

## **AC 2008-585: ASEM EM BOK**

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# **PROCESS TO DEVELOP THE ASEM ENGINEERING MANAGEMENT BODY OF KNOWLEDGE (EM BoK)**

## **Abstract**

This paper reviews the general criteria used to establish a body of knowledge and evaluates the American Society of Engineering Management's (ASEM) decision process to develop the EM BoK against these criteria. The development of the ASEM EM BoK was made possible because of the many EM undergraduate programs that are ABET (Accreditation Board for Engineering and Technology) accredited and EM graduate programs that are ASEM certified.

After a two year development effort the American Society for Engineering Management (ASEM) Board of Directors voted to adopt the EM BoK. As the lead professional society for engineering management, ASEM had made the creation of an EM BoK its key strategic goal.

Future plans for the EM BoK include the development of an Engineering Managers validation test, training modules leading to Professional Development Hours (PDH) and an EM BoK Handbook.

Future research includes continual updating of the EM BoK and continuing to survey a wide selection of EM programs.

## **Keywords:**

Engineering Management; Engineering Management Body of Knowledge; Accreditation Board for Engineering and Technology (ABET); American Society for Engineering Management (ASEM).

## **Existing EM BoK in EM Accredited/Certified Programs**

A few years ago the ASEM launched a Certification Program for Masters in Engineering Management (Westbrook, 2003, 2004). Four schools and six MS programs have achieved ASEM Certification. ASEM certification included curriculum standards for EM Masters-level program. Also in the last few years the number of ABET accredited undergraduate programs has grown from 3 to 5 (Abel, 2005). Since then the number has increased to six. A number of other programs are in the process of gaining ABET accreditation.

These two events made it possible to establish an EM BoK based on the content of ABET accredited and ASEM certified EM programs. Both ABET and ASEM require programs to be based on outcomes that are reviewed with industrial/ government advisory boards and have curricula developed by faculty who are experts in the field.

## **Criteria to Judge the Decision Process to Develop EM BoK**

Developing a Body of Knowledge (BoK) requires that the subjects/topics selected be those that practitioners and experts in the field can agree on. The overall criteria used in choosing BoK topics/subjects are that they be generally recognized as good practice most of the time. This criteria is similar to the criteria used by the Project Management Institute (PMI) in the Project Management Body of Knowledge (PMBok) <sup>14</sup>. PM BoK – 3 rd. Edition - page vii states that, “criteria for the inclusion of material” will be “generally recognized as good practice on most projects most of the time.” ASEM criteria substituted subjects/topics for projects.

In addition, the process to create a BoK needs to include input from both Subject Matter Experts (SMEs) as well as industry practitioners. Individual subjects and topics need to be based on standard references in the field. These references should be easily available to anyone who seeks them. Finally the process needs to include a peer review process that insures that the BoK has the benefit of various experts to ensure against group think or individual bias. This is also needed to validate the EM BoK. Appendix I - Figure 1 and Appendix II illustrate the ASEM EM BoK decision process.

### **ASEM EM BoK Meets the Criteria for Good Practice Most of the Time**

The first criteria relates to subjects/topics that are recognized as good practice most of the time by practitioners and SMEs. Review of the ASEM EM BOK process (Appendix I and II) indicates that the subjects were developed by analyzing ABET accredited undergraduate EM programs and ASEM certified masters EM programs. All of these programs had significant input from industry practioners and the specific courses were developed by SMEs in the respective engineering management subjects/topics. The ABET approach to establish EM outcomes for these programs is an example of this collaborative approach.

Previous research has established that the ABET accredited and ASEM certified programs share the same topics/subjects (Merino, 2005, 2006). Note the benchmarking studies in Figure 1 - step 10 were conducted for 6 undergraduate and 6 graduate EM programs and were presented as ASEM and ASEE refereed conference papers. (Merino, 2003, 2004). The overall results are summarized in an ASEE refereed conference paper (Merino, 2006) and shows that a consensus exists among those EM programs that have undergone ABET accreditation or ASEM certification. See Appendix III for a list of topics and related courses. Overall there was excellent agreement on topics among EM programs. This research justifies the claim that the ASEM EM BoK subjects are recognized as good practice most of time by practitioners and SMEs.

Two observations: The first is that the research indicates that there were far more similarities in EM subjects/topics than differences. This more than satisfied the criteria of “most of the time”. This was caused by a process of informal and formal benchmarking where EM program committees review other schools programs. The informal benchmarks are facilitated by faculty who graduate from EM programs and then become EM faculty in other schools responsible for developing EM programs. Another informal benchmark is the publication in ASEE, ASEM and the Engineering Management Journal (EMJ) of surveys of EM programs’ curricula. Formal benchmarking is driven by ABET accreditation and ASEM certification standards.

The second observation is that the exercise of reviewing accredited and certified programs would not have been successful a decade ago because there were so few ABET accredited undergraduate programs and ASEM had not yet started its certification program. The growth of ABET programs (from 3 to 6) and ASEM programs (from 0 to 6) constituted a sufficiently large sample to develop an EM BoK.

### **ASEM EM BoK Meets the Criteria for Standard References**

Note that Step 12 (Appendix I and II) asks EM faculty who are SMEs to provide at least two standard texts in the field. In addition, the Principal Contributor's (PC) choice was peer reviewed by another SME in that field. The EM BoK guidelines specified that in a case whether the PC and Peer Reviewer could not agree then another Peer Reviewer (PR) would be sought to break the tie. Most PC and PR agreed on the texts. While a few PC and PR initially disagreed on the standard texts in all cases this dispute was resolved without resort to another PR. In a few cases three standard texts were included.

The EM BoK guidelines required the PC to reference the course outline with the standard texts and to comment on any significant differences. The PR was also asked to comment on this analysis. No major differences were noted in the 13 subject areas.

Why did this process work so successfully? One reason was that most of the subjects/topics in the EM BoK are well established. The older subjects (e.g. engineering economics, accounting, statistics, etc.) have well developed bodies of knowledge and standard references. The newer subjects like Project Management, Quality Management, etc. have been developing robust bodies of knowledge

### **ASEM EM BoK Meets the Criteria for Validation**

Validation requires agreement among independent SMEs. The ASEM EM BoK subjects were developed by analyzing ABET undergraduate EM programs and ABET graduate EM programs. These programs involve a peer review by either an industry or academic SME. For ABET accreditation see Appendix I and II - steps 1a – 5. For ASEM certification see Appendix I and II - steps 1b – 7. In both cases there is an independent assessment of what constitutes an EM program by a SME.

In addition, the course outlines were prepared by a Principal Contributor who was an SME and then peer reviewed by another SME in the field. The combination of these two processes ensures that the ASEM EM BoK was validated.

### **Other Approaches to an EM BoK**

There are a number of other approaches to establish an EM BoK using different approaches. One approach uses an industry survey as the primary basis to establish an EM BoK. While this approach captures EM Managers' needs later in their careers, it does not address many of the

basic topics taught to EM students in various programs. Also for this approach to have validity there needs to be a process of peer review by practitioners and SMEs.

### **Subject Matter Experts (SMEs) Qualifications**

Based on the above it is obvious that the quality of the ASEM EM BoK depends greatly upon the qualifications of the EM faculty and industry experts. The ASEM EM BoK had a rating system to qualify the reviewers. Requirements are similar to those used for accreditation and Promotion and Tenure decisions.

Criteria include the following:

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

Overall ratings were excellent and will be published in a journal article on this topic.

### **Future Plans to Use EM BoK**

There a number of other activities that is based on the approved EM BoK

#### EM Test on ASEM BOK

One is to develop a test that would validate the BS EM and MS EM programs. Previous research established that the topics have approximately the same weight in the various curricula (Merino 2005, 2006). Using these weights a test can be constructed for recent graduates.

The two key facts needed for this test are the topic and the length of the exam. The EM BoK developed (Merino, 2006) identifies the topic and the weight. An example would be:

4. *A Project Management with a weight of 12%*
  - *Given a 7 hr. total exam would result in a 50 minute exam on project management.*

The same process for selecting subject matter experts will be used to develop the tests. It is assumed that recent graduates of BS EM and MS EM would pass the test with scores that would correlate with their GPAs. If this hypothesis is proven then this is one way to validate the tests.

Another way to validate the test is to conduct training modules before the EM Certification exam. Students who take these modules could be pre and post tested to determine their knowledge of the subject matter and to assess the effectiveness of the training module. Comparing the post test with the certification test can also provide validation.

### Develop Training to provide Professional Development Hours (PDH)

PDHs could be given for the training modules taken to prepare for the EM Certification exam. We assume that recent graduates would not take many of the modules because the material is still “fresh”. On the other hand, EM Managers who took a MSEM more than five years ago and those who did not take any MSEM or related MS programs (MBA, etc.) would need to take the training modules to pass the EM Certification test.

### Develop an EM BoK Handbook

The topics in the EM Handbook would include all those identified in benchmarking EM programs. See Appendix A. In addition, information about EM accreditation and certification will be included.

### **EM BoK and ASEM Mission**

The ASEM has identified the development of an EM BoK as a prime objective. The ASEM is the first step to developing an EM validation test, an EM Handbook and training efforts that give PDHs.

### **Future Research**

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.

Another area for further study is to identify how closely the EM BoK for accredited /certified programs differs from the entire population of EM programs – accredited and non-accredited or certified. Preliminary analysis indicates that this sample is representative of this larger population.

There are some obvious methodological problems with this last statement. A major problem is defining EM programs. In many schools EM is a collection of business courses and is not based on input from advisory boards. Also, in many cases there is no EM designated faculty for EM programs. Faculty members from other disciplines and/or the business school are used to teach in EM programs. Given that these programs lack EM designated faculty and lack external input should these schools/programs be considered EM? If you exclude these programs then the number of EM programs drops significantly and the 11 programs used to establish the EM BoK become mores representative of EM programs.

## Appendix I – ASEM EM BoK Process Flow Diagram

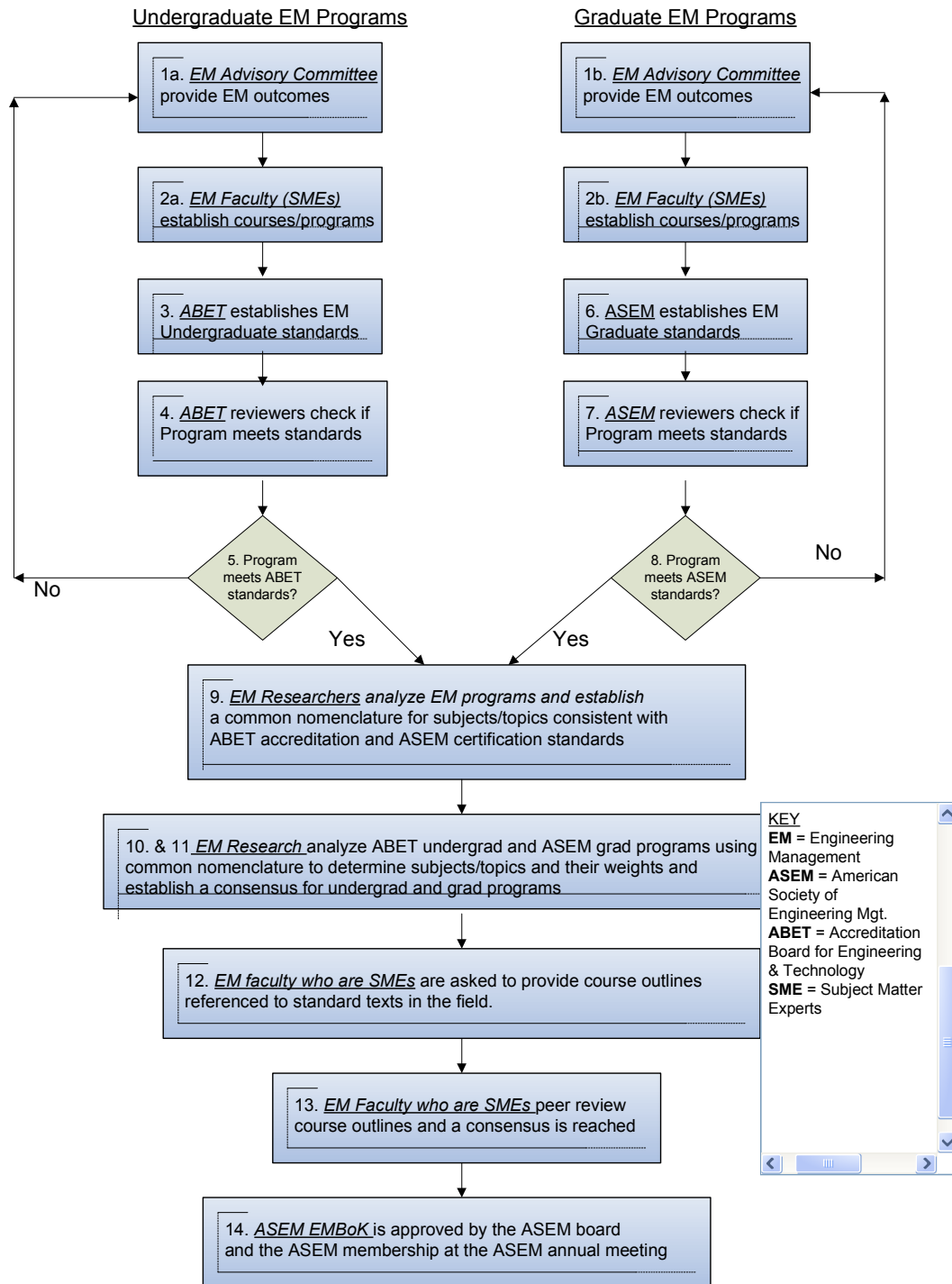


Figure 1. Processes Involved in Developing EM BoK

## **Appendix II – Description of Decision Process**

The following actions/steps were involved in the development process by the schools and ASEM

1. *EM Advisory Committees* (Undergrad & Grad) provide EM faculty with EM practice and outcomes.
2. *EM Faculty* (Undergrad & Grad) who are Subject Matter Experts (SME) translates EM practices and outcomes into courses and programs.
3. *ABET* establishes EM Undergraduate program standards.
4. *ABET Reviewers* conduct Undergrad EM program visits to determine if ABET standards are met.
5. *ABET* accredits or denies accreditation to EM Undergrad program. Accreditation usually lasts six years. Failure to achieve accreditation starts the process over (e.g. steps 1 thru 5 is repeated until accreditation is achieved).
6. *ASEM* establishes EM graduate program standards.
7. *ASEM Reviewers* conduct Graduate EM programs visit to determine if ASEM standards are met.
8. *ASEM* certifies or denied certification to EM Grad program. ASEM certification usually lasts three years. Failure to achieve certification starts the process over (e.g. steps 1, 2, 6-8, are repeated till certification is achieved.).
9. *EM researches* analyze EM programs over the years and establish a common nomenclature for subjects/topics consistent with accreditation and certification standards.
10. *EM researches* analyze accredited ABET EM Undergrad programs and certified ASEM Grad programs using the common nomenclature to determine the subjects/topics and their weights.
11. *EM research* establishes that there was a consensus in Undergrad and Grad EM subjects/topics.
12. *EM faculty, who are SMEs* are asked to provide course outlines referenced to standard texts in the field.
13. *EM faculty, who are SMEs* are asked to peer review the course outlines. Through the peer review process (requiring some iteration) a consensus is reached on the course outlines.
14. *ASEM Board* approves EM BoK and the *ASEM membership* approves EM BoK at the ASEM annual meeting.

## **Appendix III. EM BoK: Major Functional Definitions; Sub Fields; Typical Course Names**

### 1. Qualitative / Conceptual Courses

#### *A. Individual People oriented*

Typical Course Names: Individual Psychology; Personnel Management

#### *B. Organization or Group oriented*

Typical Course Names: Organizational Behavior; Management Theory; Teaming

### 2. Quantitative / Methodical Courses

#### *A. Quantitative*

Typical Course Names: Statistics; Operations Research; Decision Theory; Simulation

#### *B. Methodical*

Typical Course Names: Systems Engineering



### 3. Accounting / Financial and Economics Courses

#### *A. Accounting / Finance*

Typical Course Names: Managerial Accounting; Financial Accounting;  
Cost Accounting; Eng. Accounting; Financial Management; Managerial Finance

#### *B. Economics*

Typical Course Names: Eng. Economics; Macro or Micro or Managerial Economics

### 4. Project Related Courses

#### *A. Project Management*

Typical Course Name: Project Management

#### *B. Capstone*

Typical Course Names: Capstone; Special Projects

### 5. Functional Courses

#### *A. Functional Technical Management*

Typical Course Names: Operations Management; Quality Management; Engineering Management; R&D Management; Marketing Management

#### *B. Functional Business Management*

Typical Course Names: Marketing; Engineering Law; Mgt. Information Systems

### 6. Engineering and Science Courses

#### *A. Engineering Courses*

Typical Course Names: any with “engineering” in title – except for Engineering Management; Systems Engineering and Industrial Engineering

#### *B. Science Courses*

Typical Course Names: Mathematics, Chemistry or Physics courses

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