The Body of Knowledge and Curriculum to Advance Systems Engineering

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and BKCASE Project Leader

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www.bkcase.org

www.sebokwiki.org

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 (Co-Project Leader David Olwell) with primary support from US Department of Defense
- Project will run through December 2012
- Intended for world-wide use – all products available free in perpetuity

Vision and Objectives

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.

Value to Community

1. SE competency development across industry and government 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 will have a ready reference for key SE terminology, ideas, and references
3. SE practitioners and managers will have more mature guidance for professional certification of systems engineers
4. A maturing SE field makes it easier for executives and project managers to adopt SE best practices
5. Staff and managers understand better what schools should/do offer in their SE programs

Rules for BKCASE Activities

1. Products generated by the authors, not the sponsor or supporters
2. Even though US Department of Defense is the sponsor, it does not have any authority over the content of the products, nor are the products slanted towards defense systems development and acquisition
3. Volunteer authors do the bulk of the writing
4. Core Team from Stevens and Naval Postgraduate School provides stable labor and direction
5. Core Team responsible for final integration, technical editing, and clean up of products

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

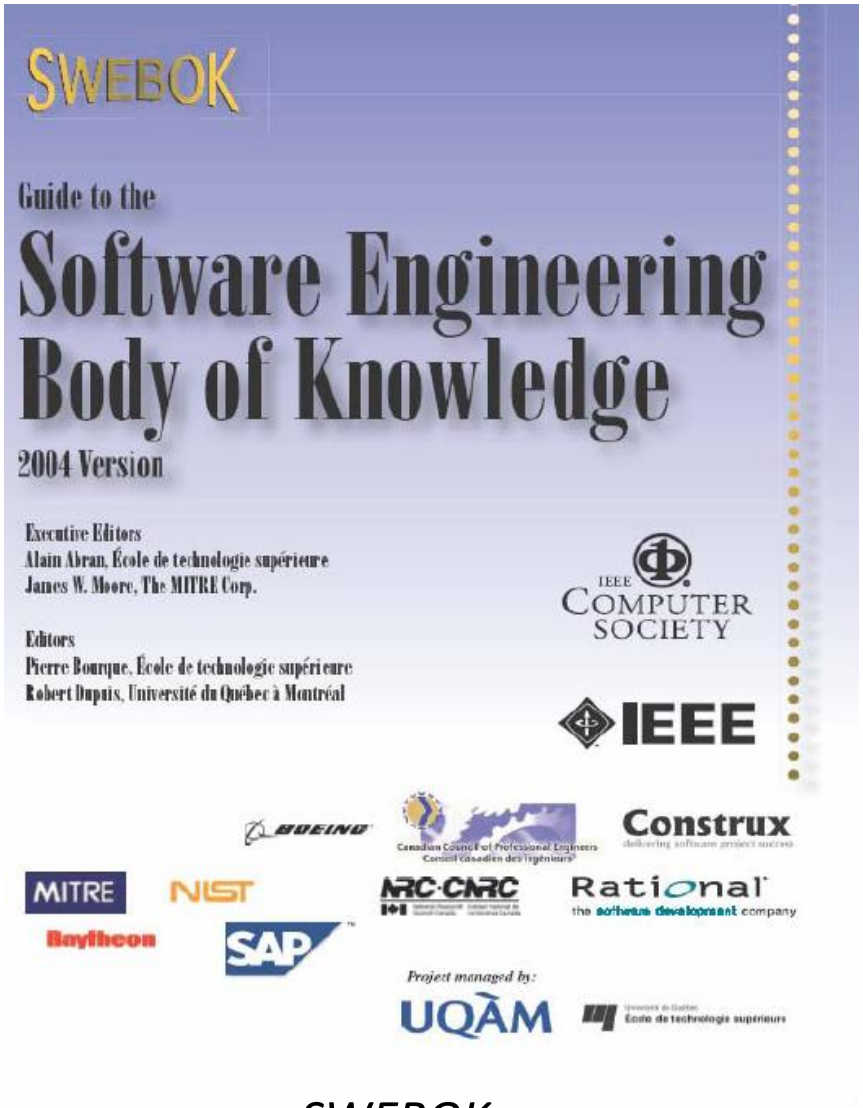
Segment	Number
Academia	30
Industry	24
Government	3
Professional Societies	6

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

BKCASE™

Systems Engineering Body of Knowledge: SEBoK

SWEBOK Was Starting Point



www.SWEBOK.org

SWEBOK

- 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

Philosophy for SEBoK

- 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

SEBoK Purpose

To provide the boundaries, terminology, content, and structure needed to systematically and consistently *support* the following*:*

Purpose	Description
Inform Practice	Inform systems engineers about the boundaries, terminology, and structure of their discipline and point them to useful information needed to practice SE in any application domain
Inform Research	Inform researchers about the limitations and gaps in current SE knowledge that should help guide their research agenda
Inform Interactors	Inform performers in interacting disciplines (system implementation, project and enterprise management, other disciplines) of the nature and value of SE
Inform Curriculum Developers	Inform organizations defining the content that should be common in undergraduate and graduate programs in SE
Inform Certifiers	Inform organizations certifying individuals as qualified to practice systems engineering
Inform SE Staffing	Inform organizations and managers deciding which competencies that practicing systems engineers should possess in various roles ranging from apprentice to expert

Guide to the literature, not all the content of the literature

Who will use the SEBoK?

1. **Practicing Systems Engineers** – ID best references to support a new SE role; expand their areas of SE expertise and specialization; understand best SE practices in a project they are reviewing
2. **Process Engineers** – Understand which SE processes and assets are the most relevant; find examples in the literature of how others have tailored processes; find examples in the literature of how others have done self-assessed SE processes
3. **Faculty Members** – Decide on the knowledge their students should master; incorporate SE concepts into non-SE courses or curricula
4. **GRCSE authors** - Decide what knowledge to expect from all SE graduate students
5. **Certifiers** - Understand what others have done, how such programs are typically structured, and how to select the knowledge that each person seeking certification should master

Who will use the SEBoK?

6. **General Managers, Other Engineers** - Understand the scope of SE relative to their roles; understand basic vocabulary, boundaries, and structure of SE; identify primary references; understand the role of the systems engineer versus others on a project

7. **Customers of Systems Engineering** – Better understand what to ask for, how to request it, and how to judge the quality of what is received

8. **SE Managers** – Read independent information to evaluate a proposal; develop competency-based job descriptions

9. **SE Researchers** - Identify gaps in SE knowledge to guide research agendas

SEBoK Scope

- Natural systems: Solar system, real number system
  - Not a concern of SEBoK, other than being external environments
- Engineered systems: Technical or sociotechnical aggregations of physical, informational, and human elements that exhibit emergent properties not exhibited by the individual elements
  - Created by and for people
  - Have a purpose, often with multiple views of that purpose
  - Satisfy key stakeholders' value propositions
  - Have a life cycle and evolution dynamics
  - Have a boundary and an external environment
  - Are part of a system-of-interest hierarchy

SEBoK Schedule and Transition

1. Project began in September 2009
2. Four releases:
   - Prototype: SEBoK 0.25 (September 2010)
   - Early Adoption: SEBoK 0.5 (September 2011) as a Wiki,
   - Early Resolution: SEBoK 0.75 (March 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

SEBoK 0.5 Table of Contents

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?

Sample of More than 100 Topics

- 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 - Bkcase Wiki

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

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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.

SEBoK

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.

SYSTEMS ENGINEERING Research Center | NPS | SYSTEMS ENGINEERING ESTABLISHED 2002 | STEVENS INSTITUTE of TECHNOLOGY THE INNOVATION UNIVERSITY

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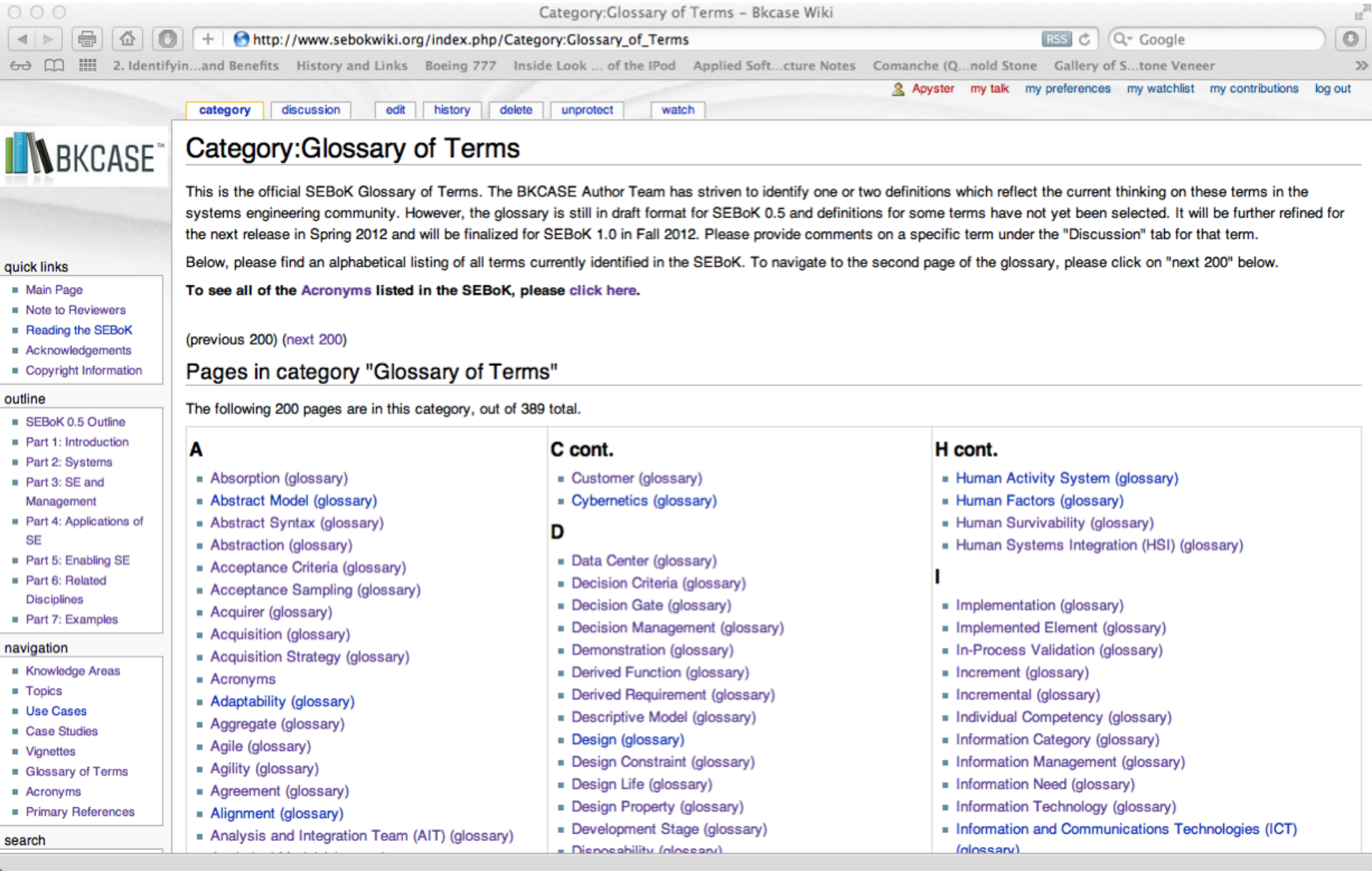
Category:Glossary of Terms - Bkcase Wiki
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Category:Glossary of Terms
This is the official SEBoK Glossary of Terms. The BKCASE Author Team has striven to identify one or two definitions which reflect the current thinking on these terms in the systems 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.
A
Absorption (glossary)
Abstract Model (glossary)
Abstract Syntax (glossary)
Abstraction (glossary)
Acceptance Criteria (glossary)
Acceptance Sampling (glossary)
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C cont.
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D
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Decision Gate (glossary)
Decision Management (glossary)
Demonstration (glossary)
Derived Function (glossary)
Derived Requirement (glossary)
Descriptive Model (glossary)
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Design Constraint (glossary)
Design Life (glossary)
Design Property (glossary)
Development Stage (glossary)
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Human Factors (glossary)
Human Survivability (glossary)
Human Systems Integration (HSI) (glossary)
I
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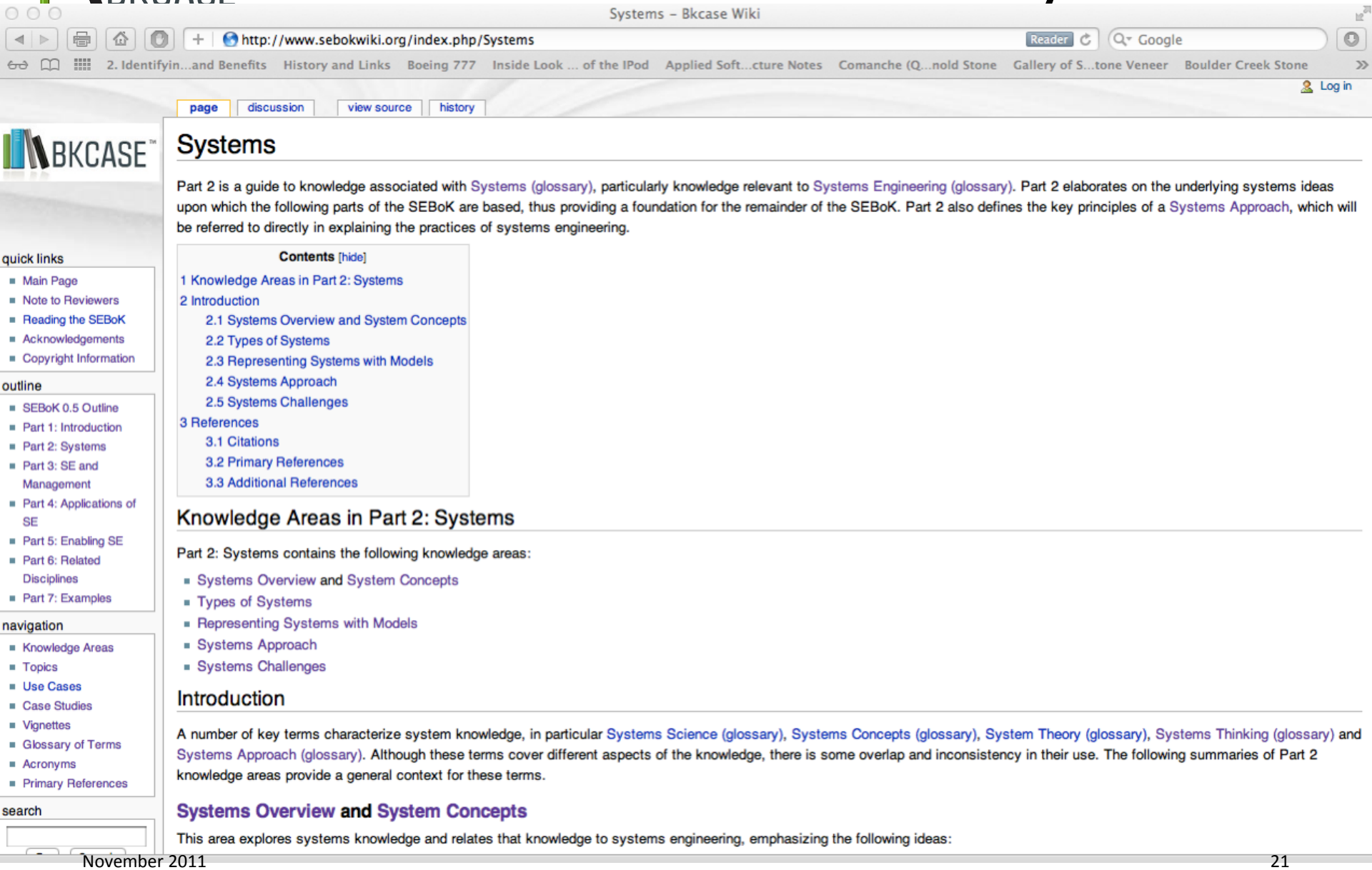
Increment (glossary)
Incremental (glossary)
Individual Competency (glossary)
Information Category (glossary)
Information Management (glossary)
Information Need (glossary)
Information Technology (glossary)
Information and Communications Technologies (ICT) (glossary)

Part 2 Introductory Article



Systems – Bkcase Wiki

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

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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
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- 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

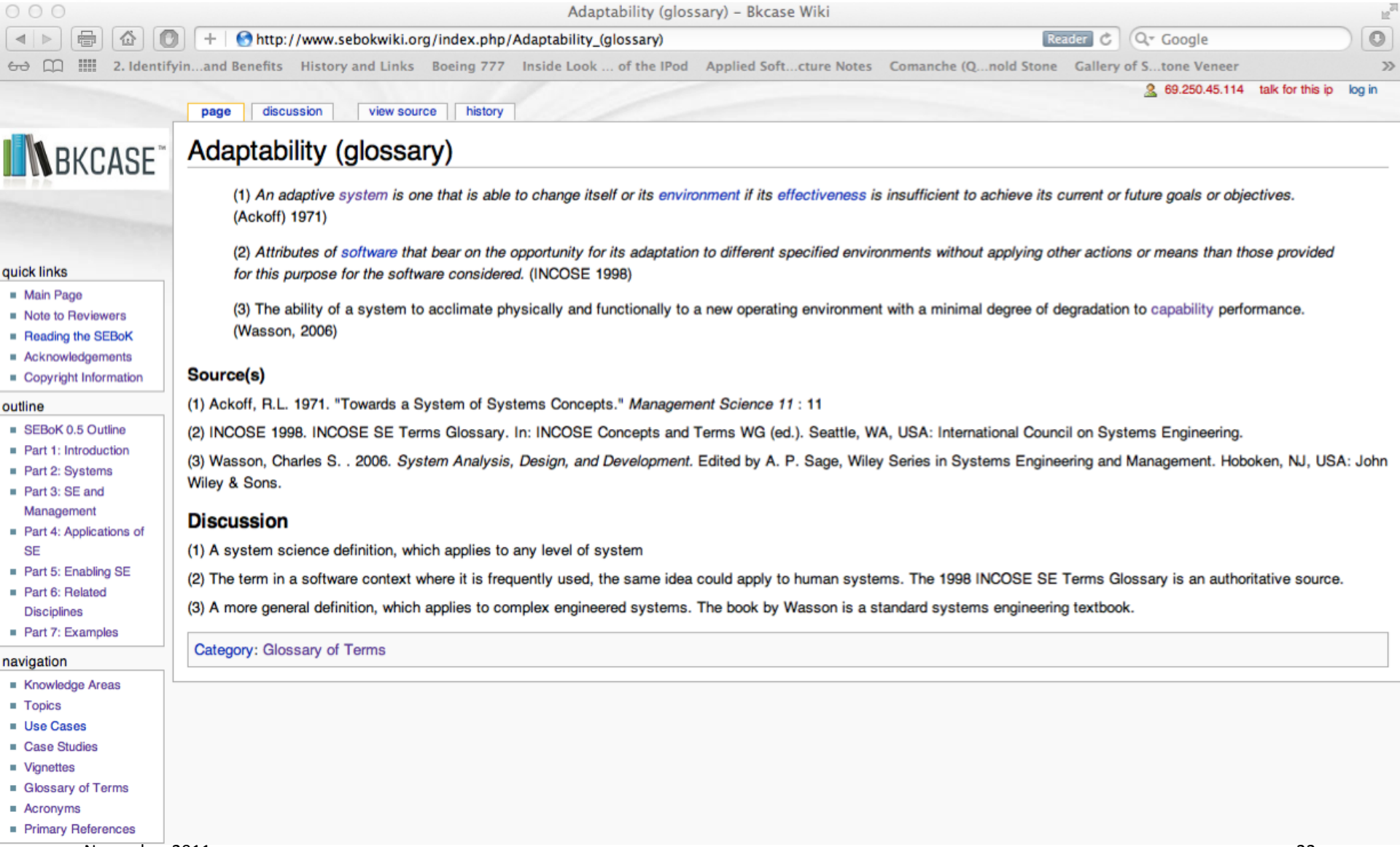
Introduction

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.

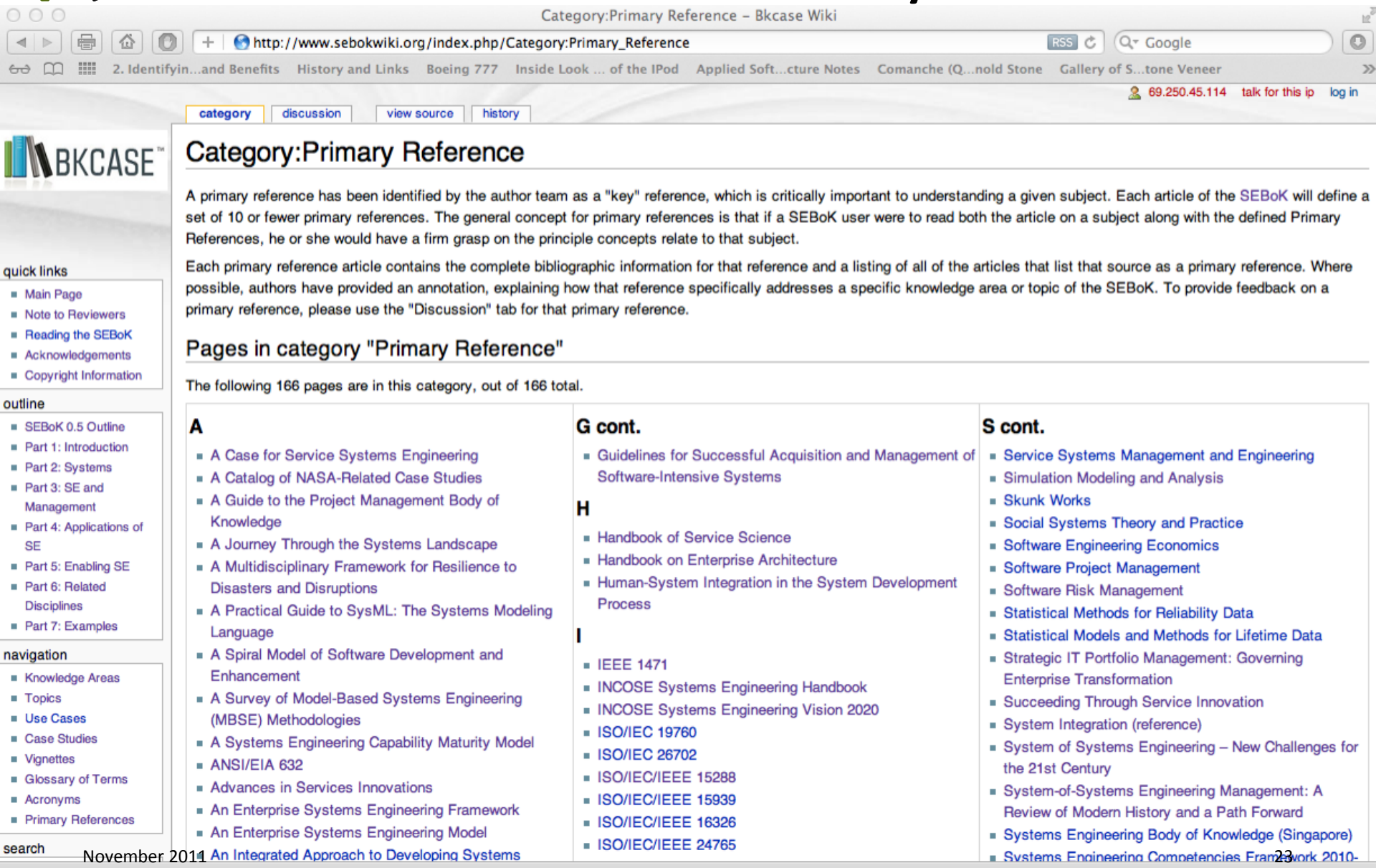
Systems Overview and System Concepts

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

Definition of Adaptability



Primary References



Category:Primary Reference – Bkcase Wiki

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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.

A

- 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

G cont.

- Guidelines for Successful Acquisition and Management of Software-Intensive Systems

H

- Handbook of Service Science
- Handbook on Enterprise Architecture
- Human-System Integration in the System Development Process

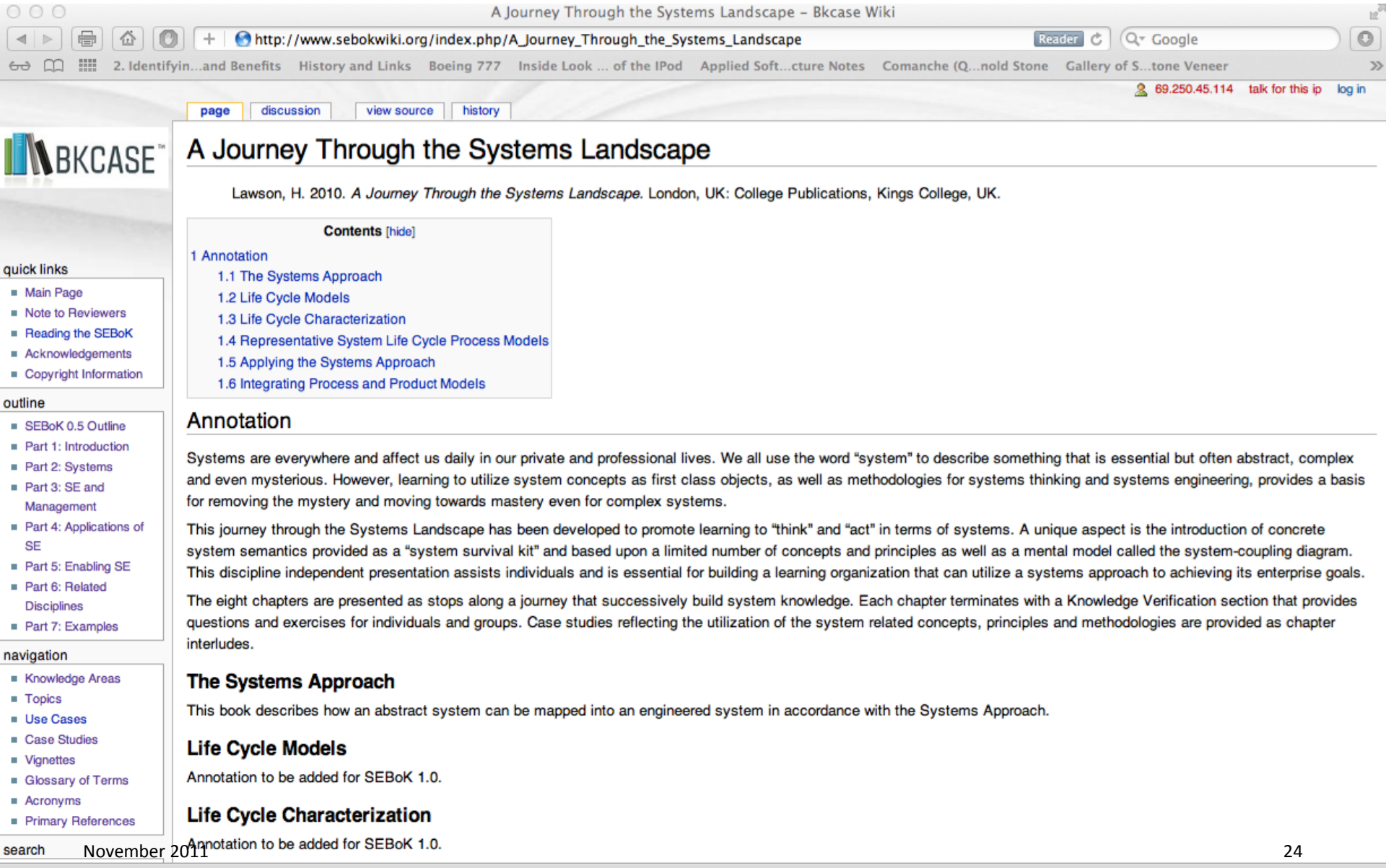
I

- 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

S cont.

- 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-

Sample Primary Reference



A Journey Through the Systems Landscape – Bkcase Wiki

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

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A Journey Through the Systems Landscape

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

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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

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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.

BKCASE™

Graduate Reference Curriculum on Systems Engineering: GRCSE

Why GRCSE?

1. Enable graduate program developers and maintainers world-wide to improve existing SE programs from viewpoint of universities, students, graduates, employers, and systems customers and users
2. Assist development of new master's SE programs by providing guidelines on curriculum content and advice on how to implement those guidelines
3. Provide framework to guide deliberations of strategic advisory boards established to assist universities in the appropriate design of their programs
4. Support increased enrollment in SE programs by increasing the value of those programs to potential students and employers
5. Assist understanding diversity of available SE educational programs and assist prospective students and employers in gauging suitability of a particular program for their individual purposes

GRCSE Schedule and Transition

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

BKCASE™ Started with 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


iSSEc

Integrated Software & Systems Engineering Curriculum (iSSEc) Project

Graduate Software Engineering 2009(GSwE2009)

Curriculum Guidelines for
Graduate Degree Programs in Software Engineering

GSwE 2009

Version 1.0

September 30, 2009

Unlimited Global Distribution

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i

Endorsed by INCOSE, NDIA SE Division, Brazilian Computer Society

Originally sponsored by DoD. **Now sponsored by the IEEE Computer Society and ACM**

www.GSwE2009.org

Preliminary Look at Core Courses for13 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

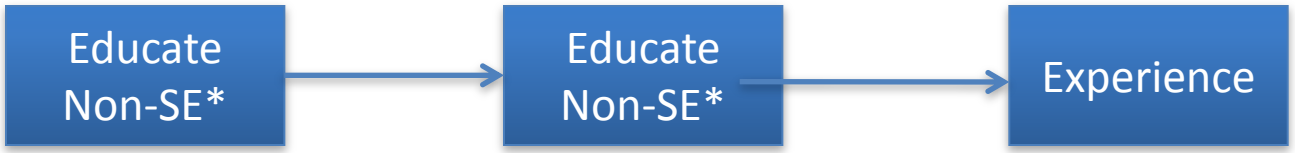
Broad Applicability Sought

Model 1:

Common in US and Europe

Model 2:

Common in US and Europe



Model 3:

Less common in US and Europe

GRCSE 0.5 provides recommendations for Model 1

* Non-SE includes mechanical, electrical, and other "traditional" engineering degrees

GRCSE 0.5 Table of Contents

Chapters

1. Introduction – The background, summary, and purpose of GRCSE
2. Guiding principles – Underlying principles
3. Objectives – Description of expected level of attainment of graduates 3-5 years after graduation, resulting from education and experience
4. Outcomes – Levels of attainment of graduates at time of graduation, directly linked to the education experience
5. Entrance expectations – Knowledge assumed of entrants to the program

Not specific courses. Not specific packaging. Adaption and selective adoption expected and encouraged.

GRCSE 0.5 Table of Contents

Chapters

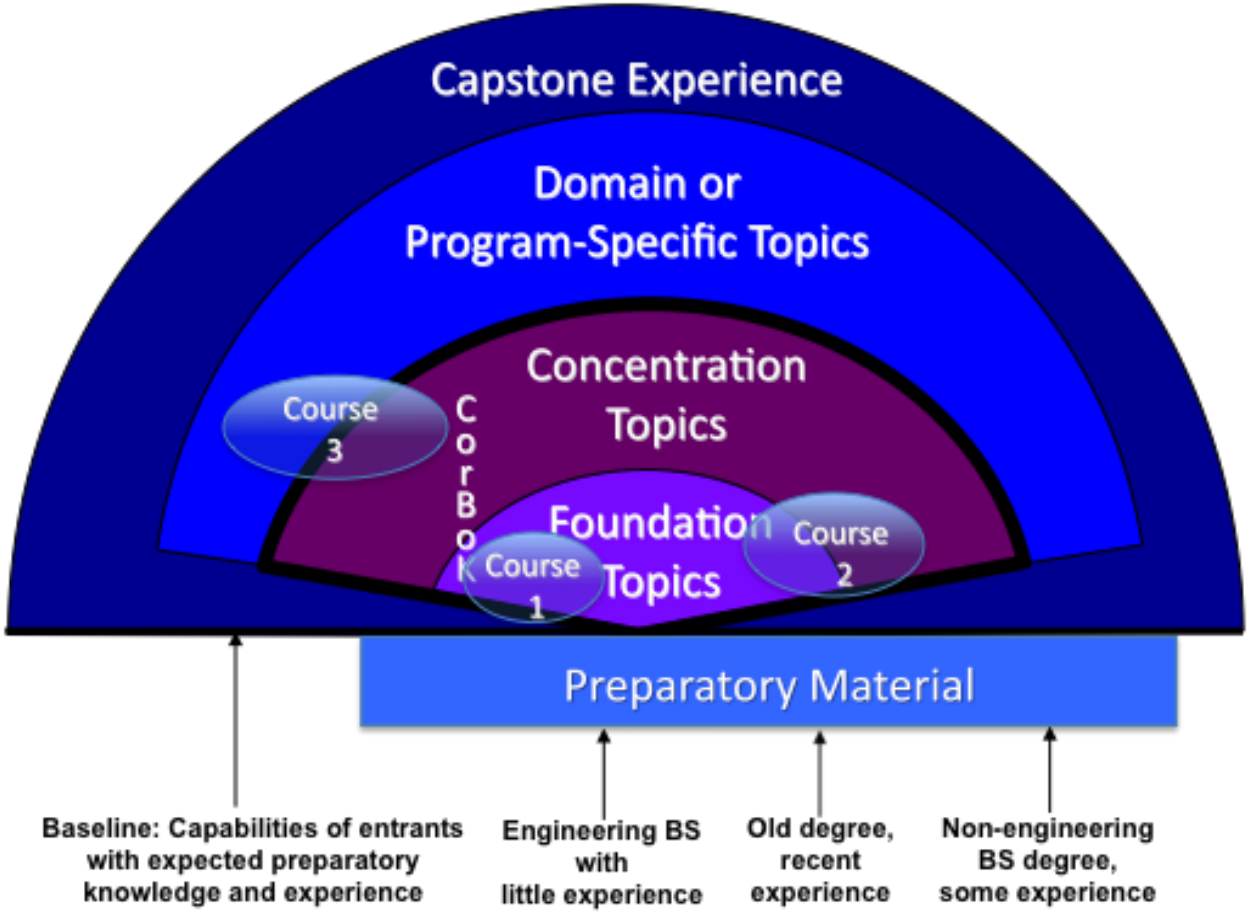
6. Architecture – Design framework of the curriculum, to include core and specialization related materials

7. CorBOK – Core body of knowledge, required of all graduates, expressed as levels of achievement using Bloom's taxonomy – *no more than 50% of program*

8. Assessment - Guidance to educators on how to assess students as achieving course outcomes and for how to evaluate programs as effective in meet their goals

9. Future maintenance – Plans for maintaining GRCSE into the future

Typical SE Program Architecture



GRCSE 0.5 Table of Contents

Appendices

A. Survey of existing programs

B. Bloom's taxonomy - Guide to how Bloom's taxonomy has been used in GRCSE

C. Mapping of how CorBOK supports outcomes

D. Assessment – Background information for chapter 8

E. Competency based curriculum – Discussion of issues in designing curriculum to achieve certain competencies

F. Use cases and examples – Use cases and examples provided to assist users in how to use GRCSE

If We Are Successful…

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

Reviews of SEBoK 0.5 sought through December 15. See www.sebokwiki.org or visit www.bkcase.org