want to allow their information to be viewed by other members. A short survey to professional interests, background, etc. could also be provided. If information is shared the site could be used as a networking tool to find other users with similar interests. It is important to keep the amount of information input to a minimum, since some people would not take the time to enter excessive amounts.

The About page would provide background on the Handbook itself, and contain the mission statement. Information on the oversight committee and their role would be explained. A listing of the SME's and information about them would be provided for each subject area on this page.

The other contents/features, History and Background, General Information, Theory/Opinion/Insight, Current Issues or Industry Issues, Tools, Streaming Video, and Links to Google Books, would appear on the page for each subject and the sub-topic pages. Care should be taken to associate the contents and features to the lowest level possible, i.e., the sub-topic level.

The final page to be mentioned, but discussed earlier, is the Submission Page. A link would be provided to this page on the start page. Those interested in submitting content to the Handbook would be asked upload the content for review by the appropriate group of SME's. The submission guidelines would be listed on the page for review by the submitter. An e-mail would be sent to confirm receipt, with a follow-up e-mail being sent when the content is either accepted or rejected for inclusion in the Handbook. If the content is rejected, an explanation would be provided with a reason or set of reasons so that modifications could be made for re-submission.

One of the issues to be considered is the use of links as opposed to having a server to store the material. When using links effort must be expended to ensure that the links are current. When practical, material should be hosted by the Handbook website instead of being linked. This will not be possible with some of the items under the "Tools" category and the some Google Books links. In these cases the links must be reviewed on a regular basis, a recommended interval would be at least every six months. This is to ensure that the links are not broken and that the content has not been changed in a way that makes it an inappropriate linkage from the Handbook website. An example of this would be a change in the linked website that violates one of the submission guidelines.

Necessary permissions/approvals would need to be gained for the use and linking of certain content from other sources. Many websites require that approval be given before content is linked on another site. Copyright infringement would also need to be avoided. This issue may also present itself if the goal is to store articles and other information on the Handbook website server instead of providing a link to the material. A page may need to be created to note these permissions and approvals or this could be annotated for each item that requires it.

In addition to these topics, items such as information (data) collection, online advertising, and search functionality need to be considered. It was suggested earlier to have a registration feature in order to send updates to users. This feature would also be used to collect demographic information about users to tailor the site over time to those that use it the most. Another way of accomplishing this is to collect the number of hits per week, month, year, etc. on the contents to determine their value. If an article or application is not used, consideration should be given to eliminate its existence in the Handbook. This is especially true if it is being hosted by a server provided by ASEM.
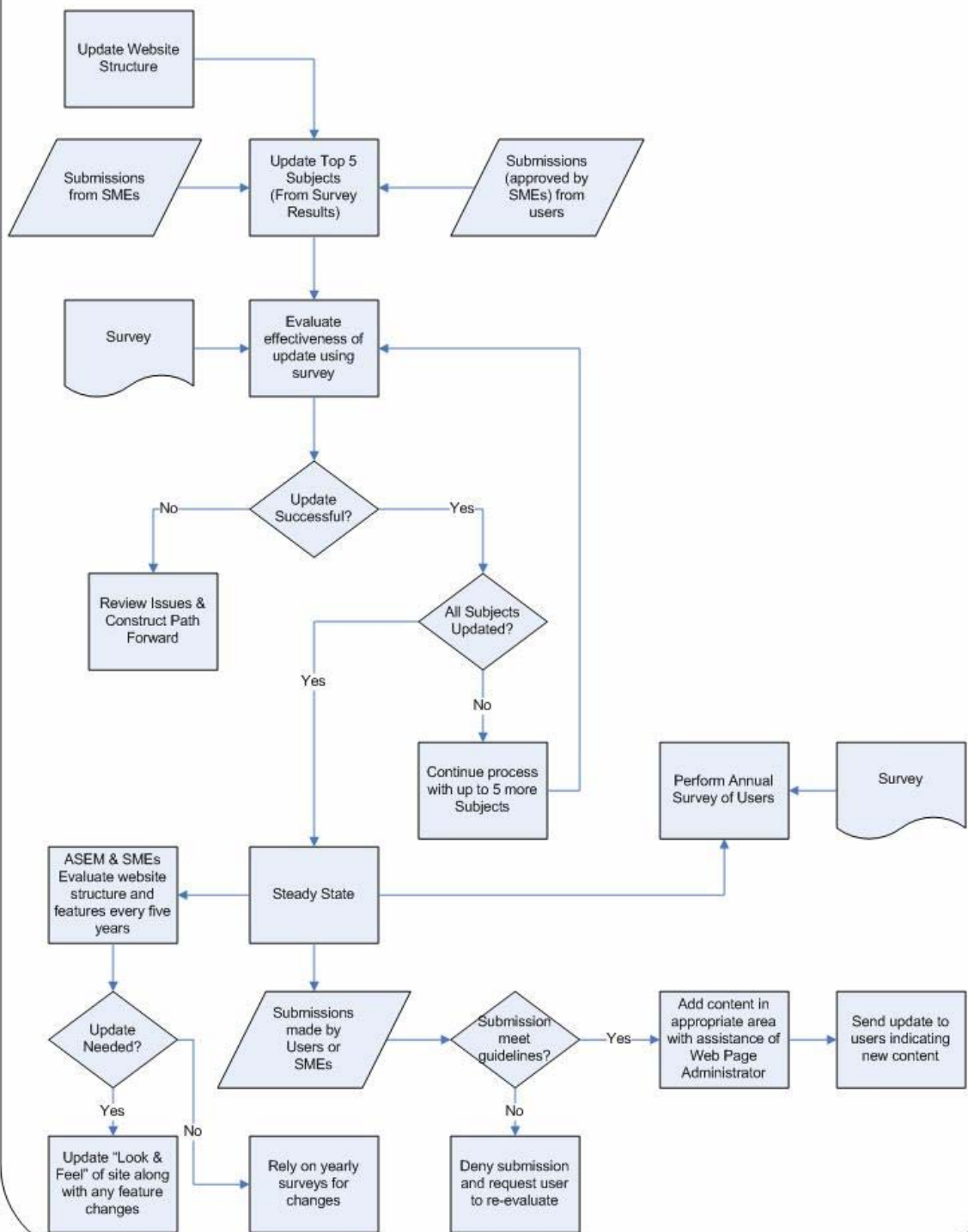
With the cost of hosting a website and server space consideration should be given to providing on-line advertising to entities with close ties to ASEM and the Engineering Management field. Examples of this might be certification programs, training courses, colleges and universities, software companies, etc. The use of advertising would offset the cost of hosting the website, paying for server space, paying the web address fee, and compensation for a webmaster to handle updates and coordination with SME's when content is to be added, changed, or removed. All advertising would be approved by the ASEM board for relevance and appropriateness. It should be considered to have

advertising be specific to area of the site when appropriate. In other words, advertisements related to Simulation would only appear on pages related to Simulation.

Search functionality is one of the most important aspects of the Handbook. If content is not simple to find a user is less likely to use the site. One tool that could be used is a custom search engine provided by Google. This tool allows the user to search specific websites, in this case the ASEM Handbook websites. The tool would be hosted by the Handbook website and is fully customizable. Non-profit and educational organizations can show results without advertisements from Google. This allows ASEM to further control advertising on the website. This search feature would be present on each page that could be viewed by the user, in case navigation through the site does not lead them to the information they seek.

A plan for the initial update of the Handbook along with how the steady-state operation of the site will function must also be in place. Figure 12 shows the steps in the process including the initial structure update using the guidelines established above. Important to this process is the understanding of the phased-approach to the update process, performing updates on approximately five subject areas at a time. The final portion of the flow chart shows the steady-state maintenance of the site and includes recommendations for surveys and website evaluations, and again addresses the issue of submissions.

Figure 12 – Handbook Update and Steady-State Maintenance Process

Use of the Handbook

The following section is being provided in order to assist the reader in understanding the vision of an updated online EM Handbook. Up to this point the site and its functions have been described in words alone. This is not enough to appreciate how divergent an idea such as this is from a Handbook in printed format or even from the previous attempt by ASEM in creating an online Handbook.

Example 1 – Engineering Manager

The first example of the use of the Handbook will be from the viewpoint of an Engineering Manager. The manager has a proposal from a group of engineers working for them to purchase a new piece of equipment. This piece of equipment would greatly increase the productivity of an integral operation. In order to determine if the proposal is sound the manager needs to use concepts of Engineering Economy. Knowing that assistance will be needed, the manager decides to look online for help. Being a member of ASEM his first choice is to seek the answer in the EM Handbook. He starts his journey toward the answer at the Handbook Homepage.

The manager has several options at this point. He can search using the Search bar at the top of the page or he can go to the Table of Contents. He knows that he needs interest tables, but also wants to ensure that he uses the information correctly. So, he selects Table of Contents and is taken to this page. After reviewing the subject area headings the manager selects "Engineering Economy." Again the manager is presented with a list of topics. He selects "Figures of Merit," and is taken to the next web page.

The manager sees that one of the example topics on this page is "Three Worths." After reviewing the options he first selects "Tools" and is presented with a page of tools

related to Figures of Merit and a description of each. One tool he sees is a link to a webpage that provides formulas for solving Present Worth problems. This is better in his mind that a link also provided to Interest Tables and related formulas. He selects the link to the webpage with formula solving capabilities.

The manager uses the information provided by the engineers to determine that the new piece of equipment is economically justified. However, before he calls them back to his office to discuss he decides he needs to read up a little more on Engineering Economy in case more questions are posed. He uses the Back button on the browser to get back to the Engineering Economy Page he viewed earlier. He remembered seeing an interesting link at the bottom of the page to Google Books.

The links at the bottom of the page provide the content that is under each sub-topic. He realizes he could have selected "Tools" on this page, but would have had to look at all tools and not just those related to Figures of Merit. Not wanting to limit results solely to Figures of Merit when searching for the Google Books, he selects the link on this page, so that he can see all the Google Books that are suggested by ASEM for the subject of Engineering Economy. He is taken to a page with a list of links to Google Books and a brief description of each. He selects a book titled Engineering Economy, by Blank & Tarquin.

The manager reviews the key aspects of the book to ensure that he has solved the problem correctly and has an understanding of what other issues might need to be considered. Feeling comfortable about the situation he calls the engineers in to review the data and give them his decision to fund the purchase of the new piece of equipment.
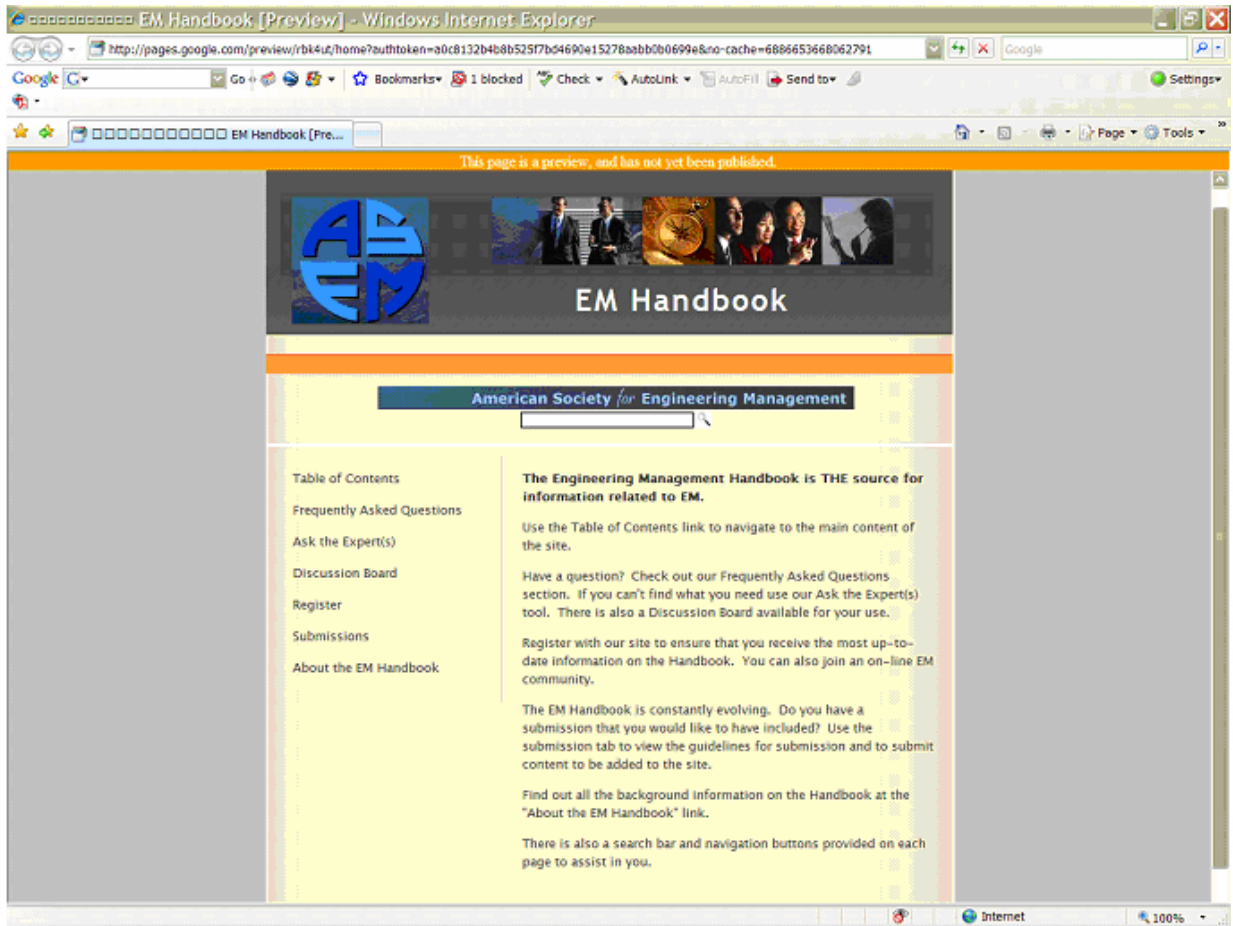
The flow described above is represented in figures 13-19.

Figure 13 - EM Handbook Homepage
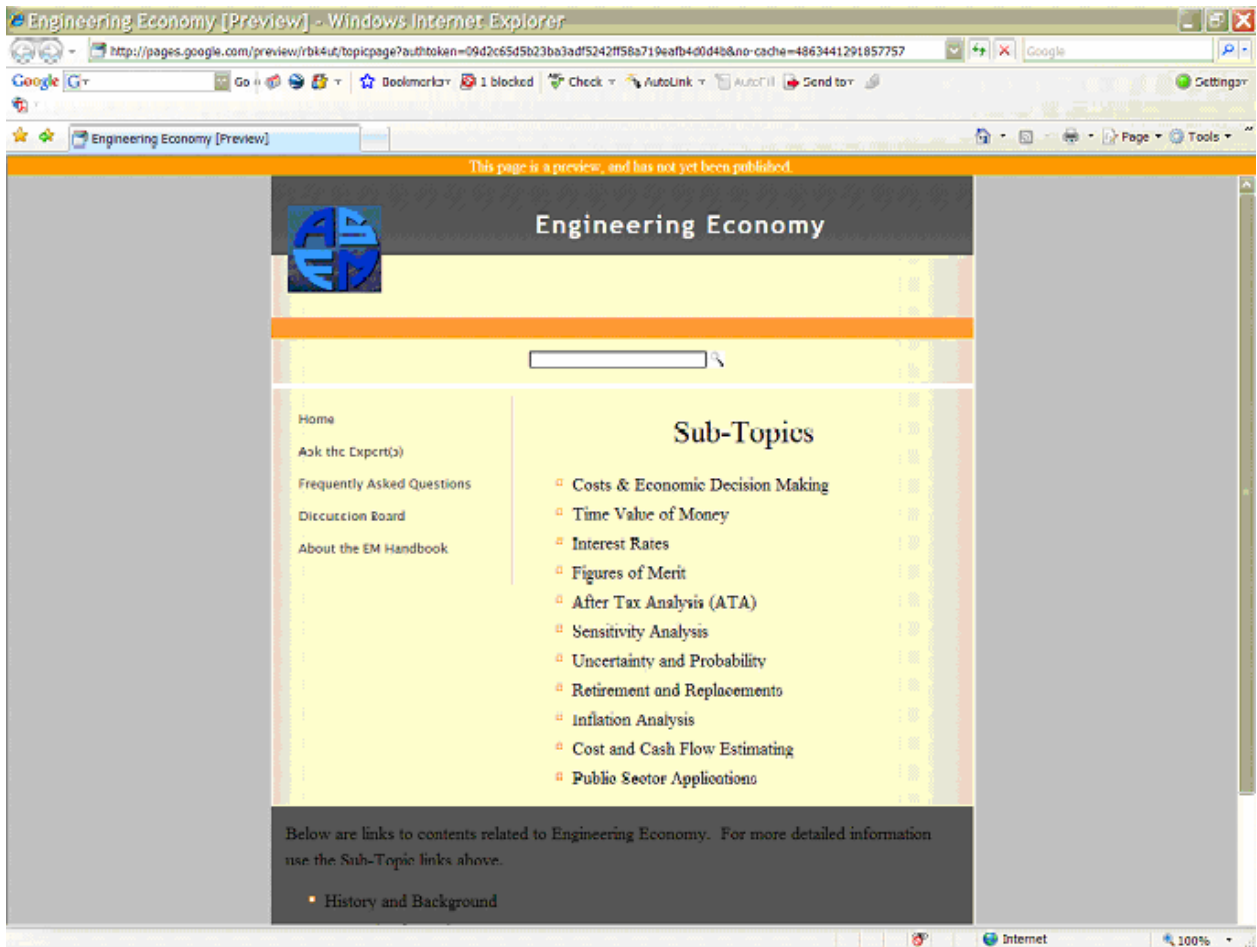
Figure 14 - EM Handbook Table of Contents

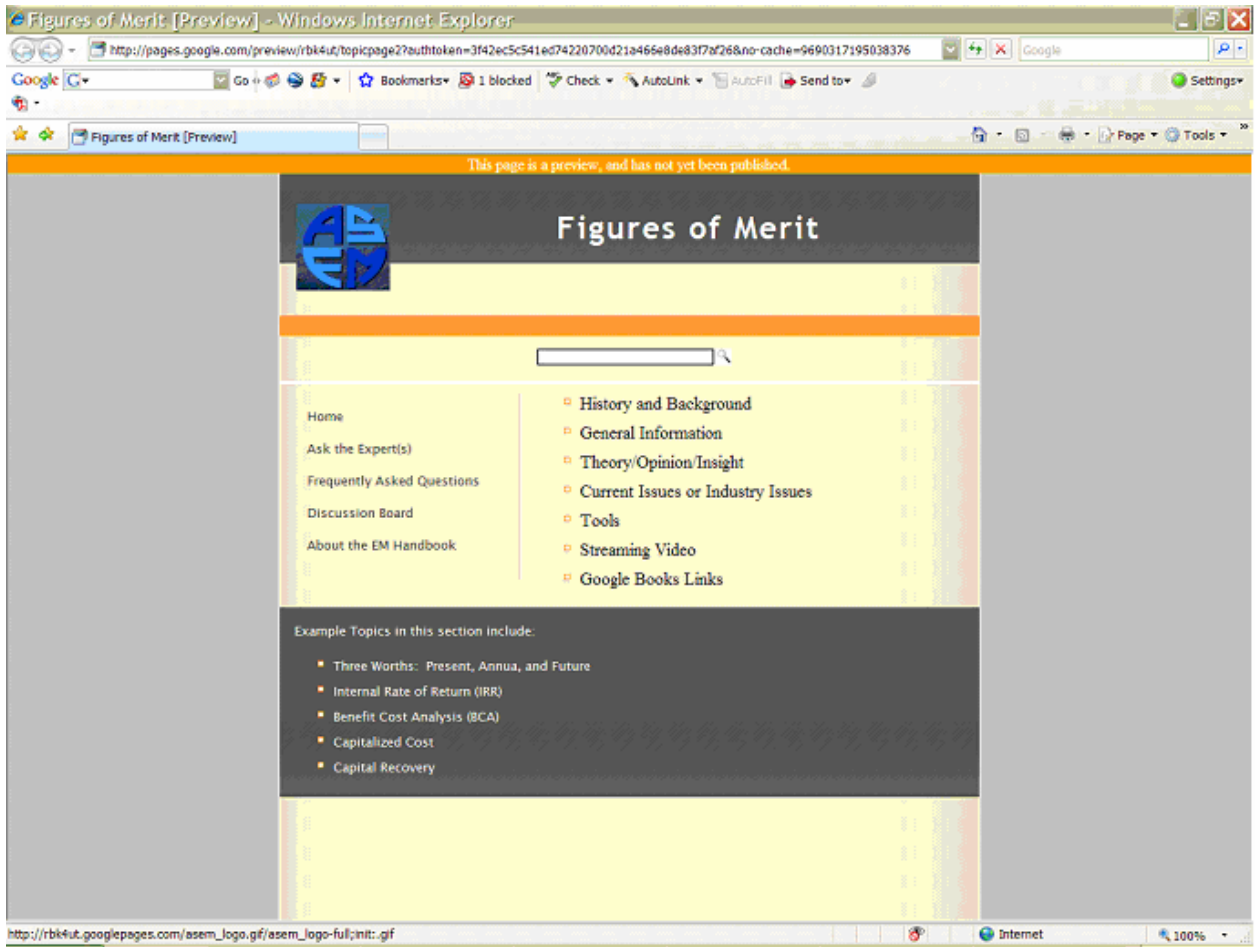**Figure 15 - Engineering Economy Page in EM Handbook**

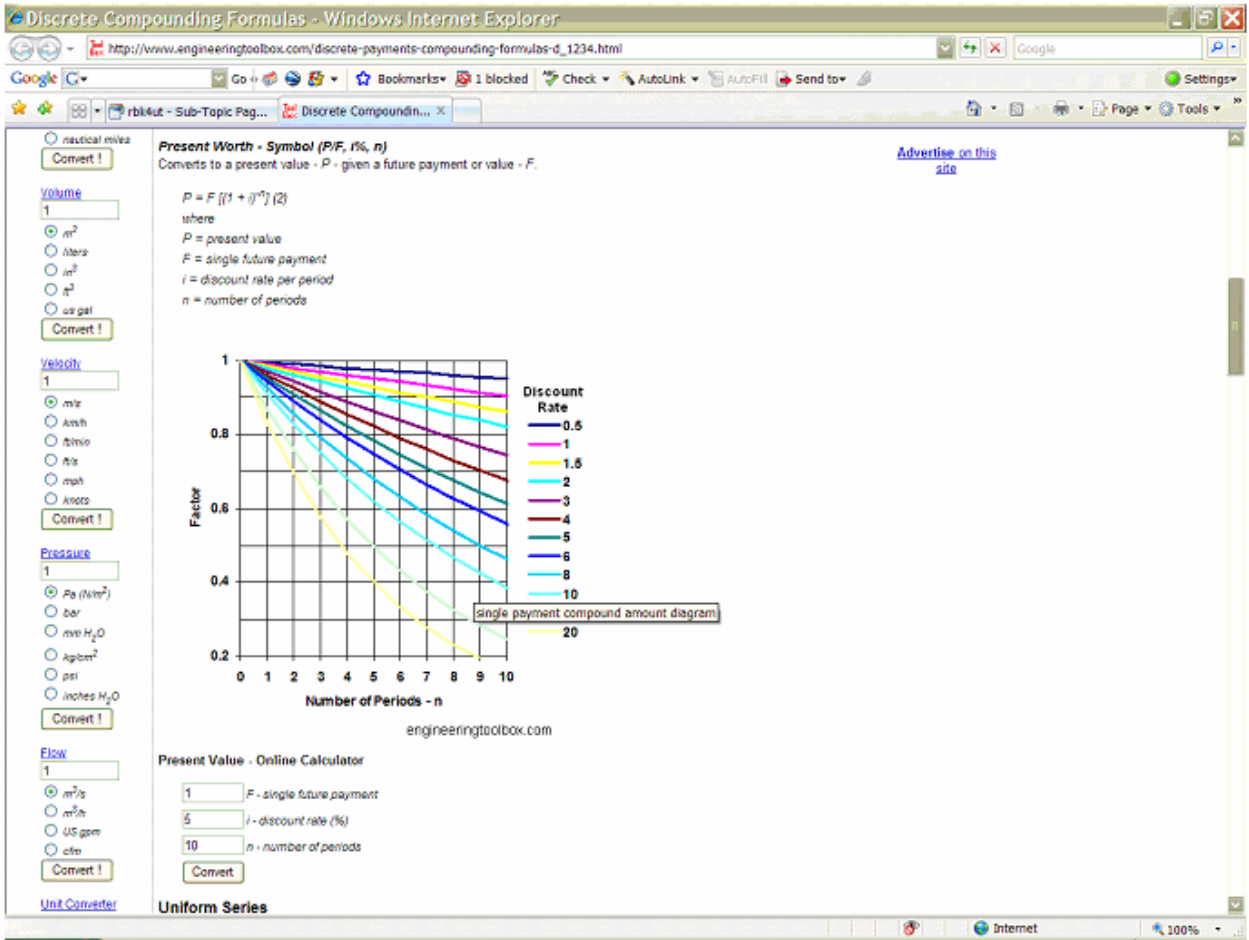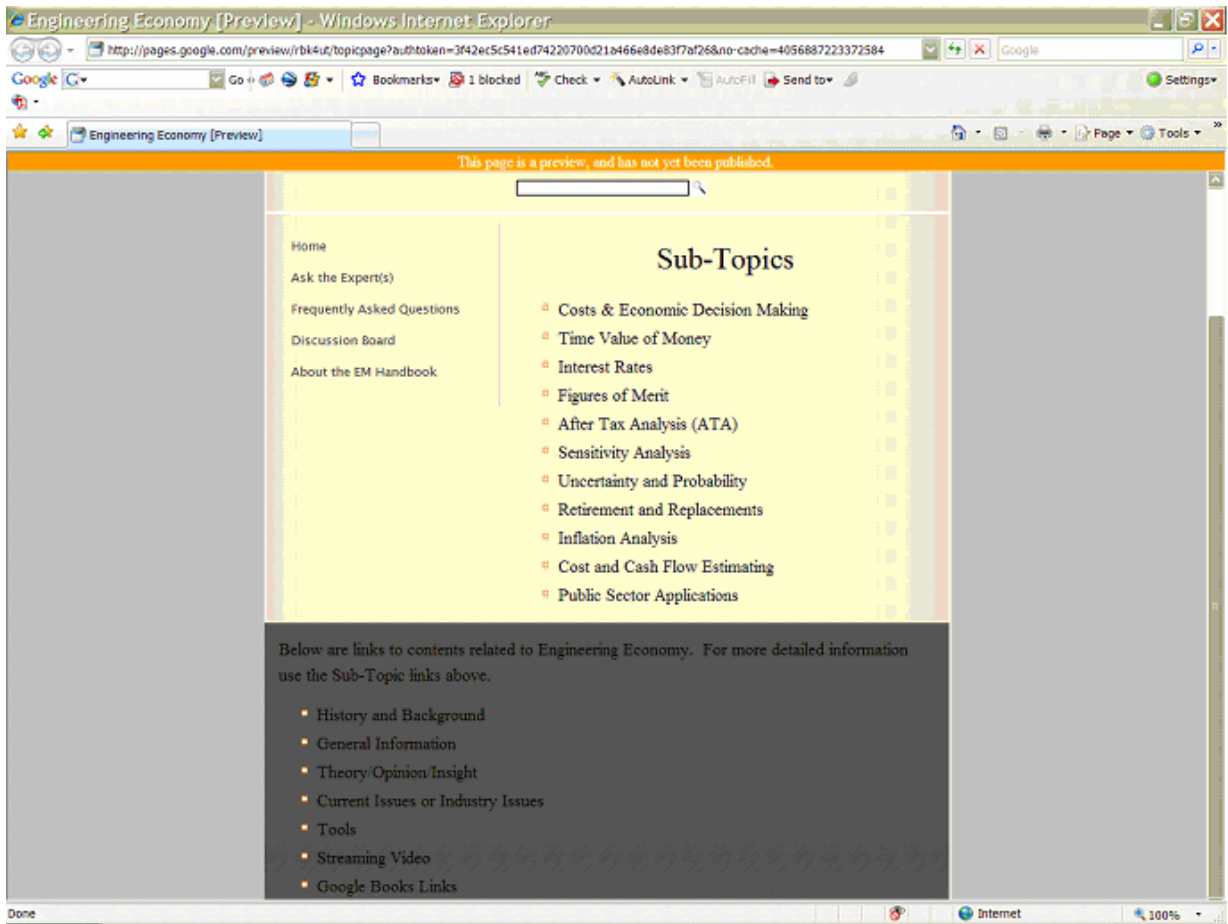**Figure 16 - Figures of Merit Page in EM Handbook**

Figure 17 - Tool, Figures of Merit, Present Worth

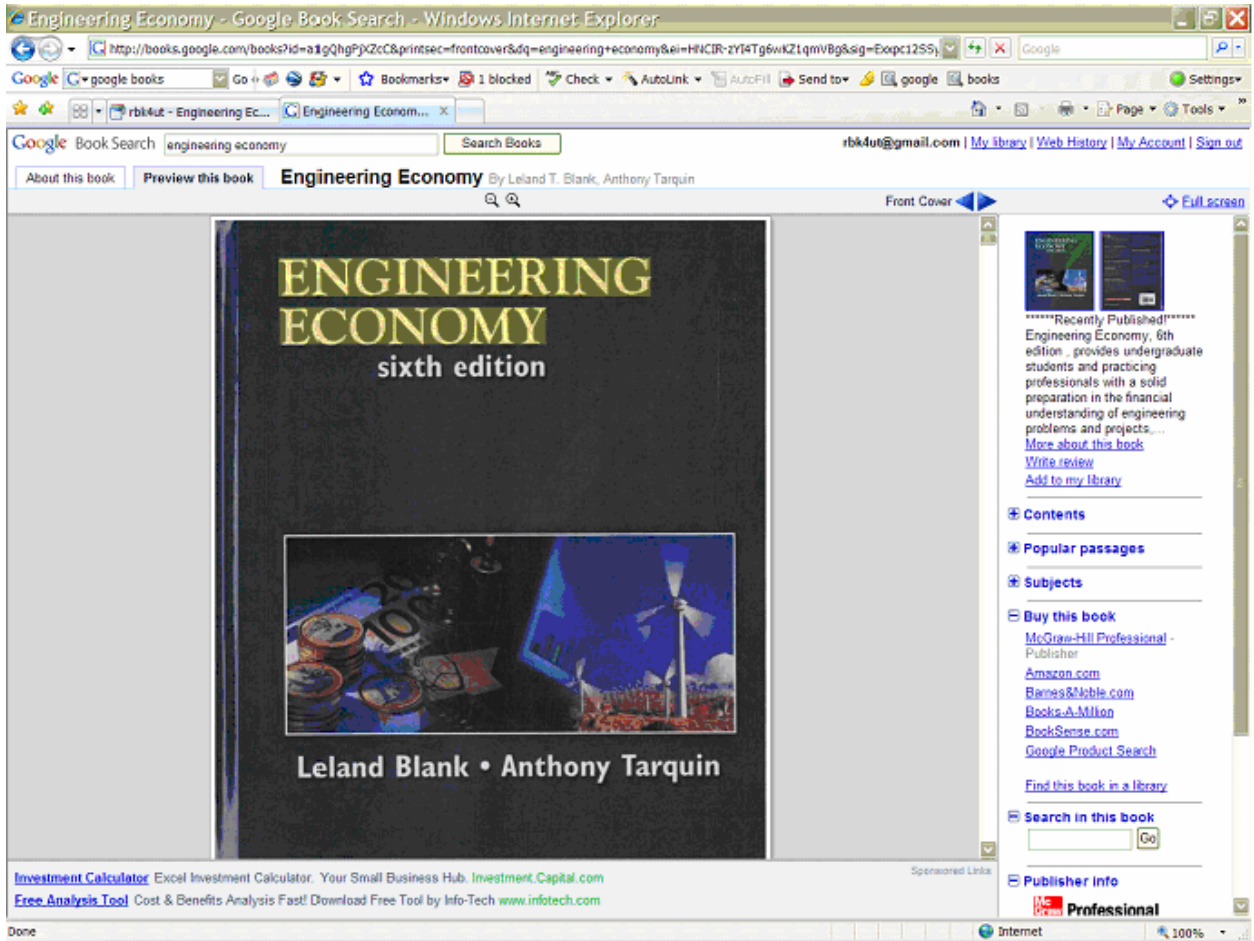**Figure 18 - Engineering Economy Page in EM Handbook**

Figure 19 - Engineering Economy, Linked at Google Books

Example 2 – Engineering Management Graduate Student

The second example of the use of the Engineering Management Handbook will be from the viewpoint of a Graduate Student. This student is writing a research paper on Statistical Engineering and its effect on product quality. She decides to do a quick Google search for Statistical Engineering thinking that will be a good place to start. The Google search returns several interesting websites. However, near the top of the list of pages sees a link to a site she has never heard of before…the ASEM Handbook. When she selects the link she is taken directly to the Table of Contents page, because this is the first page on the site in which Statistical Engineering is mentioned. She sees two subject areas that she thinks might contain information that will help her, Statistics and Quality Management. She decides to take a look at both pages.

She first goes to the Statistics page and then selects General Information. She does a quick scan of the articles, and then decides to look at the Quality Management page. She again selects the General Information link at the bottom of the page and is presented with a list of papers and articles. She recognizes one that she had seen when looking under Statistics called <u>Statistical Engineering: The Key to Quality</u>, by S.J. Morrison. She decides if it is under both topics the chances are good that it will relate to her paper, so she clicks the link and a PDF version of the article opens in a new window.

After printing the article and closing the window she notices a link to the left of the page called "Ask the Experts." She has a question about what mistakes are most common when applying statistical engineering to product quality. She clicks the link to "Ask the Experts" her question. A pop-up box appears asking if she has checked the "Frequently Asked Questions" section of the site. She selects "No" and is redirected to

this page. She reads through the questions, but does not find one that even remotely addresses her question, so she again selects "Ask the Experts." At the pop-up box she selects "Yes" and is taken to the Ask the Experts page.

She looks over the page and notices that answers can take up to one month to answer. She has started early on her research paper and has about half of the semester left, so she thinks there will be enough time to integrate the answer into the paper even if it takes one month to receive. She enters her e-mail address, selects Statistics as the subject, types her question, and clicks the submit button.

The student continues her literature search in the Handbook and finds enough information combined with other sources to begin to write her paper. With more research and an answer to her question she feels she will have no issues completing the research paper by the assigned date.

The flow described above is represented in figures 20 -23.

Figure 20 - EM Handbook Table of Contents
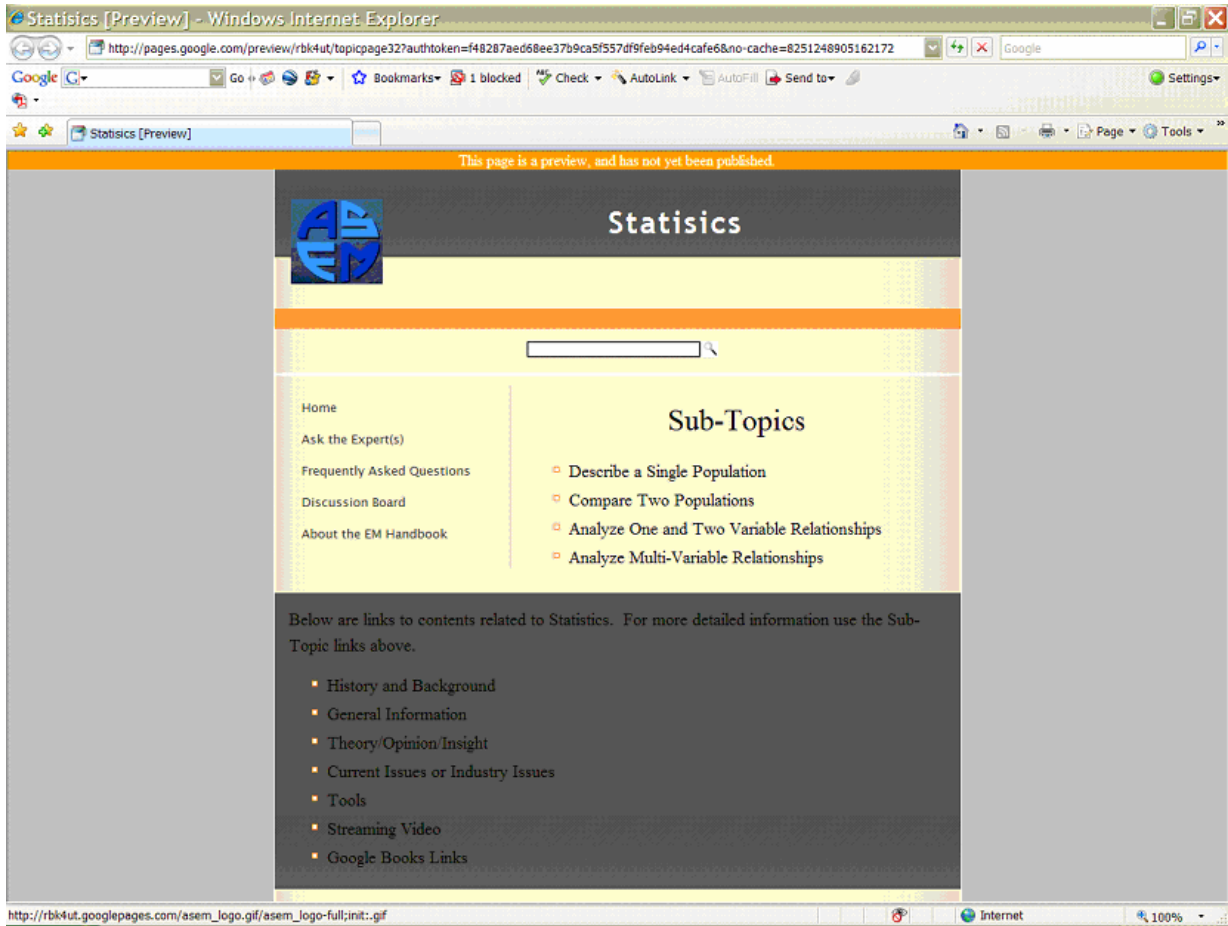
Figure 21 - Statistics Page in EM Handbook
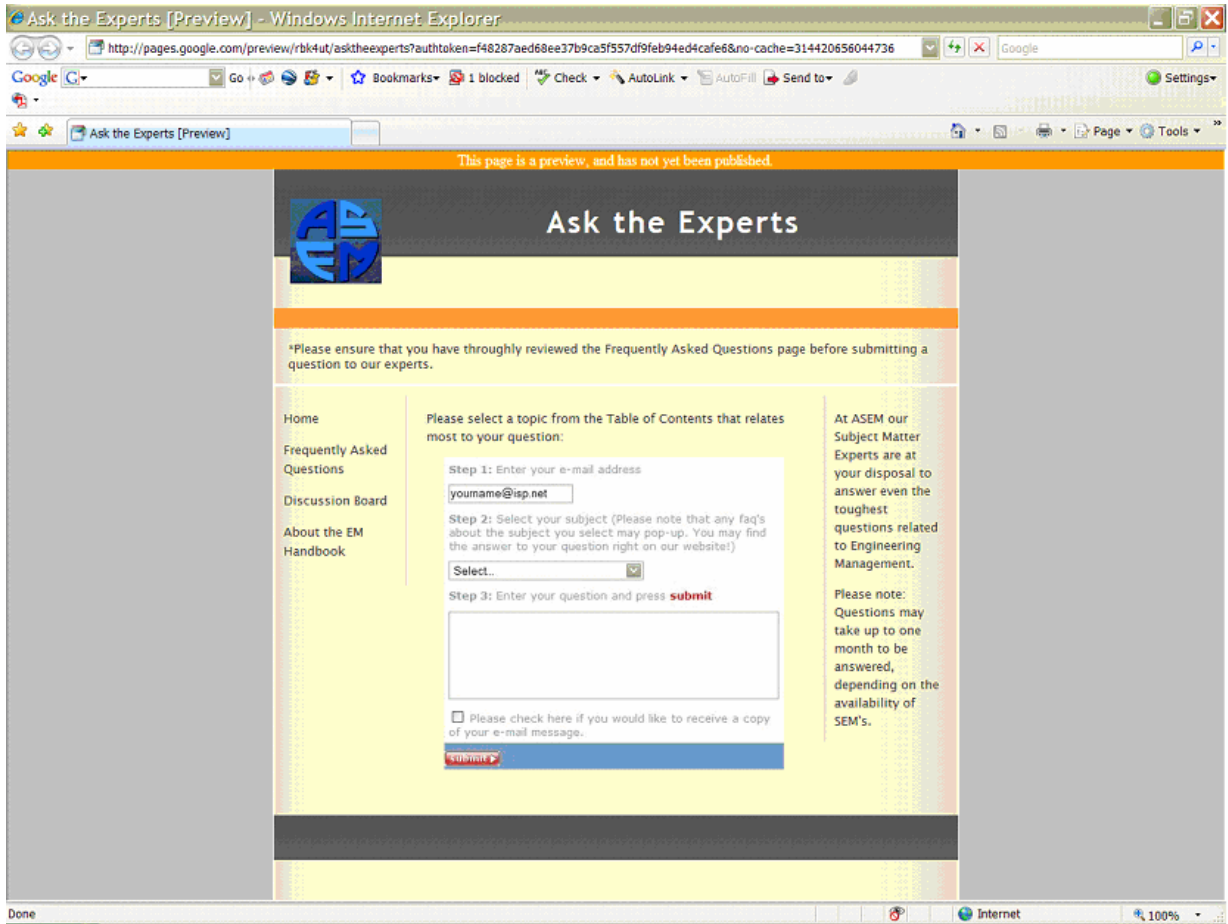
Figure 22 - Quality Management Page in EM Handbook

Figure 23 - Ask the Experts Page in EM Handbook

Example 3 – University Professor

The final example of the use of the Handbook will be from the viewpoint of someone in academia. A Professor has recently been asked to teach a class on Simulation. The professor has been teaching Human Factors for the last five years, but with the recent resignation of the department's Simulation expert he has been asked to fill this void for a semester until a replacement can be hired. He has taught simulation in the past and has even done some consulting when working as a graduate student, but he understands that time has past since this time and many things have had the opportunity to change. After reviewing the course content and objectives he feels comfortable, but feels he needs to learn about current industry uses of Simulation since he wants to make the class relevant to his students. He also wants to connect with other professors currently teaching the subject to interface on their approach. The professor decides to visit ASEM's online Handbook to see what resources are available.

The professor enters "Simulation" into the search bar on the top of the home page and is redirected to the Simulation page in the Handbook. At the bottom of this page he sees a link to "Current Issues or Industry Issues." Obviously he has started down the correct path, so he selects this link and is presented with a list of articles related to Simulation. One article, out of the several presented, catches his eye. This article is titled <u>Simulation Modeling in Manufacturing Process Design</u>, by Andrew Greasley. He selects this article and is presented with a PDF version that loads in a separate window. He prints himself a copy of the article to read later and closes the window.

Still wanting one on one interaction with other professors he returns to the Simulation page and selects the "Discussion Board" link at the left. He is redirected to

the Discussion Board section of the site. In order to start a new thread the professor would select the "New Topic" button. The format would be similar to other message boards in that a title such as "Teaching Simulation" or "Advice for teaching Simulation" would be entered. He would go on to explain his situation and ask for help from seasoned professors in Simulation field. University Professors who use the site could give input or provide contact information such as an e-mail address or related "blogs" so that further conversations could take place.

After reading the article about simulation modeling in manufacturing the professor decides he would like a few more current issue articles on the topic, so he searches again and finds papers he feels will allow him to relate the subject to current issues for his students. After only a week he has made contact with several other professors and feels confident that he can lay out a course plan to effectively cover the material and address all of the course objectives. He also knows that if questions arise he has a resource online that both he and his students can use… the ASEM online Handbook.

The flow described above is represented in figures 24 - 26.

Figure 24 - EM Handbook Table of Contents

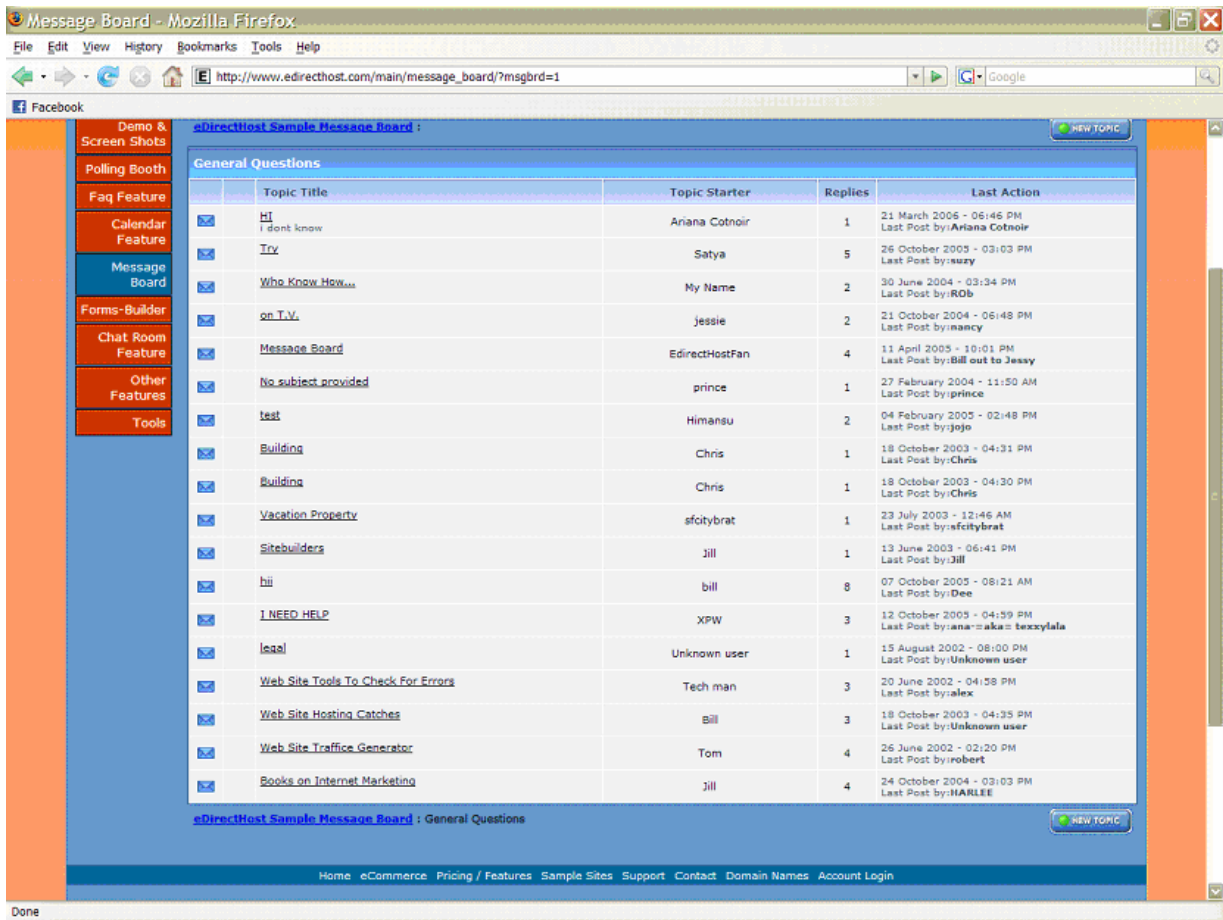**Figure 25 - EM Simulation Page in the EM Handbook**

Figure 26 - Example of a Message Board

Chapter VI

Recommendations and Conclusions

This thesis addressed the primary research question: What is the path forward to design and implement an on-going Engineering Management Handbook. A literature review was performed to understand what is Engineering Management, its history, and this history's impact on the EM Body of Knowledge over the years. The current state of the EM Handbook was also discussed. Further research could be performed to expand the knowledge base associated with the definition of Engineering Management and its history. However, for the purposes of understanding the path forward for designing and implementing a Handbook the information presented is sufficient. Likewise, the impact of EM's history on the associated Body of Knowledge that will make up the Handbook is also open to more research. It is recommended that further research be done on the content of subjects for the Handbook. Engineering Management encompasses a vast array of subject areas which have changed over time. In order to effectively implement the Handbook of the future this research would need to be performed.

The methodology used to answer the question, "How do users perceive the Handbook?" included the use of two surveys and an interview. Though the response rate was good for both surveys more data would be useful in understanding the wants and needs of users. It is recommended that when the on-line Handbook is implemented and has been in use for at least six months to one year that another survey be performed. This survey would address the usefulness of the site, what features need to be added or

removed, and how the Handbook might be changed. The creation of an on-going, ever-changing, Handbook requires that input be gained on a regular basis.

Another recommendation for when the Handbook has been updated is that an announcement be made and possibly advertised on sites that Engineering Management professionals, faculty, and students are known to visit. In order to gain users the Handbook must first be known to exist and second it must be useful. A useful and complete tool speaks for itself and by its existence encourages use.

By performing the surveys and the interview it was found that there was a desire for a useful on-line EM Handbook. This research allows for decisions to be made in the future as the Handbook is updated by showing what subjects and features are most important to users, as well as the need for structure development from the beginning. Obviously the previous recommendation to research content for the Handbook would play an important role in this as well. The purpose of the information in this paper was the understanding that all areas could not be updated simultaneously, so subjects would need to be chosen by perceived usefulness of the user to create the structure presented in this thesis for the on-line Handbook.

Discussion included specifics on the features to be included in the new Handbook along with its structure. The functionality of the system was also discussed. A thorough presentation was given for each of these areas. However, it is understood that a web page designer would need to be involved in the final implementation. The basis for the execution of the Handbook has been presented even if minor tweaks to the structure might be required. It is recommended that a user group or "focus group" be convened to test the site and provide feedback to the web designer from the beginning. It is always

risky to leave design and implementation up to one individual or one small group. The use of the site will depend very much on its functionality and ease of use.

List of References

List of References

Engineering management: From Pioneers Years to Year 2010
Baker, M
Engineering Management Conference, 1988. 'Engineering Leadership in the 90's., IEEE
24-26 Oct. 1988 Page(s):108 – 115

50 Years of Engineering Management through the Lens of IEEE Transactions
Allen, T. J. and Sosa, M.L.
IEEE Transactions on Engineering Management, Vol. 51, No. 4, November 2004.

Simulation Modeling in a Manufacturing Process Design
Greasley, Andrew
Engineering Management Journal, August 1999

Statistical Engineering: The Key to Quality
Morrison, S.J.
Engineering Management Journal, August 1997

What is Engineering Management?
Lannes III, W.J.
IEEE Transactions of Engineering Management, Vol. 48, No. 1, February 2001

Online Resources:

www.abet.org
Last updated: 7 Dec 07

www.asem.org specifically the Engineering Management Handbook.
Last updated: 11 Jan 00

http://en.wikipedia.org/wiki/Wikipedia:Your_first_article
Last updated: 13 Feb 08

http://mitsloan.mit.edu/newsroom/history.php
Last updated: 2008

Appendix

<u>Vita</u>

Robert Kring was born in Oak Ridge, TN, on October 30, 1980. He was raised in Harriman and Kingston, TN. He graduated from Roane County High School in 1999. From there, he went to the University of Tennessee, Knoxville, and received a B.S. in Industrial Engineering with a Cum Laude designation. He receivd the Master of Science in 2008.