

The Body of Knowledge and Curriculum to Advance Systems Engineering

By

Art Pyster

Deputy Executive Director, SERC

Distinguished Research Professor, Stevens Institute of Technology,

Principal Investigator, BKCASE

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Marriott Inn and Convention Center

Hyattsville, MD

What is BKCASE?

- Project to create:
 - Systems Engineering Body of Knowledge (SEBoK – pronounced “sea bock”)
 - Graduate Reference Curriculum in Systems Engineering (GRCSE™ – pronounced “Gracie”)
- Started Sept 2009 by Stevens and NPS with primary support from DASD/SE
- Project will run through December 2012
- Intended for world-wide use – all products available free in perpetuity



Vision

“Systems Engineering competency models, certification programs, textbooks, graduate programs, and related workforce development initiatives around the world align with BKCASE.”

Objectives

1. Create the SEBoK and have it be globally recognized by the SE community as the authoritative guide to the body of knowledge for the SE discipline.
2. Create GRCSE and have it be globally recognized by the SE community as the authoritative guidance for graduate programs in SE.
3. Facilitate the global alignment of related workforce development initiatives with SEBoK and GRCSE.
4. Transfer stewardship of SEBoK and GRCSE to INCOSE and the IEEE after BKCASE publishes version 1.0 of those products, including possible integration into their certification, accreditation, and other workforce development and education initiatives.

1. SE competency development in both DoD and Defense Industrial Base directly benefits from community agreement on:
 - Important SE ideas, terminology, and references and how SE relates to other disciplines such as SwE and PM
 - What students should know and be able to do when they receive a master's degree in SE
2. SE practitioners in both DoD and Defense Industrial Base will have a ready reference for key SE terminology, ideas, and references
3. SE practitioners and managers will have more mature guidance and standards for professional certification of systems engineers
4. A maturing SE field makes it easier for DoD managers to adopt SE best practices
5. Staff and managers understand better what schools should/do offer in their SE programs

Our Supporters



63 Current Authors and Liaisons

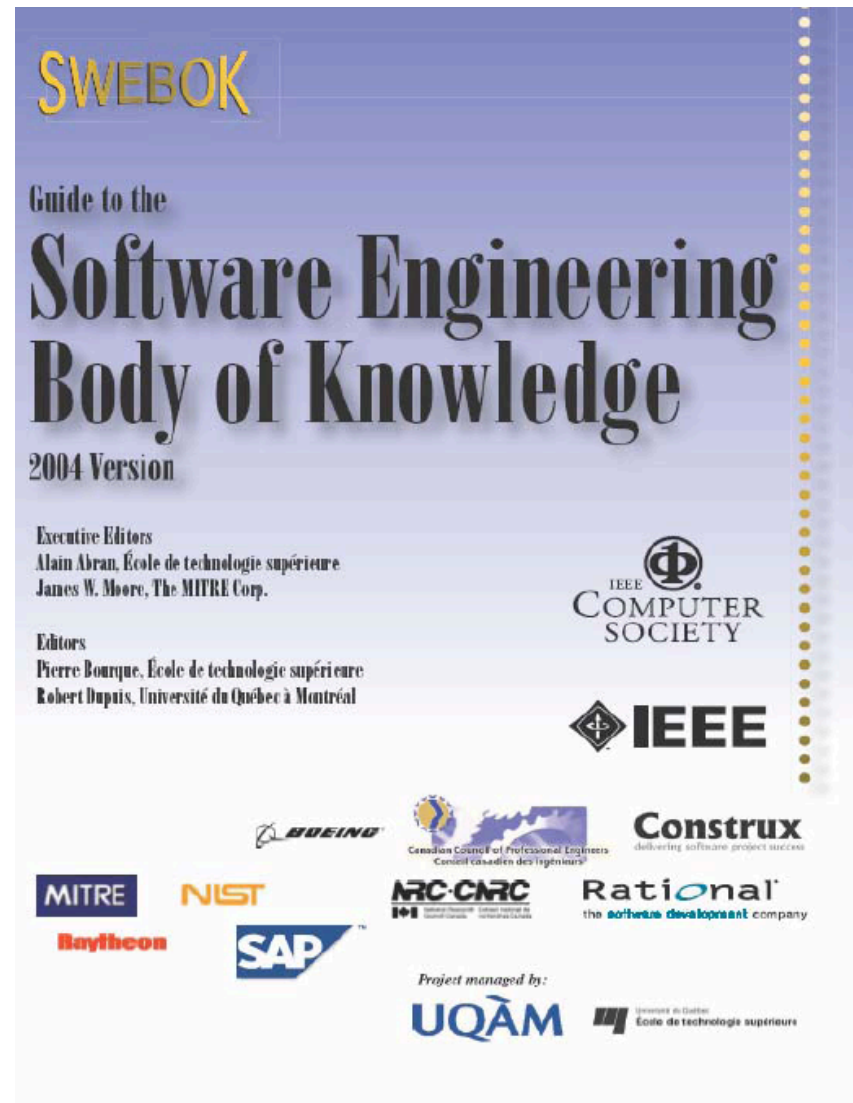
Location	Number
United States	44
Europe (UK, France, Sweden)	11
Asia-Pacific (Singapore, Japan, China, Australia)	7
Latin America (1 country)	1

Segment	Number
Academia	30
Industry	24
Government	3
Professional Societies	6

3 Liaisons from IEEE Computer Society/Systems Council and 2 from INCOSE are sponsored from the highest levels of their organizations to develop an agreement for those societies to assume joint ownership of SEBoK and GRCSE in late 2012

Systems Engineering Body of Knowledge

SWEBOK Was Starting Point



- SWEBOK is a way of organizing all the knowledge that is within the software engineering (SwE) discipline
- It is a hierarchical structure for the knowledge and references to key documents stating the knowledge as of 2004
- Developed by a community of authors and reviewers from around the world
- It is static – it has not changed since it was published as a PDF document
- A refresh project is underway to produce a new version

- Guide to literature just as SWEBOK is
- Community-based with broad participation, open review, transparent process
- Intent to go beyond SWEBOK (by the time SEBoK 1.0 is released):
 - Implementation as a wiki
 - More substantial article about each topic
 - More substantial information about relationship of SE to other disciplines
 - More substantial glossary of terms
 - More substantial information about how SE is applied and enabled

-
- Part 1: A guide to the SEBoK itself; e.g., Why does it exist? What is in it? How will different people use it?
 - Part 2: A guide to knowledge about systems; e.g., What types of systems exist? What fundamental principles help explain systems?
 - Part 3: A guide to knowledge about generic SE practice; e.g., How is SE performed? What are typical SE activities?
 - Part 4: A guide to knowledge about the application of SE in products, services, enterprises, and systems of systems; e.g., how is the generic information in Part 3 tailored when applying to different system types?
 - Part 5: A guide to knowledge about enabling SE; e.g., When is SE performed? Who performs it? How does culture affect it?
 - Part 6: A guide to knowledge about related disciplines and specialties; e.g., How are software engineering and project management related to SE? How do safety, reliability, and other “ilities” relate to SE?
 - Part 7: Implementation examples; e.g., What do existing case studies and vignettes reveal about SE knowledge and practice? How does SE practice vary by domain and system type?

- Alignment and comparison of standards
- An overview of project management
- Application of systems engineering standards
- Applying the systems approach
- Architecting approaches for systems of systems
- Architectural design
- Assessing systems engineering performance of teams
- Complexity
- Configuration Management
- Dynamically changing systems
- Emergence
- Fundamentals of system definition
- Hubble Space Telescope case study
- Mission analysis and stakeholder requirements
- Resilience engineering
- System assurance
- System requirements
- The enterprise as a system
- The service view of engineered systems



Guide to the Systems Engineering Body of Knowledge (SEBoK) v. 0.5

(Redirected from Main Page)

Welcome to the *Guide to the Systems Engineering Body of Knowledge (SEBoK)*, version 0.5.



- quick links
- Main Page
 - Note to Reviewers
 - Reading the SEBoK
 - Acknowledgements
 - Copyright Information

- outline
- SEBoK 0.5 Outline
 - Part 1: Introduction
 - Part 2: Systems
 - Part 3: SE and Management
 - Part 4: Applications of SE
 - Part 5: Enabling SE
 - Part 6: Related Disciplines
 - Part 7: Examples

- navigation
- Knowledge Areas
 - Topics
 - Use Cases
 - Case Studies
 - Vignettes
 - Glossary of Terms
 - Acronyms
 - Primary References

search

Go Search

- toolbox
- What links here
 - Related changes
 - Upload file
 - Special pages
 - Printable version
 - Permanent link

Introduction [edit]

This Wiki site contains version 0.5 of the Guide to the Systems Engineering Body of Knowledge (SEBoK).

The **SEBoK 0.5 Introduction** contains information about the **Purpose of the SEBoK**, **Scope of the SEBoK**, and the **Uses** of the SEBoK.

This SEBoK is the product of the work of many contributors: sponsor, partner organizations, core team, authors, reviewers, and participants. They are identified and their contributions listed at the **Acknowledgements** page.

Primary leadership of the project was provided by Stevens Institute of Technology and the Naval Postgraduate School, working together through the U.S. Department of Defense Systems Engineering Research Center. The primary funding sponsor was the office of the Deputy Assistant Secretary of Defense for Systems Engineering (DASD/SE).

For information about the rules for using the information in the SEBoK 0.5, please see **About Bkcase Wiki**.

Structure

The sidebar contains navigation links to the seven parts. These seven parts comprise the body of the SEBoK. **We recommend you begin with the SEBoK 0.5 Introduction.**

Each part contains **knowledge areas** and **topics**, organizational units designed to provide structure to the discussion.

There are additional pages for the **glossary** and **primary references**.

To view the articles for a specific category (e.g. all topics in the SEBoK), please click the appropriate term under "navigation" on the sidebar. Note the very useful search box in the sidebar.

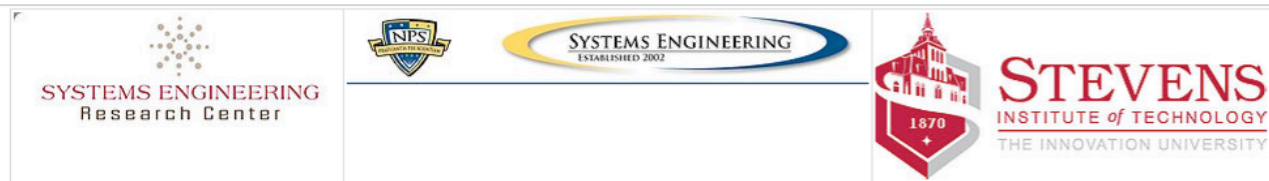
For a detailed explanation of the different types of articles, please see **Reading the SEBoK**.

Review Information

This interim version 0.50 is released for world-wide review, and we respectfully request your feedback. The content of the wiki is locked - all articles contained here may be viewed but they may not be directly edited. Please see the **Note to Reviewers** for instructions on how to provide a review in the wiki.

Future Releases Planned in 2012

Two more releases are planned for the SEBoK. A minor update is planned for the spring of 2012, and version 1.0 will be released in fall 2012. After version 1.0 is released, stewardship of the SEBoK is expected to pass to INCOSE and the IEEE Computer Society. View the plan for the **SEBoK Evolution** here.



Category:Glossary of Terms – Bkcase Wiki

http://www.sebokwiki.org/index.php/Category:Glossary_of_Terms

2. Identifin...and Benefits History and Links Boeing 777 Inside Look ... of the iPod Applied Soft...cture Notes Comanche (Q...old Stone Gallery of S...tone Veneer

Apyster my talk my preferences my watchlist my contributions log out

category discussion edit history delete unprotect watch

Category:Glossary of Terms

This is the official SEBoK Glossary of Terms. The BKCASE Author Team has striven to identify one or two definitions which reflect the current thinking on these terms in the systems engineering community. However, the glossary is still in draft format for SEBoK 0.5 and definitions for some terms have not yet been selected. It will be further refined for the next release in Spring 2012 and will be finalized for SEBoK 1.0 in Fall 2012. Please provide comments on a specific term under the "Discussion" tab for that term.

Below, please find an alphabetical listing of all terms currently identified in the SEBoK. To navigate to the second page of the glossary, please click on "next 200" below.

To see all of the **Acronyms** listed in the SEBoK, please [click here](#).

(previous 200) (next 200)

Pages in category "Glossary of Terms"

The following 200 pages are in this category, out of 389 total.

<p>A</p> <ul style="list-style-type: none"> ■ Absorption (glossary) ■ Abstract Model (glossary) ■ Abstract Syntax (glossary) ■ Abstraction (glossary) ■ Acceptance Criteria (glossary) ■ Acceptance Sampling (glossary) ■ Acquirer (glossary) ■ Acquisition (glossary) ■ Acquisition Strategy (glossary) ■ Acronyms ■ Adaptability (glossary) ■ Aggregate (glossary) ■ Agile (glossary) ■ Agility (glossary) ■ Agreement (glossary) ■ Alignment (glossary) ■ Analysis and Integration Team (AIT) (glossary) 	<p>C cont.</p> <ul style="list-style-type: none"> ■ Customer (glossary) ■ Cybernetics (glossary) <p>D</p> <ul style="list-style-type: none"> ■ Data Center (glossary) ■ Decision Criteria (glossary) ■ Decision Gate (glossary) ■ Decision Management (glossary) ■ Demonstration (glossary) ■ Derived Function (glossary) ■ Derived Requirement (glossary) ■ Descriptive Model (glossary) ■ Design (glossary) ■ Design Constraint (glossary) ■ Design Life (glossary) ■ Design Property (glossary) ■ Development Stage (glossary) ■ Disposability (glossary) 	<p>H cont.</p> <ul style="list-style-type: none"> ■ Human Activity System (glossary) ■ Human Factors (glossary) ■ Human Survivability (glossary) ■ Human Systems Integration (HSI) (glossary) <p>I</p> <ul style="list-style-type: none"> ■ Implementation (glossary) ■ Implemented Element (glossary) ■ In-Process Validation (glossary) ■ Increment (glossary) ■ Incremental (glossary) ■ Individual Competency (glossary) ■ Information Category (glossary) ■ Information Management (glossary) ■ Information Need (glossary) ■ Information Technology (glossary) ■ Information and Communications Technologies (ICT) (glossary)
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Systems – Bkcase Wiki

http://www.sebokwiki.org/index.php/Systems

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page discussion view source history

Systems

Part 2 is a guide to knowledge associated with [Systems \(glossary\)](#), particularly knowledge relevant to [Systems Engineering \(glossary\)](#). Part 2 elaborates on the underlying systems ideas upon which the following parts of the SEBoK are based, thus providing a foundation for the remainder of the SEBoK. Part 2 also defines the key principles of a [Systems Approach](#), which will be referred to directly in explaining the practices of systems engineering.

Contents [hide]

- 1 Knowledge Areas in Part 2: Systems
- 2 Introduction
 - 2.1 Systems Overview and System Concepts
 - 2.2 Types of Systems
 - 2.3 Representing Systems with Models
 - 2.4 Systems Approach
 - 2.5 Systems Challenges
- 3 References
 - 3.1 Citations
 - 3.2 Primary References
 - 3.3 Additional References

Knowledge Areas in Part 2: Systems

Part 2: Systems contains the following knowledge areas:

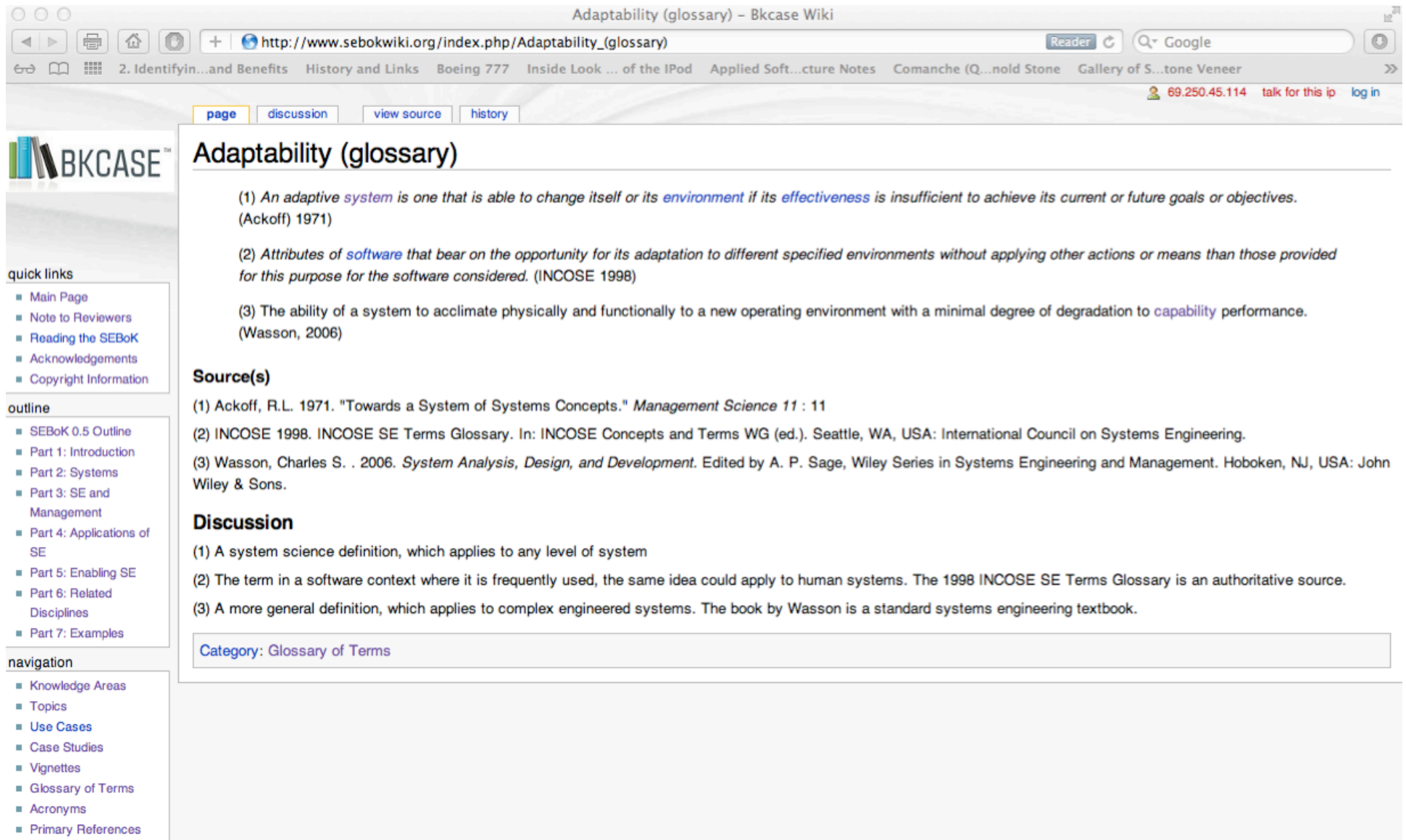
- [Systems Overview and System Concepts](#)
- [Types of Systems](#)
- [Representing Systems with Models](#)
- [Systems Approach](#)
- [Systems Challenges](#)

Introduction

A number of key terms characterize system knowledge, in particular [Systems Science \(glossary\)](#), [Systems Concepts \(glossary\)](#), [System Theory \(glossary\)](#), [Systems Thinking \(glossary\)](#) and [Systems Approach \(glossary\)](#). Although these terms cover different aspects of the knowledge, there is some overlap and inconsistency in their use. The following summaries of Part 2 knowledge areas provide a general context for these terms.

Systems Overview and System Concepts

This area explores systems knowledge and relates that knowledge to systems engineering, emphasizing the following ideas:



Adaptability (glossary) – Bkcase Wiki

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Adaptability (glossary)

(1) An adaptive *system* is one that is able to change itself or its *environment* if its *effectiveness* is insufficient to achieve its current or future goals or objectives. (Ackoff) 1971

(2) Attributes of *software* that bear on the opportunity for its adaptation to different specified environments without applying other actions or means than those provided for this purpose for the software considered. (INCOSE 1998)

(3) The ability of a system to acclimate physically and functionally to a new operating environment with a minimal degree of degradation to *capability* performance. (Wasson, 2006)

Source(s)

(1) Ackoff, R.L. 1971. "Towards a System of Systems Concepts." *Management Science* 11 : 11

(2) INCOSE 1998. INCOSE SE Terms Glossary. In: INCOSE Concepts and Terms WG (ed.). Seattle, WA, USA: International Council on Systems Engineering.

(3) Wasson, Charles S. . 2006. *System Analysis, Design, and Development*. Edited by A. P. Sage, Wiley Series in Systems Engineering and Management. Hoboken, NJ, USA: John Wiley & Sons.

Discussion

(1) A system science definition, which applies to any level of system

(2) The term in a software context where it is frequently used, the same idea could apply to human systems. The 1998 INCOSE SE Terms Glossary is an authoritative source.

(3) A more general definition, which applies to complex engineered systems. The book by Wasson is a standard systems engineering textbook.

Category: Glossary of Terms

quick links

- Main Page
- Note to Reviewers
- Reading the SEBoK
- Acknowledgements
- Copyright Information

outline

- SEBoK 0.5 Outline
- Part 1: Introduction
- Part 2: Systems
- Part 3: SE and Management
- Part 4: Applications of SE
- Part 5: Enabling SE
- Part 6: Related Disciplines
- Part 7: Examples

navigation

- Knowledge Areas
- Topics
- Use Cases
- Case Studies
- Vignettes
- Glossary of Terms
- Acronyms
- Primary References

Category:Primary Reference – Bkcase Wiki

http://www.sebokwiki.org/index.php/Category:Primary_Reference

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Category:Primary Reference

A primary reference has been identified by the author team as a "key" reference, which is critically important to understanding a given subject. Each article of the SEBoK will define a set of 10 or fewer primary references. The general concept for primary references is that if a SEBoK user were to read both the article on a subject along with the defined Primary References, he or she would have a firm grasp on the principle concepts relate to that subject.

Each primary reference article contains the complete bibliographic information for that reference and a listing of all of the articles that list that source as a primary reference. Where possible, authors have provided an annotation, explaining how that reference specifically addresses a specific knowledge area or topic of the SEBoK. To provide feedback on a primary reference, please use the "Discussion" tab for that primary reference.

Pages in category "Primary Reference"

The following 166 pages are in this category, out of 166 total.

<p>A</p> <ul style="list-style-type: none"> A Case for Service Systems Engineering A Catalog of NASA-Related Case Studies A Guide to the Project Management Body of Knowledge A Journey Through the Systems Landscape A Multidisciplinary Framework for Resilience to Disasters and Disruptions A Practical Guide to SysML: The Systems Modeling Language A Spiral Model of Software Development and Enhancement A Survey of Model-Based Systems Engineering (MBSE) Methodologies A Systems Engineering Capability Maturity Model ANSI/EIA 632 Advances in Services Innovations An Enterprise Systems Engineering Framework An Enterprise Systems Engineering Model An Integrated Approach to Developing Systems 	<p>G cont.</p> <ul style="list-style-type: none"> Guidelines for Successful Acquisition and Management of Software-Intensive Systems <p>H</p> <ul style="list-style-type: none"> Handbook of Service Science Handbook on Enterprise Architecture Human-System Integration in the System Development Process <p>I</p> <ul style="list-style-type: none"> IEEE 1471 INCOSE Systems Engineering Handbook INCOSE Systems Engineering Vision 2020 ISO/IEC 19760 ISO/IEC 26702 ISO/IEC/IEEE 15288 ISO/IEC/IEEE 15939 ISO/IEC/IEEE 16326 ISO/IEC/IEEE 24765 	<p>S cont.</p> <ul style="list-style-type: none"> Service Systems Management and Engineering Simulation Modeling and Analysis Skunk Works Social Systems Theory and Practice Software Engineering Economics Software Project Management Software Risk Management Statistical Methods for Reliability Data Statistical Models and Methods for Lifetime Data Strategic IT Portfolio Management: Governing Enterprise Transformation Succeeding Through Service Innovation System Integration (reference) System of Systems Engineering – New Challenges for the 21st Century System-of-Systems Engineering Management: A Review of Modern History and a Path Forward Systems Engineering Body of Knowledge (Singapore) Systems Engineering Competencies Framework 2010-
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A Journey Through the Systems Landscape – Bkcase Wiki

http://www.sebokwiki.org/index.php/A_Journey_Through_the_Systems_Landscape

2. Identifying...and Benefits History and Links Boeing 777 Inside Look ... of the iPod Applied Soft...cture Notes Comanche (Q...nold Stone Gallery of S...tone Veneer

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page discussion view source history

A Journey Through the Systems Landscape

Lawson, H. 2010. *A Journey Through the Systems Landscape*. London, UK: College Publications, Kings College, UK.

Contents [hide]

- 1 Annotation
 - 1.1 The Systems Approach
 - 1.2 Life Cycle Models
 - 1.3 Life Cycle Characterization
 - 1.4 Representative System Life Cycle Process Models
 - 1.5 Applying the Systems Approach
 - 1.6 Integrating Process and Product Models

Annotation

Systems are everywhere and affect us daily in our private and professional lives. We all use the word "system" to describe something that is essential but often abstract, complex and even mysterious. However, learning to utilize system concepts as first class objects, as well as methodologies for systems thinking and systems engineering, provides a basis for removing the mystery and moving towards mastery even for complex systems.

This journey through the Systems Landscape has been developed to promote learning to "think" and "act" in terms of systems. A unique aspect is the introduction of concrete system semantics provided as a "system survival kit" and based upon a limited number of concepts and principles as well as a mental model called the system-coupling diagram. This discipline independent presentation assists individuals and is essential for building a learning organization that can utilize a systems approach to achieving its enterprise goals.

The eight chapters are presented as stops along a journey that successively build system knowledge. Each chapter terminates with a Knowledge Verification section that provides questions and exercises for individuals and groups. Case studies reflecting the utilization of the system related concepts, principles and methodologies are provided as chapter interludes.

The Systems Approach

This book describes how an abstract system can be mapped into an engineered system in accordance with the Systems Approach.

Life Cycle Models

Annotation to be added for SEBoK 1.0.

Life Cycle Characterization

Annotation to be added for SEBoK 1.0.

quick links

- Main Page
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- Copyright Information

outline

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- Part 1: Introduction
- Part 2: Systems
- Part 3: SE and Management
- Part 4: Applications of SE
- Part 5: Enabling SE
- Part 6: Related Disciplines
- Part 7: Examples

navigation

- Knowledge Areas
- Topics
- Use Cases
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- Vignettes
- Glossary of Terms
- Acronyms
- Primary References

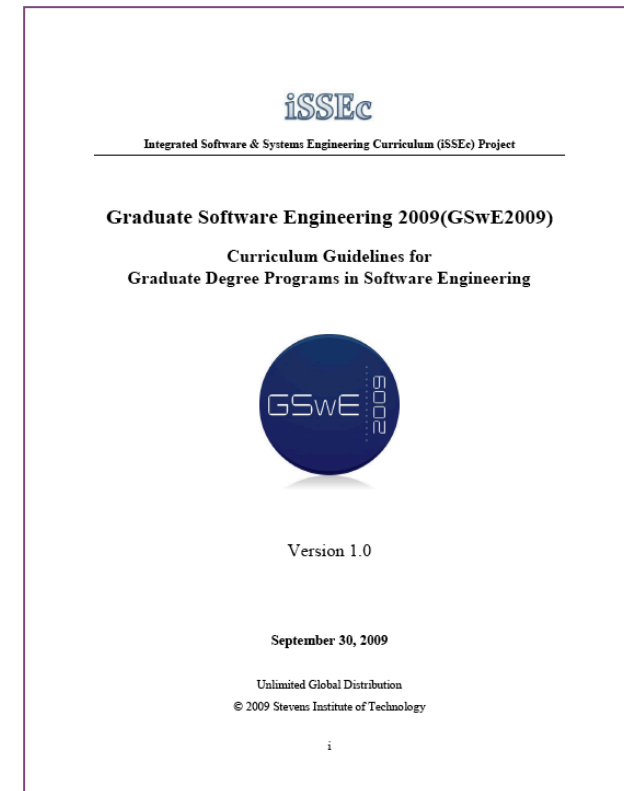
search

1. Project began in September 2009
2. Four releases planned:
 - Prototype: SEBoK 0.25 (September 2010)
 - Early Adoption: SEBoK 0.5 (September 2011) as a Wiki,
 - Early Resolution: SEBoK 0.75 (Spring 2012) as a Wiki
 - Full Use: SEBoK 1.0 (September 2012) as a Wiki
3. Transfer of sponsorship to INCOSE and IEEE expected in late 2012 – INCOSE and IEEE will perform and fund maintenance, evolution, and support

Graduate Reference Curriculum in Systems Engineering

Graduate Reference Curriculum in Software Engineering

- Graduate Software Engineering 2009 (GSWE2009): Curriculum Guidelines for Graduate Degree Programs in Software Engineering
- GSWE2009 Companion Document: Comparisons of GSWE2009 to Current Master's Programs in Software Engineering
- GSWE2009 Companion Document: Frequently Asked Questions on Implementing GSWE2009

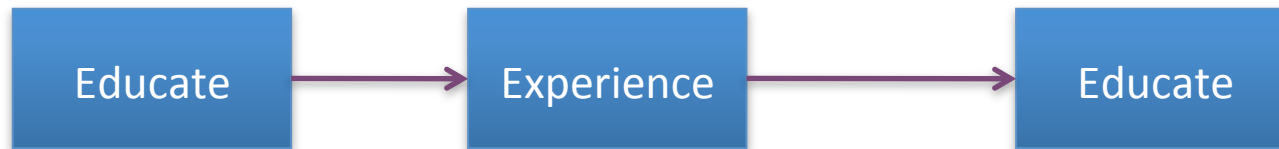


Endorsed by INCOSE, NDIA SE Division, Brazilian Computer Society
Originally sponsored by DoD. **Now sponsored by the IEEE Computer Society and
ACM**

Preliminary Look at Core Courses for 13 MSE Programs

Course	School													Total
	A	B	C	D	E	F	G	H	I	J	K	L	M	
Introduction to System Engineering	•	•	•	•	•	•	•	•			•	•	•	11
Modeling and Simulation		•		•	•	•	•	•	•	•	•			9
Systems Architecture and Design	•	•	•			•	•	•		•		•	•	9
Systems Integration			•	•		•	•	•		•	•			7
Project Management		•	•		•		•	•					•	6
Systems Analysis		•	•		•						•	•	•	6
Risk and Decision Analysis		•	•	•			•					•		5
Systems Management	•					•				•	•	•		5
Systems Requirements & Analysis	•				•			•			•		•	5
Intro Systems Software Engineering		•	•		•					•				4
Probability and Statistical Analysis		•		•	•				•					4
Engineering Economics			•	•									•	3
Optimization Theory				•	•				•					3
Verification and Validation			•								•			2
System Definition and Cost Modeling						•							•	2
Capability Engineering			•											1
Dynamic Programming									•					1
Dynamic Systems Theory									•					1
Human Factors			•											1
Integrative Workshop				•										1
Life Cycle Management											•			1
Logistics Systems Engineering			•											1
Problem Solving					•									1
Quality Assurance	•													1
Stochastic Processes / Modeling									•					1
Systems Suitability			•											1
Advanced Topics in Systems Engineering													•	1

Model 1



Model 2

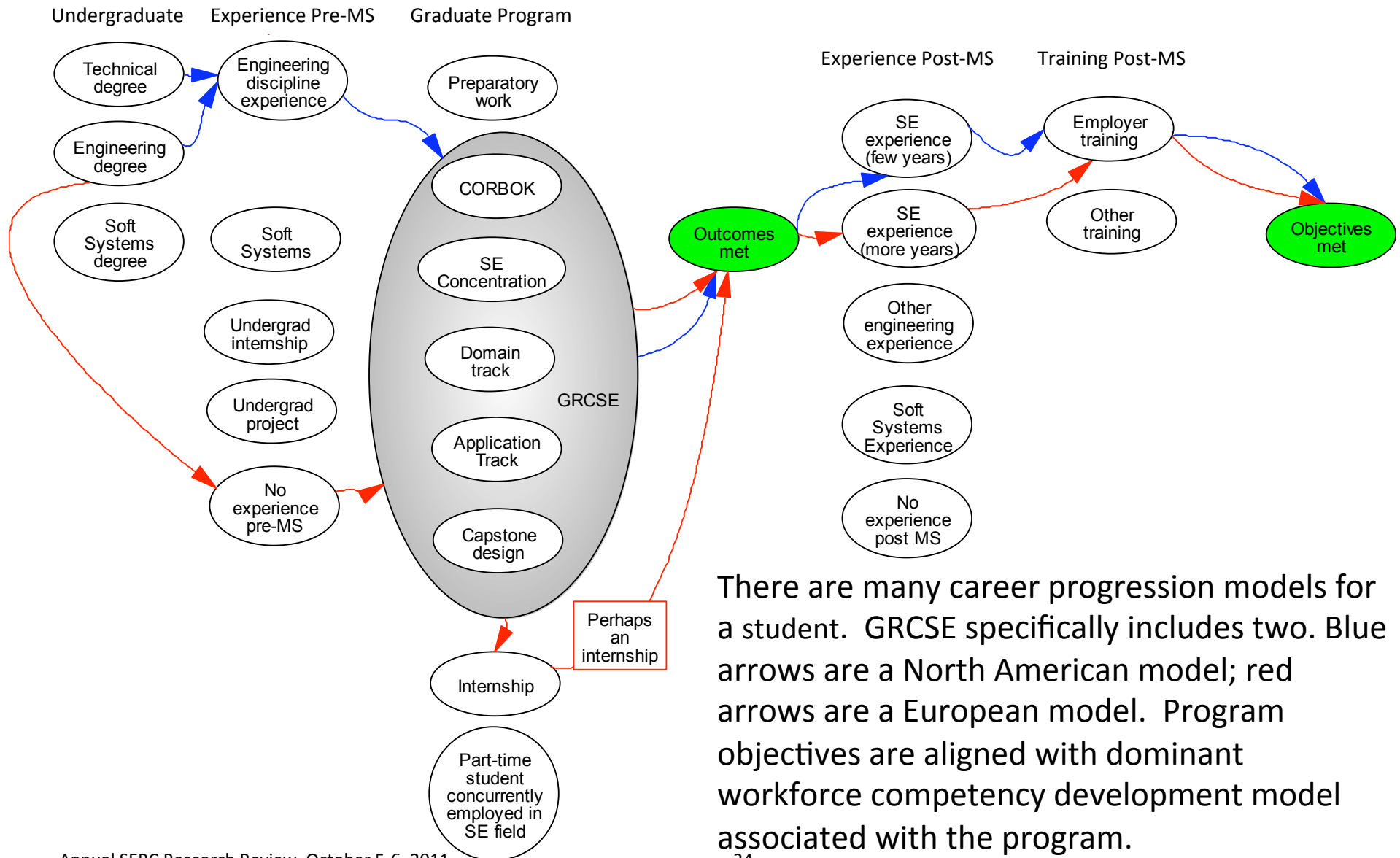


Additional activities
Practical/Hands-on work
Labs

Model 3 – undergraduate program out of scope



Other Models Possible



There are many career progression models for a student. GRCSE specifically includes two. Blue arrows are a North American model; red arrows are a European model. Program objectives are aligned with dominant workforce competency development model associated with the program.

#	Chapter Title
1.	Introduction
2.	Context and guidance for the construction and maintenance of GRCSE
3.	Expected student background when entering a master's program
4.	Expected objectives of graduate programs
5.	Expected outcomes when a student graduates
6.	Curriculum architecture
7.	Core body of knowledge
8.	Assessment
9.	Anticipated GRCSE evolution

1. Project began in September 2009
2. Three releases planned:
 - Prototype: GRCSE 0.25 (December 2010)
 - Early Adoption: GRCSE 0.5 (December 2011)
 - Full Use: GRCSE 1.0 (December 2012)
3. Transfer of sponsorship to INCOSE and IEEE expected in December 2012 – INCOSE and IEEE will perform and fund maintenance, evolution, and support

When We Finish...

SEBoK will strongly influence the practice of SE worldwide, the certification of SE professionals in both industry and government, and increase significantly the quality of communication among systems engineers worldwide.

GRCSE will strongly influence the content of graduate SE programs worldwide leading to a stronger and more predictable defense SE workforce