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Comparative Analysis of Different Engineering Management Bodies of Knowledge and Engineering Management Handbooks

Abstract

Multiple Engineering Management Bodies of Knowledge (EM BoK) exist. They have been established by the American Society for Engineering Management (ASEM), The Engineering Management Certification International (EMCI) and The Society of Manufacturing Engineers (SME).

There are also Engineering Management (EM) handbooks which include EM subjects and topics. This paper analyzes the similarities and differences between these published EM BoKs and EM handbooks to help clarify the current state of the EM BoKs. Areas for future research include evaluating the role and perspectives of the Subject Matter Experts.

History of EMBoK

EM is a relatively new discipline which combines knowledge of academic and practice topics. A working knowledge in several areas, often frequently with additional depth in one area, [3] is required.

Over the last 25 years a number of articles have been published which analyzed EM curricula and helped define an EMBoK. (See Bibliography A). Several authors have analyzed undergraduate and graduate EM programs and provided their definitions of EM. [1, 2]

Development of ASEM EM BoK

The ASEM, as the lead professional society in Engineering Management developed a certification program for Masters in Engineering Management. This helped provide curriculum standards for EM Masters level programs[4]. Over the last few years the number of undergraduate EM programs achieving accreditation form the Accrediting Board for Engineering and Technology (ABET) have increased from three to six[5].

The ASEM certified MS EM programs and the ABET accredited BS/BE programs formed the basis for ASEM to establish an EM BoK. Both ASEM and ABET require programs to be based on outcomes developed with industrial advisory boards. Curricula are developed by faculty who are subject matter experts in the various subjects. This has the benefit of utilizing in-depth work of faculty and advisory boards to define EM outcomes[7].

SME and EMCI EM BoKs

There are several other bodies which offer certifications for engineering managers. These certifications are provided based on feedback from industry practitioners and developed by various organizations such as the Society of Manufacturing Engineers (SME) and Engineering

Management Certification International (EMCI). As with any body of knowledge that has been compiled by different groups, some variations between the various EM BoKs exist.

Purpose of Paper

The purpose of this paper is to compare the SME and EMCI EM BoKs with the ASEM EM BoK. This paper will identify similarities and differences which exist among these various EMBoKs.

This comparison could lead to further modification or standardization of the bodies of knowledge, which is consistent with the continuous process improvement (CPI) policy that every engineering manager should adhere to.

Methodology

This paper examines the three published EMBoKs and compares the various topics and sub topics using the approach in Table 1.

Degree of Commonality Between EM BoKs.	
Degree of Commonality	Approx. % of commonality
HIGH	> 80 %
MEDIUM	20% -- 80%
LOW	< 20%
NONE	0%

Table 1: Degree of Commonality (Scale)

The above table describes the Degree of Commonality between the various EMBoKs and is based on the logic of normal distribution[6]. The 68-95-99.7 rule or empirical rule states that for a normal distribution, almost all values lie within 3 standard deviations of the mean. From that, about 68% of the values lie within 1 standard deviation of the mean.

The ASEM EMBoK[7] is used as the basis of comparison to other EM BoKs since it is based on the undergraduate and graduate EM programs. ASEM EM BoK is the basis of the knowledge EM graduates should have before they join the workforce. It is considered to be a pivotal point in the career of an engineering manager; therefore it was decided to choose the ASEM EM BoK as the basis for comparison.

Source Research – Published EM BoKs

For this section of the paper, three different EMBoKs were selected. The three EM Bodies of Knowledge currently in use are sponsored by:

1. The American Society of Engineering Management (ASEM)
2. The Society of Manufacturing Engineers (SME)
3. Engineering Management Certification International (EMCI)

The ASEM EM BoK was developed from an academic perspective; the SME & EMCI are certification programs from an industry perspective. One reason for choosing them is to be able to identify gaps between the perspective of academic and industry subject matter experts. As mentioned earlier, the common goal should be for that these types of bodies of knowledge are in general agreement so that academia can produce the type of engineering management graduates which industry requires/needs.

Appendix A, B and C contain tables listing the major and sub-topics for ASEM EMBoK, SME Certified Engineering Manager (CEM) BoK, and the EMCI EM BoK.

Comparison of Three EM BoKs - Observations and Comments

Appendix C shows a table comparing the three EM BoKs major topics. Some general observations are as follows:

1. Overall Comparison
   In general, the topics contained more commonality than differences. A majority of the topics were addressed in all three EM BoKs although they differed in depth. The ASEM subjects were more in depth than the SME and EMCI EM BoKs.

2. Quantitative Topics
   There was low or no commonality among the EM BoKs on Quantitative topics. The SME BoK and EMCI EM BoKs had low commonality and very little depth or detail.

   This gap could exist because subject matter experts have different perspectives in academia and industry. Another reason could be because the ASEM EM BoK is based on fundamental topics required of Engineering Management students. Conversely engineering managers from industry may not think that quantitative courses are relevant because, by the time an engineer gets to be an engineering manager, he/she is more involved with managing tasks and people rather than with the actual quantitative analyses.

3. People and Project Management Topics
   Project Management and People Management topics were covered in all three bodies of knowledge although not in the same depth. The ASEM subjects were more in depth compared to the SME and EMCI EM BoKs.

   The reason for this could be that Project Management and People Management are a core competency for any engineering manager to be successful. It is likely that Subject Matter Experts in academia as well as in industry stress these topics. ABET 2000 and other national studies of engineering curricula emphasize leadership, communication and team skills.

4. Accounting/Finance
   Accounting / Finance was also a topic which was emphasized more in the ASEM EM BoK and less in the other two EMBoKs. We assume that the same reasoning which has

been used to explain the lack of quantitative analysis can be used for the lack of representation of accounting/finance topics.

5. Systems Engineering
   The ASEM EM BoK includes Systems Engineering which is increasingly used in today's competitive business environment. However, this topic was not addressed by the EMCI or the SME EM BoKs.

   This gap possibly exists because the ASEM EM BoK was developed from an academic perspective for engineers that could involve in engineering design. For an engineering design viewpoint EM graduates need to understand systems engineering as well as engineering management. Conversely practitioners from industry may not think Systems Engineering is necessary for an engineering manager to perform effectively.

6. Professional Responsibilities and Legal Issues
   This topic is covered by EMCI but not by the ASEM or by the SME. The reason is that the EMCI looks at certifying their engineering managers through an industry perspective where legal issues are important.

7. Marketing and Sales
   This topic was addressed by EMCI but has not been covered by the ASEM and the SME. Again, the reason is that EMCI is industry focused where marketing and sales are considered a competency for engineering managers. Conversely, the ASEM EM BoK assumed that an engineer would learn about Marketing and Sales on the job or in Masters programs which provide this training. It should be noted that some BS EM and MS EM programs offer Marketing as an elective course and this topic is added for more advanced EM graduates.

Source Research – Published EM Handbooks

What other sources of Engineering Management topics are available? An extensive Google search was undertaken and subject matter experts were consulted. This process helped to identify five books which are thought to be standardized textbooks in the field of Engineering Management. These 5 standardized Engineering Management textbooks are listed below and can be found in the bibliography:

1. "Engineering Management", Mazda, Fraidoon
2. "Engineering Management", Shannon, Robert
3. "The Management of Engineering", Bennett, Lawrence,F.
4. "Handbook of Engineering Management (2nd Edition)", Edited: Lock, Dennis
5. "Engineering Management – Managing Effectively in Technology Based Organizations", Thamhain, Hans J.

The next step, after the identification process was completed, was to compare the base EMBoK, which was the ASEM EMBoK, with the various standardized textbooks mentioned above. Tables were constructed that are included in Appendix B, which show these comprehensive

comparisons. The paper concludes by assigning a level of commonality between the ASEM EMBoK and the handbooks, which is shown in Table 6 of Appendix B.

Comparison between the Five Standardized EM Handbooks and the ASEM EMBoK

Some general observations when comparing the five standardized textbooks with the ASEM Engineering Management Body of Knowledge (EMBoK) are as follows:

1. Overall Comparison:
In general, all five textbooks had a medium level of commonality with the ASEM EMBoK. None of the textbooks covered topics on Quantitative courses, which was a major gap that has been identified.

2. Quantitative Topics:
None of the five textbooks covered the topics usually found in Quantitative Courses, such as Statistics, Operations Research (OR) and Simulation. It is probable that none of the authors considered statistics, Operations Research or simulation to be an engineering manager's responsibility because they are generally not involved in the design process. Most engineers are involved in the design process before they become engineering managers.

3. People and Project Management Topics:
People and Project Management topics were covered in all five textbooks. It is evident that all the authors considered this to be a core necessity for any engineering manager to be successful. This indicates a commonality between the industry and academic perspectives of what is required to be a successful and efficient engineering manager.

4. Accounting/Finance
Accounting/Finance is another topic that was addressed by only 60% of the books. This could be because the authors considered it to be a job function of employees in the finance or accounting division and not the responsibility of the engineering manager.

Overall comparison of EMBoKs and EM Handbooks:

The examination of the three EMBoKs and five EM Handbooks identified the following:

- People and Project Management topics were covered in all BoKs as well as handbooks reviewed. However, ASEM and EMBoKs covered these topics more in depth.
- Quantitative topics were covered in the ASEM EMBoK but not in the other documents.
- Accounting and Finance was covered in depth in the ASEM EMBoK but not in the other two EMBoKs and only in some EM Handbooks.
- Professional Responsibility & Legal Issues and Marketing & Sales were covered in the EMCI EMBoK but not in the other two EMBoKs or in the EM Handbooks.

- Systems Engineering was covered in the ASEM EMBoK but not in the other two EMBoKs or in any of the EM Handbooks.

Future Research:

Future research should include interviewing subject matter experts (SMEs) as well as authors of the standardized textbooks, to determine why they did not consider the quantitative courses, systems engineering and accounting/finance (partial) significant enough to be included in their material. Future research should encourage industry and academia SMEs to evaluate EM BoKs.

Bibliography A: Articles relating to EMBoK

1. Farr, John V., and Bowman, Bruce A. "Engineering Management Programs: Contemporary and Future Issues", Engineering Management Journal, Vol 11, No.4, December 1999.
2. Westbrook, Jerry D., "ASEM's Effort to recognize quality in Engineering Management Master's Programs", Engineering Management Journal, Vol 17, No.1, March 2005, pp 33-38.
3. Peterson, William R, and Collin, Terry, "Engineering Management Body of Knowledge," Unpublished position paper presented to ASEM Board.
4. Westbrook (2003, 2004)
5. Abel, Kate, and Fernandez, Abel, "ABET Accreditation of Undergraduate Engineering Management Programs – the similarities and differences", Engineering Management Journal, Vol 17, No.1, March 2005, pp 3-7.
6. http://www-stat.stanford.edu/~naras/jsm/NormalDensity/NormalDensity.html

Bibliography B: Engineering Management Bodies of Knowledge

7. Merino, Donald, "The American Society for Engineering Management (ASEM) Engineering Management Body of Knowledge (EMBoK)", 27th Annual ASEM Conference proceedings, Chattanooga, Tennessee, November 7-10, 2007
8. Society of Manufacturing Engineers (SME) "Certified Engineering Manager (CEM) Body of Knowledge"; Published by the Society of Manufacturing Engineers.
9. EMCI; "A guide to the Engineering Management Certification Body of Knowledge"; The Engineering Management Certification International (EMCI); Published by American Society of Mechanical Engineers; ISBN 0-7918-0247-7

Bibliography C: Standardized Textbooks for the field of Engineering Management

10. Mazda, Fraidoon ,"Engineering Management",; ISBN: 0-201-17798-6; Publisher: Prentice Hall, 1st edition (November 1, 1997)
11. Shannon, Robert , "Engineering Management",; ISBN: 0-471-03408-8; Publisher: John Wiley & Sons, March 10, 1980.
12. Bennett, F. Lawrence , "The Management of Engineering",; ISBN:0-471-59329-X; Publisher: John Wiley & Sons, 1st Edition, October 20, 1995.
13. Lock, Dennis , "Handbook of Engineering Management (2nd Edition)", ISBN: 0 7506 0786 6
14. Thamhain, Hans J , "Engineering Management – Managing Effectively in Technology Based Organizations"; ISBN: 0-471-82801-7; Publisher: Wiley – Interscience, 1st edition, November 5, 1992.

Appendix A: Engineering Management Body of Knowledge Tables

Table 1: American Society of Engineering Management (ASEM) Body of Knowledge contents

American Society of Engineering Management (ASEM) EMBoK Contents

Serial Number	MAJOR TOPIC / Sub – topics
1.A	**Individual / People Oriented**
1.A.1	**Organizational Behavior**
	Introduction to Organizational Behavior
	The Contemporary Context of OB
	Individual Differences and Work Behavior
	Human Motivation and Performance
	Learning and Development
	Group Process and Team Dynamics
	Power and Political Behavior
	Leadership
	Interpersonal Communication
	Conflict Management/Negotiation
	Decision Making and Creative Problem Solving
1.B.	**Organizational / Group Oriented**
1.B.1	**Management Theory**
	Historic Performance
	Attempt in Integration of Management Concepts
	Effect of the type of organization
	What is working?
2.A	**Quantitative**
2.A.1	**Statistics**
	Introduction
	Describe a single population
	Compare two populations
	Analyze one and two variable relationships
	Analyze Multi Variable Relationships
2.A.2	**Operations Research**
	Introduction to Operations Research Modeling
	Deterministic Models
	Stochastic Models
2.A.3	**Simulation**
	Mathematical Foundations
	Computer Science Foundations
	Discrete Event Simulation
	Data Analyses
	Monte-Carlo Simulation
2.B	**Methodical**
2.B.1	**Systems Engineering**
	Overview of the Systems Engineering Process
	Systems Design Process
	Systems Analysis and Design Evaluation

	Systems Engineering Management
3.A	**Accounting / Finance**
3.A.1	**Accounting for Engineers**
	Basic Accounting -- Fundamentals
	Basic Financial Accounting
	Advanced Cost Accounting
	Advanced Cost Estimation
3.A.2	**Engineering Economics**
	Costs & Economic Decision Making
	Time Value of Money
	Interest Rates
	Figures of Merit
	After Tax Analysis
	Sensitivity Analysis
	Uncertainty and probability
4.A	**Project Management**
4.A.1	**Project Management**
	Project Life Cycle
	Processes involved in project management
	Project management environment
	Tools used in project management
	Scope of project
	Determination of skills required
	Development of schedules
	Development of cost estimates
	Risk Management Issues
	Monitoring project Progress
	Making tradeoffs in a project
4.A.2	**Capstone Related**
5.A	**Functional Courses**
5.A.1	**Engineering Management**
	Introduction to Engineering Management
	Functions of Engineering Management
	Managing Technology through the product life cycle.
5.A.2	**Operations Management**
	Strategy and competition
	Forecasting
	Aggregate planning
	Inventory management
	Operations Scheduling
	Supply Chain Management
	Quality
	Process Management
	Project Management
	Location and Layout
5.A.3	**Quality Management**
	Quality Management Concepts / Theories

	Management of Quality Continuous Process Improvement (CPI) and process management Measurement of Quality Quality Standards

Table 2: Society of Manufacturing Engineers (SME) Certified Engineering Manager (CEM) Body of Knowledge

Society of Manufacturing Engineers (SME) Certified Engineering Manager (CEM) Body of Knowledge	
Serial Number	**Major Topic /** Sub topics
1	**Customer Focus**
1.1	Customer Needs Identification and Anticipation
1.2	Business Mission, Vision and Strategy
1.3	Market / Product Strategy
2	**People, Teamwork and Organization**
2.1	Personnel (Interns, Employees, Consultants, Contractors, Loaned)
2.2	Organizational Planning, Structure and Development
2.3	Teaming and Teamwork
2.4	Continuous Learning and Training
2.5	Performance Management
2.6	Communications
2.7	Culture
2.8	Management/Leadership
3	**Not mentioned in TOC of CEM**
4	**Business Processes**
4.1	Product/Process Development
4.2	Manufacturing
4.3	Customer Support
5	**Resources and Responsibilities**
5.1	Resources (Human, Finance, Facilities, Equipment, Intellectual Property, Technology)
5.2	Organizational Responsibilities (Employees, Shareholders & Community)

6	**External Enterprise Influences**
6.1	Resources
6.2	Standards
6.3	Programs

Table 3: Engineering Management Certification International (EMCI) Body of Knowledge

Engineering Management Certification International (EMCI) Body of Knowledge	
Serial Number	**Major Topics /** Sub topics
1	**Market Research, Technology Updates & Environmental Scanning**
1.1	Market Analysis
1.2	Best Practices and Lessons Learned
1.3	Business Research and Forecasting
1.4	Risk Analysis
1.5	Trend Analysis
1.6	Technology Assessment Practices
1.7	Presentation Skills
2	**Planning & Adjusting Business Strategies**
2.1	Strategic Destinations and Planning
2.2	System Design and Life Cycle Engineering
2.3	Partnering and Outsourcing Strategies
2.4	Financial Risk Management Strategies and Models for new techniques
2.5	Change Management Techniques and Adjustment Strategies
3	**Developing Products, Services & Processes**
3.1	Engineering Disciplines
3.2	Manufacturability
3.3	Computer Hardware & Software Systems
3.4	System Design Methodology and Life Cycle Engineering Product/Process Creation
4	**Engineering Operations and Change**
4.1	Capital Budget and Resource Planning
4.2	Project Management Techniques
4.3	Scheduling Techniques
4.4	Computer Hardware & Software Requirements
4.5	Strategies for maintaining customer service and satisfaction
4.6	Total Quality Management (TQM)
4.7	Manufacturability; Cycle Time Analysis

4.8	Maintenance and Repair Oversight
4.9	Operations Systems Analysis
5	**Financial Resources and Procurement**
5.1	Procurement and Contract Procedures
5.2	Funding Sources
5.3	Financial Accounting and Budgeting Procedures
5.4	Engineering Economic Analysis Techniques
5.5	Inventory control procedures and supply chain management
6	**Marketing & Sales**
6.1	Sales and Advertising Practices
6.2	Customer Satisfaction Strategies
6.3	Marketing and Branding Techniques
6.4	Product Portfolio Analysis
6.5	Global Trade and International Operations
6.6	Pricing Strategies
7	**Learning Individuals & Engineering Project Teams**
7.1	Knowledge of Performance Management, Coaching and Motivation Techniques
7.2	Negotiation Strategies
7.3	Recruitment, Selection and Compensation Practices
7.4	Team Processes
7.5	Managing a diverse workforce
7.6	Training and development techniques
7.7	Representing management to direct reports
7.8	Conflict Resolution Techniques
8	**Professional Responsibility & Legal Issues**
8.1	Company Specific Policies and Procedures
8.2	Regulatory Requirements
8.3	Business Contracts, Patents, Copyrights and trademark laws
8.4	U.S and International Codes, Standards and Regulations
8.5	Professional Code of Ethics; Professional Liability

Appendix B: Comparison Tables of ASEM EMBoK versus Standardized EM Handbooks

Table 1: ASEM EMBoK versus "Engineering Management"; Mazda, Fraidoon

	ASEM EMBoK Versus "Engineering Management"; Mazda, Fraidoon	
Serial Number	**Topic**	**Corresponding Topic in Engineering Management By Fraidoon Mazda ISBN: 0-201-17798-6**
1.A	**Individual / People Oriented**	
1.A.1	**Organizational Behavior**	
	Introduction to Organizational Behavior	3.1 -- Defining the organization
	The Contemporary Context of OB	3.4 -- Organizational Change
	Individual Differences and Work Behavior	
	Human Motivation and Performance	17 -- Leadership and motivation
	Learning and Development	
	Group Process and Team Dynamics	18 -- Team Building
	Power and Political Behavior	
	Leadership	17 -- Leadership and motivation
	Interpersonal Communication	
	Conflict Management/Negotiation	
	Decision Making and Creative Problem Solving	6 -- Decision Making
1.B.	**Organizational / Group Oriented**	
1.B.1	**Management Theory**	2 -- Definitions of Management
		2.1 -- What is management
	Historic Performance	2.2 -- The history of management
	Attempt in Integration of Management Concepts	
	Effect of the type of organization	3.2 -- Organization Structures
	What is working?	
2.A	**Quantitative**	
		7 Information Presentation
2.A.1	**Statistics**	7.1 Statistical Analysis
	Introduction	
	Describe a single population	
	Compare two populations	
	Analyze one and two variable relationships	
	Analyze Multi Variable Relationships	
		8 -- Mathematical Models in
2.A.2	**Operations Research**	decision making
	Introduction to Operations Research Modeling	
	Deterministic Models	
	Stochastic Models	
2.A.3	**Simulation**	Not covered in this book
	Mathematical Foundations	
	Computer Science Foundations	
	Discrete Event Simulation	
	Data Analyses	
	Monte-Carlo Simulation	
2.B	**Methodical**	
2.B.1	**Systems Engineering**	Not covered in this book

	Overview of the Systems Engineering Process	
	Systems Design Process	
	Systems Analysis and Design Evaluation	
	Systems Engineering Management	
3.A	**Accounting / Finance**	
3.A.1	**Accounting for Engineers**	10 -- The Financial Environment
	Basic Accounting -- Fundamentals	
	Basic Financial Accounting	
	Advanced Cost Accounting	
	Advanced Cost Estimation	
3.A.2	**Engineering Economics**	12 -- Investment Decisions
	Costs & Economic Decision Making	
	Time Value of Money	
	Interest Rates	
	Figures of Merit	
	After Tax Analysis	
	Sensitivity Analysis	
	Uncertainty and probability	
4.A	**Project Management**	
4.A.1	**Project Management**	13 -- Project Planning and control
	Project Life Cycle	
	Processes involved in project management	
	Project management environment	
	Tools used in project management	
	Scope of project	
	Determination of skills required	
	Development of schedules	
	Development of cost estimates	
	Risk Management Issues	
	Monitoring project Progress	
	Making tradeoffs in a project	
5.A	**Functional Courses**	
5.A.1	**Engineering Management**	2 -- Definitions of management
	Introduction to Engineering Management	2.6 -- The Engineering Manager
	Functions of Engineering Management	2.6 -- The Engineering Manager, 9 -- Forecasting, 13 -- Project Planning and Control
	Managing Technology through the product life cycle.	
5.A.2	**Operations Management**	
	Strategy and competition	5 -- Strategy Formulation
	Forecasting	9 -- Forecasting
	Aggregate planning	13 -- Project Planning and control,
	Inventory management	
	Operations Scheduling	
	Supply Chain Management	

	Quality	14.7 -- Quality
	Process Management	13 -- Project Planning and control,
	Project Management	13 -- Project Planning and control,
	Location and Layout	
5.A.3	**Quality Management**	14.7 -- Quality
	Quality Management Concepts / Theories	
	Management of Quality	
	Continuous Process Improvement (CPI) and process management	
	Measurement of Quality	
	Quality Standards	

Table 2: ASEM EMBoK versus "Engineering Management"; Shannon, Robert

ASEM EMBoK Versus "Engineering Management"; Shannon, Robert		
Serial Number	**Topic**	**Corresponding in Engineering Management By Robert Shannon ISBN: 0-471-03408-8**
1.A	**Individual / People Oriented**	
1.A.1	**Organizational Behavior**	3 -- Organization
	Introduction to Organizational Behavior	
	The Contemporary Context of OB	
	Individual Differences and Work Behavior	
	Human Motivation and Performance	6 -- Motivation
	Learning and Development	
	Group Process and Team Dynamics	5.3 & 5.8 -- Creative Process and Brainstorming
	Power and Political Behavior	
	Leadership	7 -- Leadership
	Interpersonal Communication	
	Conflict Management/Negotiation	
	Decision Making and Creative Problem Solving	5 -- Creativity and Innovation
1.B.	**Organizational / Group Oriented**	
1.B.1	**Management Theory**	11 -- Unwritten laws of engineering
	Historic Performance	
	Attempt in Integration of Management Concepts	
	Effect of the type of organization	
	What is working?	
2.A	**Quantitative**	
2.A.1	**Statistics**	Not covered in this book
	Introduction	

	Describe a single population	
	Compare two populations	
	Analyze one and two variable relationships	
	Analyze Multi Variable Relationships	
2.A.2	**Operations Research**	Not covered in this book
	Introduction to Operations Research Modeling	
	Deterministic Models	
	Stochastic Models	
2.A.3	**Simulation**	Not covered in this book
	Mathematical Foundations	
	Computer Science Foundations	
	Discrete Event Simulation	
	Data Analyses	
	Monte-Carlo Simulation	
2.B	**Methodical**	
2.B.1	**Systems Engineering**	10 -- Systems Management
	Overview of the Systems Engineering Process	
	Systems Design Process	
	Systems Analysis and Design Evaluation	
	Systems Engineering Management	
3.A	**Accounting / Finance**	
3.A.1	**Accounting for Engineers**	Not covered in this book
	Basic Accounting -- Fundamentals	
	Basic Financial Accounting	
	Advanced Cost Accounting	
	Advanced Cost Estimation	
3.A.2	**Engineering Economics**	8 -- Project Selection
	Costs & Economic Decision Making	
	Time Value of Money	
	Interest Rates	
	Figures of Merit	
	After Tax Analysis	
	Sensitivity Analysis	
	Uncertainty and probability	
4.A	**Project Management**	
4.A.1	**Project Management**	10 -- Systems Management
	Project Life Cycle	
	Processes involved in project management	
	Project management environment	
	Tools used in project management	
	Scope of project	
	Determination of skills required	
	Development of schedules	
	Development of cost estimates	
	Risk Management Issues	
	Monitoring project Progress	
	Making tradeoffs in a project	

5.A	**Functional Courses**	
5.A.1	**Engineering Management** Introduction to Engineering Management Functions of Engineering Management Managing Technology through the product life cycle.	1 -- Environment of Engineering Management
5.A.2	**Operations Management** Strategy and competition Forecasting Aggregate planning Inventory management Operations Scheduling Supply Chain Management Quality Process Management Project Management Location and Layout	2.1 & 2.3 -- Planning and the phases of planning 2.5 & 2.7 -- Forecasting and the pitfalls in forecasting
5.A.3	**Quality Management** Quality Management Concepts / Theories Management of Quality Continuous Process Improvement (CPI) and process management Measurement of Quality Quality Standards	Not covered in this book

Table 3: ASEM EMBoK versus "The Management of Engineering"; Bennett, Lawrence

ASEM EMBoK Versus "The Management of Engineering"; Bennett, Lawrence		
Serial Number	**Topic**	**Corresponding Topic in The Management of Engineering By F. Lawrence Bennett ISBN: 0-471-59329-X**
1.A	**Individual / People Oriented**	
1.A.1	**Organizational Behavior**	2 -- The Engineering Organization
	Introduction to Organizational Behavior	2.1 -- The Effective Organization
	The Contemporary Context of OB Individual Differences and Work Behavior	5.6 -- The personnel administration function
	Human Motivation and Performance	5.1 – Motivation
	Learning and Development	
	Group Process and Team Dynamics	
	Power and Political Behavior	

	Leadership	5.2 -- Leadership
	Interpersonal Communication	6 -- Communication in the Engineering Organization
	Conflict Management/Negotiation	
	Decision Making and Creative Problem Solving	
1.B.	**Organizational / Group Oriented**	
1.B.1	**Management Theory**	
	Historic Performance	1.1 -- Engineering/management as a profession and career 1.2 Engineering Versus Management
	Attempt in Integration of Management Concepts	1.3 -- The transition to Engineering Manager
	Effect of the type of organization	2.2 -- Organizational Structures
	What is working?	
2.A	**Quantitative**	
2.A.1	**Statistics**	Not covered in this book
	Introduction	
	Describe a single population	
	Compare two populations	
	Analyze one and two variable relationships	
	Analyze Multi Variable Relationships	
2.A.2	**Operations Research**	Not covered in this book
	Introduction to Operations Research Modeling	
	Deterministic Models	
	Stochastic Models	
2.A.3	**Simulation**	Not covered in this book
	Mathematical Foundations	
	Computer Science Foundations	
	Discrete Event Simulation	
	Data Analyses	
	Monte-Carlo Simulation	
2.B	**Methodical**	
2.B.1	**Systems Engineering**	Not covered in this book
	Overview of the Systems Engineering Process	
	Systems Design Process	
	Systems Analysis and Design Evaluation	
	Systems Engineering Management	
3.A	**Accounting / Finance**	
3.A.1	**Accounting for Engineers**	Not Covered in this book
	Basic Accounting -- Fundamentals	
	Basic Financial Accounting	
	Advanced Cost Accounting	
	Advanced Cost Estimation	
3.A.2	**Engineering Economics**	Not Covered in this book
	Costs & Economic Decision Making	
	Time Value of Money	
	Interest Rates	
	Figures of Merit	
	After Tax Analysis	

	Sensitivity Analysis Uncertainty and probability	
4.A	**Project Management**	
4.A.1	**Project Management**	7 -- Management of Engineering Projects
	Project Life Cycle	7.1.3 -- The project Life Cycle
	Processes involved in project management	7.1.2 -- The Essence of successful project management
	Project management environment	7.2 -- Project Organizations
	Tools used in project management	
	Scope of project	
	Determination of skills required	
	Development of schedules	
	Development of cost estimates	
	Risk Management Issues	
	Monitoring project Progress	
	Making tradeoffs in a project	
5.A	**Functional Courses**	
5.A.1	**Engineering Management**	
	Introduction to Engineering Management	1.3 -- The Transition to an Engineering Manager
	Functions of Engineering Management	1.5 -- The Engineering Manager's Functions and Activities
	Managing Technology through the product life cycle.	
5.A.2	**Operations Management**	
	Strategy and competition	
	Forecasting	
	Aggregate planning	
	Inventory management	
	Operations Scheduling	
	Supply Chain Management	
	Quality	3 -- Total Quality Management: Principles and Approaches
	Process Management	7 -- Management of Engineering Principles
	Project Management	7 -- Management of Engineering Principles
	Location and Layout	
5.A.3	**Quality Management**	3 -- Total Quality Management: Principles and Approaches, 4 -- Total Quality Management: Techniques and applications
	Quality Management Concepts / Theories	
	Management of Quality	
	Continuous Process Improvement (CPI) and process management	
	Measurement of Quality	
	Quality Standards	

Table 4: ASEM EMBoK versus "The Handbook of Engineering Management", Edited: Lock, Dennis

	ASEM EMBoK Versus "Handbook of Eng. Management" Edited By Dennis Lock	
Serial Number	**Topic**	**Corresponding Topic in The Handbook of Engineering Management By Dennis Lock ISBN: (0-7506-0786-6)**
1.A	**Individual / People Oriented**	
1.A.1	**Organizational Behavior**	Part Two: Organization and Human Behavior
	Introduction to Organizational Behavior	
	The Contemporary Context of OB	
	Individual Differences and Work Behavior	
	Human Motivation and Performance	Motivation -- The technique of management by objectives
	Learning and Development	Integration of supervision, leadership and motivation
	Group Process and Team Dynamics	
	Power and Political Behavior	
	Leadership	Leadership -- an essential part of engineering management
	Interpersonal Communication	8 -- Personal Communication Skills
	Conflict Management/Negotiation	
	Decision Making and Creative Problem Solving	
1.B.	**Organizational / Group Oriented**	
1.B.1	**Management Theory**	Management of Technical Activities
	Historic Performance	
	Attempt in Integration of Management Concepts	
	Effect of the type of organization	
	What is working?	
2.A	**Quantitative**	
2.A.1	**Statistics**	Not covered in this book
	Introduction	
	Describe a single population	
	Compare two populations	
	Analyze one and two variable relationships	
	Analyze Multi Variable Relationships	
2.A.2	**Operations Research**	Not covered in this book
	Introduction to Operations Research Modeling	
	Deterministic Models	
	Stochastic Models	
2.A.3	**Simulation**	Not covered in this book
	Mathematical Foundations	

	Computer Science Foundations	
	Discrete Event Simulation	
	Data Analyses	
	Monte-Carlo Simulation	
2.B	**Methodical**	
2.B.1	**Systems Engineering**	Not covered in this book
	Overview of the Systems Engineering Process	
	Systems Design Process	
	Systems Analysis and Design Evaluation	
	Systems Engineering Management	
3.A	**Accounting / Finance**	
3.A.1	**Accounting for Engineers**	10 -- Management and cost accounting
	Basic Accounting -- Fundamentals	
	Basic Financial Accounting	
	Advanced Cost Accounting	
	Advanced Cost Estimation	
3.A.2	**Engineering Economics**	12 -- Project Investment Appraisal
	Costs & Economic Decision Making	
	Time Value of Money	
	Interest Rates	
	Figures of Merit	
	After Tax Analysis	
	Sensitivity Analysis	
	Uncertainty and probability	
4.A	**Project Management**	
4.A.1	**Project Management**	Part Five: Operations and Work Management
	Project Life Cycle	
	Processes involved in project management	
	Project management environment	
	Tools used in project management	
	Scope of project	
	Determination of skills required	
	Development of schedules	
	Development of cost estimates	
	Risk Management Issues	
	Monitoring project Progress	
	Making tradeoffs in a project	
5.A	**Functional Courses**	
5.A.1	**Engineering Management**	1 -- Engineering Management
	Introduction to Engineering Management	Definition of Engineering Management
	Functions of Engineering Management	Management of Technical Activities
	Managing Technology through the product life cycle.	The management of broader functions

5.A.2	**Operations Management**	
	Strategy and competition	
	Forecasting	
	Aggregate planning	
	Inventory management	
	Operations Scheduling	
	Supply Chain Management	
	Quality	32 -- Quality Management
	Process Management	Work Management
	Project Management	
	Location and Layout	
5.A.3	**Quality Management**	32 -- Quality Management
	Quality Management Concepts / Theories	
	Management of Quality	
	Continuous Process Improvement (CPI) and process management	
	Measurement of Quality	
	Quality Standards	

Table 5: ASEM EMBoK versus "Engineering Management: Managing Effectively in Technology based Organizations"; Thamhain, Hans

ASEM EMBoK Versus "Engineering Management: Managing Effectively in Technology based organizations"; Thamhain, Hans		
Serial Number	**Topic**	**Corresponding Topic in Engineering Management: Managing Effectively in Tech Org. By Hans J. Thamhain ISBN: 0-471-82801-7**
1.A	**Individual / People Oriented**	
1.A.1	**Organizational Behavior**	2 -- Organizing the Engineering Function
	Introduction to Organizational Behavior	
	The Contemporary Context of OB	
	Individual Differences and Work Behavior	
	Human Motivation and Performance	10.2 -- Human Motivation in Engineering
	Learning and Development	
	Group Process and Team Dynamics	12 -- Team Building in Engineering
	Power and Political Behavior	
	Leadership	10.4 -- Leadership in Engineering
	Interpersonal Communication	
	Conflict Management/Negotiation	13 -- Managing Conflict and Change
	Decision Making and Creative Problem Solving	
1.B.	**Organizational / Group Oriented**	
1.B.1	**Management Theory**	1 -- Managing in Engineering: A

		Perspective
	Historic Performance	1.4 -- Evolution of Modern Engineering Management
	Attempt in Integration of Management Concepts	8.1 -- The need for Integrated Management 2.1 -- Organizational Interdependence
	Effect of the type of organization	2.2 -- Why organizational structures are changing
	What is working?	10.6 -- How to make it work
2.A	**Quantitative**	
2.A.1	**Statistics**	Not covered in this book
	Introduction	
	Describe a single population	
	Compare two populations	
	Analyze one and two variable relationships	
	Analyze Multi Variable Relationships	
2.A.2	**Operations Research**	Not covered in this book
	Introduction to Operations Research Modeling	
	Deterministic Models	
	Stochastic Models	
2.A.3	**Simulation**	Not covered in this book
	Mathematical Foundations	
	Computer Science Foundations	
	Discrete Event Simulation	
	Data Analyses	
	Monte-Carlo Simulation	
2.B	**Methodical**	
2.B.1	**Systems Engineering**	Not covered in this book
	Overview of the Systems Engineering Process	
	Systems Design Process	
	Systems Analysis and Design Evaluation	
	Systems Engineering Management	
3.A	**Accounting / Finance**	
3.A.1	**Accounting for Engineers**	Not covered in this book
	Basic Accounting -- Fundamentals	
	Basic Financial Accounting	
	Advanced Cost Accounting	
	Advanced Cost Estimation	
3.A.2	**Engineering Economics**	Not covered in this book
	Costs & Economic Decision Making	
	Time Value of Money	
	Interest Rates	
	Figures of Merit	
	After Tax Analysis	
	Sensitivity Analysis	
	Uncertainty and probability	
4.A	**Project Management**	

4.A.1	**Project Management** Project Life Cycle Processes involved in project management Project management environment Tools used in project management Scope of project Determination of skills required Development of schedules Development of cost estimates Risk Management Issues Monitoring project Progress Making tradeoffs in a project	5 -- Tools and Techniques for Managing Engineering Projects
5.A	**Functional Courses**	
5.A.1	**Engineering Management** Introduction to Engineering Management Functions of Engineering Management Managing Technology through the product life cycle.	1 -- Managing in Engineering: A Perspective
5.A.2	**Operations Management** Strategy and competition Forecasting Aggregate planning Inventory management Operations Scheduling Supply Chain Management Quality Process Management Project Management Location and Layout	8.2 -- Forecasting 3 -- Planning the Engineering Function 11.6 -- Total Quality Management 4 -- Engineering Project Planning
5.A.3	**Quality Management** Quality Management Concepts / Theories Management of Quality Continuous Process Improvement (CPI) and process management Measurement of Quality Quality Standards	11.6 -- Total Quality Management

Table 6: Engineering Management Handbook Analysis

Engineering Management Standardized Textbook Analysis			
No.	**EM Handbook Author**	**General Commonality rating for book with ASEM EMBoK**	**Gap Analysis - Topics**
1	Fraidoon Mazda	HIGH	Quantitative Subjects
2	Robert Shannon	MEDIUM	Quantitative Subjects, Quality Management
3	Lawrence Bennett	MEDIUM	Quantitative Subjects Accounting/ Finance
4	Dennis Lock	HIGH	Quantitative Subjects
5	Hans J. Thamhain	MEDIUM	Quantitative Subjects Accounting/Finance

Appendix C: Topic Comparison for the various EMBoKs

Table 1: Comparative Table between 3 EMBoKs

Comparison of Topics by Various Engineering Management Bodies of Knowledge			
Sponsor	**American Society of Engineering Management (ASEM)**	**Society of Manufacturing Engineers (SME)**	**Engineering Management Certification International (EMCI)**
Major Topic / Subject	**ASEM EMBoK**	**CEM BoK**	**EMCI BoK**
PEOPLE	1.A.1 & 1.A.2 -- Organizational Behavior & Management Theory	2 -- People, Teamwork and Organization	7 -- Learning Individuals & Engineering Project Teams
Quantitative Courses	2.A.1 -- Statistics	Statistics not covered in CEM BoK	Statistics not covered in EMC BoK
	2.A.2 -- Operations Research	4.2.1 -- Operations and Resource Planning	Operations Research not covered in EMC BoK
	2.A.3 -- Simulation	Simulation not covered in CEM BoK	Simulation not covered in EMC BoK
Methodical Courses	2.B.1 -- Systems Engineering	4.1.1 -- System Design, 4.1.4 -- Documentation and release	2.2 -- System Design and life-cycle engineering 3.4 -- System Design Methodology and life cycle engineering product/process creation.

Accounting, Financial and Economics	3.A.1 -- Accounting for Engineers	5.1.2 -- Finance / Capital	4.1 Capital Budget and resource planning, 5.3 Financial accounting and budgeting procedures; balance sheets and cash flows
	3.B.1 -- Engineering Economics	5.1.2 -- Finance / Capital	4.1 Capital Budget and resource planning, 5.4 Engineering Economic analysis techniques
Project Management Courses	4.A.1 -- Project Management	2.2 Organizational Planning, Structure and Development 2.3 Teaming and Teamwork 2.8 Management Leadership 5.1.6 Management of Technology	1.4 Risk analysis 4.2 Project Management techniques during normal and changing conditions 4.3 Scheduling Techniques 6.6 Pricing Techniques 7.4 Team Processes 7.8 Conflict resolution techniques
Functional Courses	5.A.1 -- Engineering Management	1.2 Business Mission, Vision and Strategy 2.3 Teaming and Teamwork 2.5 Performance Management 2.8 Management / Leadership 5. Resources and Responsibilities	1.4 Risk Analysis 4.2 Project Management techniques during normal and changing conditions 4.3 Scheduling Techniques 4.5 Strategies for maintaining customer service and satisfaction 5. Financial Resources & Procurement 7 Leading individuals and engineering project teams 8. Professional Responsibility & Legal Issues
	5.A.2 -- Operations Management	4.2.1 Operations and Resource Planning 4.2.2 Component Fabrication and Manufacturing 4.2.3 Assembly and Test 4.2.4 Supply Chain Management 4.3.2 Distribution	1.5 Trend Analysis 1.6 Technology assessment practices and techniques 2.1 Strategic destinations and planning 4.3 Scheduling techniques 4.5 Strategies for maintaining customer service and satisfaction 4.9 Operations systems analysis 5.1 Procurement and contract procedures
	5.A.3 -- Quality Management	2.4 Continuous learning and training 4.1.3 Continuous Improvement	4.6 Total Quality Management (TQM); Continuous process improvement (CPI)