Body of Knowledge and Curriculum to Advance Systems Engineering

Guide to the Systems Engineering Body of Knowledge

Graduate Reference Curriculum for Systems Engineering

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Editor in Chief BKCASE

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Body of **Knowledge and Curriculum to Advance Systems Engineering**

- BKCASE partnership between three well known organizations
  - International Council on Systems Engineering (INCOSE),
  - Institute of Electrical and Electronics Engineers Computer Society (IEEE-CS),
  - Systems Engineering Research Center (SERC).

- The BKCASE products
  - Guide to the SE Body of Knowledge
  - Graduate Reference Curriculum for SE

- Managed by the **BKCASE Editorial Board**.
Body of Knowledge and Curriculum to Advance Systems Engineering

BKCASE Vision

“The BKCASE products continue to provide a living, shared and authoritative guide to the full scope of Systems Engineering Knowledge, becoming the most used reference in the world to guide systems engineering graduate education and systems engineering practice.” - BKCASE Vision 2014.

The Body of Knowledge and Curriculum to Advance Systems Engineering Project (BKCASE), began in the fall of 2009. Its original vision was that, through its work “Systems engineering competency models, certification programs, textbooks, graduate programs, and related workforce development initiatives around the world align with BKCASE.”

As we begin the next stage of the BKCASE project we would like to restate the vision as shown above to reflect the growing value BKCASE can bring to our stakeholder community:
Body of Knowledge and Curriculum to Advance Systems Engineering

The BKCASE products continue to provide a living, shared and authoritative guide to the full scope of Systems Engineering Knowledge, becoming the most used reference in the world to guide systems engineering graduate education and systems engineering practice. - BKCASE Vision 2014

• By continuing to work towards aligning technical initiative and research, competency models, certification programs, textbooks, standards and guides, graduate programs, and related workforce development initiatives around the world to BKCASE our sponsors can enhance their ability to
  – Share, use, evolve and co-create value from that knowledge with their stakeholders.
  – Providing a framework for the education, development and recognition of all those involved in the professional practice of Systems Engineering.
  – Better describe the place Systems Engineering holds in complex problem resolution and thus shape and grow that role.
BKCASE 2015 Highlights

• SEBoK
  – v1.4 released in May 2015
  – V1.5.1 released in Dec 2015
  – New update process

• GRCSE
  – V1.1 released in Nov 2015
  – Further updates planned

• SEBoK usage continues to grow

• Plans for 2016
Body of Knowledge and Curriculum to Advance Systems Engineering

Graduate Reference Curriculum for Systems Engineering

- Curriculum guidance for systems engineering master’s program.
- Knowledge coverage against the SEBoK
- Broader program guidance and advice

- Broad based curriculum framework, tailor-able, advisory and useful
- While setting some agreed minimum baseline of what SE Masters education needs to be
GRCSE Plans 2016

• Gather information:
  – What new or expanded programs since 2009?
  – Who is using GRCSE and how?
  – What do stakeholders want from curriculum guidance?
  – What do stakeholders want from SE Education?

• Possible updates
  – Update GRCSE within current structure
  – Review against changes to SEBoK
  – Consider other curriculum guides?
  – Make the case for SE education?
  – ETC?
Guide to the Systems Engineering Body of Knowledge

- A living authoritative guide to the knowledge most relevant and important to the advancement of Systems Engineering
- Discusses what is included in the discipline,
- how this knowledge can be structured to facilitate understanding,
- what sources are most important to the discipline.
SEBoK wiki traffic*
(www.sebokwiki.org)

- January 2016
  - Total visits: 21,012
  - Unique visitors: 17,445
  - Page views: 41,547

- Cumulative (since Sept. 2012)
  - Total visitors: 437,103
  - Page views: 993,808

* Tracked by pages visited
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# SEBoK Usage

## SEBoK Content - Top 25 Pages Visited (Month)

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<td>/wiki/Systems_Engineering_Overview</td>
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<td>544 (1.80%)</td>
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<td>/wiki/Reliability_, Availability_, and Maintainability</td>
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<td>/wiki/Relationships_between_Systems_Engineering_and_Project_Management</td>
<td>357 (1.18%)</td>
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<tr>
<td>20</td>
<td>/wiki/Configuration_Management</td>
<td>241 (0.80%)</td>
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Social/Systems Science Knowledge

Part 1
Introduction
Overview of the role and value of SE and of the SEBoK

Part 2
SE Foundations
Systems Knowledge and how it relates to SE

Part 3
SE and Management
"Standard" Life Cycle, Process and Practices

Part 4
Applications of SE
The different contexts in which "Standard" Life Cycle, Process and Practices are applied

Part 5
Enabling SE
Creating people, teams and enterprises to enable good SE

Part 6
Related Disciplines
The other disciplines involved in a Life Cycle and how we work with them

Part 7
Examples

Management & Leadership Knowledge

Science & Technology Knowledge

Operational Environment Knowledge

Engineering Discipline/Specialty Knowledge

People & Competency Knowledge

Sector & Enterprise Knowledge

Science & Technology Knowledge
Life Cycle Models

The life cycle model is one of the key concepts of systems engineering (SE). A life cycle for a system generally consists of a series of stages regulated by a set of management decisions which confirm that the system is mature enough to leave one stage and enter another.

Contents

1 Topics
2 A Generic System Life Cycle Model
3 Comparison of Value Added Products/Services
4 Publications on the Theme: Systems Engineering Responsibility
5 SEBoK Discussion

Topics

Each part of the SEBoK is divided into knowledge areas (KAs), which are groupings of information with a related theme. The KAs in turn are divided into topics. This KA contains the following topics:

- System Life Cycle Process Drivers and Choices
- System Life Cycle Process Models: Vee
- System Life Cycle Process Models: Iterative
- Integration of Process and Product Models

See the article Matrix of Implementation Examples for a mapping of case studies and vignettes included in Part 7 to topics covered in Part 3.

A Generic System Life Cycle Model

A life cycle model for a system identifies the major stages that the system goes through, from its inception to its retirement. The stages are terminated by decision gates where the key stakeholders decide whether to move on to the next stage, to remain in the current stage, or to terminate or re-scope related projects. Inception begins with a set of stakeholders and a set of objectives and a decision to develop the system.

To be successful, most organizations must be able to adapt to unforeseen changes. The system must be developed, in which the life cycle benefits are worth the investments in the life cycle costs.

Thus, there is no single "one-size-fits-all" system life cycle model that can provide specific guidance for all project situations. Figure 1, adapted from (Lawson 2010, ISO/IEC 2008, and ISO/IEC 2010), provides a generic life cycle model that describes the most common versions of pre-specified, evolutionary, sequential, opportunistic, and concurrent life cycle processes.
Questions you have?

To answer them I will try

BKCASE workshop: Monday am
BKCASE EB Planning: Tuesday am
Align with Life Cycle & Process Standards
Wider Lifecycle issues, e.g. Agile

Part 1: Introduction
Overview of the role and value of SE and of the SEBoK

Part 2: Systems
Systems Science
- Systems Approach

Part 3: SE and Management
"Standard" Life Cycle, Process and Practices

Part 4: Applications of SE
Applying SE to:
- Product System context
- Service System context
- Enterprise System context
- System of Systems context

Part 5: Enabling SE
Creating people, teams and enterprises to enable good SE

Successful SE enabled by:
- Individuals
- Teams
- Enterprises

Part 6: Related Disciplines

Relationships with other BoK

SEBoK and MBSE

Applications of SE:
- SoS & Enterprise
- Tailoring and Domains
Creating people, teams and enterprises to enable good SE.

Enabling SE

The other disciplines involved in a Life Cycle and how we work with them.

Part 1
Introduction
Overview of the role and value of SE and of the SEBoK.

Part 2
SE Foundations: Systems Knowledge and how it relates to SE.

Part 3

Part 4
Applications of SE: The different contexts in which “Standard” Life Cycle, Process and Practices are applied.

Part 5
Enabling SE: Creating people, teams and enterprises to enable good SE.

Part 6
Related Disciplines: The other disciplines involved in a Life Cycle and how we work with them.

Part 7
Examples.
Alignment of Key SE&A Resources

Cooperative Technical Co-evolution Model

DoD SE Refs (DAG: Ch 4, Sys Assurance, SoSE)

Influence evolution

ISO/IEC, IEEE, INCOSE

SEBoK evolutions gathered through Wiki

ISO/IEC/IEEE 15288

Drives lower level standards and user documents

NATO AAP-48

IEEE 15288.1 DoD Addendum

EIA 632

INCOSE SE Handbook

Influence evolution

SEH evolutions through new versions

Significant Collaboration in this Co-evolution

Copyright © 2015 by Garry Roedler
### Friedman-Sage Case Study Framework Identifies Stakeholders Benefits

<table>
<thead>
<tr>
<th>Acquisition-Oriented Concept Domains</th>
<th>Responsibility Domain (Stakeholder)</th>
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<td><strong>SWFTS SE Contractor Team</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Shared</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Government Team</strong></td>
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<tr>
<td>Requirements Definition and Management</td>
<td>MBSE simplifies and enhances traceability in multiple dimensions.</td>
</tr>
<tr>
<td>System Architecture and Conceptual Design</td>
<td>Having an accurate system model significantly improves team understanding of FoS architecture</td>
</tr>
<tr>
<td>System and Subsystem Detailed Design and Implementation</td>
<td>MBSE simplifies identifying impacts of proposed baseline changes on component systems, and greatly simplifies managing development of multiple variants.</td>
</tr>
<tr>
<td>Systems Integration and Interfaces</td>
<td>Using MBSE for interface management improved productivity and quality of products. Managing change is different between DBSE and MBSE.</td>
</tr>
<tr>
<td></td>
<td>Using MBSE improved communication across Team Submarine.</td>
</tr>
<tr>
<td>Validation and Verification</td>
<td></td>
</tr>
<tr>
<td>Deployment and Post Deployment</td>
<td></td>
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<tr>
<td>Life Cycle Support</td>
<td>Improved documentation of baselines reduces cost of support.</td>
</tr>
<tr>
<td></td>
<td>Reducing the cost of document generation through automation makes specialized SE products affordable.</td>
</tr>
<tr>
<td>Risk Assessment and Management</td>
<td></td>
</tr>
<tr>
<td>System and Program Management</td>
<td>Improved communication of system architecture reduces friction between PARMs.</td>
</tr>
</tbody>
</table>
Part 1: SEBoK Introduction

What is MBSE?
What is the MBSE vision for SE?
What is the current state of MBSE knowledge and how does SEBoK reflect this?

Part 2: SE Foundations

Review current modelling fundamentals and foundational concepts
Links between models, purpose of modelling and the Systems Approach

Part 3: SE and Management

Modelling across the Life Cycle:
- Identification of models for each phase, challenges for each
- Integration of models for architecture, design, I&T, V&V, etc.
- Model governance and configuration management

Part 4: Applications of SE

Generic challenges e.g. model validation, model maintenance, reuse, integration,
Apply models to each application context:
- What kinds of models apply to each?
- How does theory in Part 2 apply?
- How do life cycle issues in Part 3 apply?

Part 5: Enabling SE

- Competencies and skills for modelling
- Team Roles (tool smith, customization of tools and models, model architect, etc.)
- Organizing for modeling

Part 6: Related Disciplines

Model integration:
- With Domain specific models
- With specialist models
Relationships with SW Engineering
- Modeling tool development
- Shared standards and languages

Part 7: Case Studies

Specific “MBSE” Case Study
Emphasize models across case Studies

Why models? Why modelling?

How to do modelling? Who to involve?

What to model? With what models?

When to use models?
SECM Approach

INCOSE Systems Engineering Handbook V4

SEBoK V 0.5 Model

SECM – 2015 Industry Reference


SysML V2 Services Requirements

Other OMG Specs

SECM - SysML V2 RFP

SysML V2 RFP

SysML V2 Spec

SysML V2 Meta-model

Service Spec

Other Industry Ontologies

UML 4SE RFP

SECM – 2003 Industry Reference

* Joint INCO/OMG, Led by Dave Oliver
SECM Approach

Validate SECM Editorial Use Content Use

INCOSE Systems Engineering Handbook V4


SEBoK V 0.5 Model

SysML V2 Services Requirements

Other OMG Specs

SysML V2 Spec

SysML V2 Meta-model

Service Spec

Other Industry Ontologies

SECM – 2003 Industry Reference

UML 4SE RFP

SysML V1.X Spec

SECM - SysML V2 RFP

* Joint INCOSE/AP233/OMG, Led by Dave Oliver
SEBoK Core Concepts (Draft)
Creating people, teams and enterprises to enable good SE

Enabling SE

The other disciplines involved in a Life Cycle and how we work with them

Related Disciplines

SE and Management

Applications of SE

The different Contexts in which...

Standard Life Cycle, Process and Practices

Applications of SE

The different Contexts in which...

Standard Life Cycle, Process and Practices

Systems Knowledge and how it relates to SE

SE Foundations

Systems Literature: What everyone should know about Systems Foundations

Guide to the Foundational Theories and Principles for SE (taken from sciences of Systems, Social, Cognitive, Design, Math, Organisations, etc.)

Improve conceptual foundations, integration, consistency across SEBoK

Enabling SE

Creating people, teams and enterprises to enable good SE

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The different Contexts in which...

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Part 7
Adding Domain Knowledge

- Domain Examples
  - SEBoK Case study with focus on unique domain issues

- Domain Overviews
  - SEBoK Article aimed at none Domain SE’s
  - Domain overview, key systems issues, key domain standards and guides, SE discussion

- Domain Knowledge Areas
  - SEBoK KA (plus articles) aimed at Domain SE’s
  - For each SE topic details of domain application, tools, etc. (linked to SEBoK topics)

- Domain Content
  - SEBoK discussion, reference, etc. within existing articles
  - Expands the scope and coverage of SEBoK
Adding Domain Knowledge

• Adding material to SEBoK:
  – Short descriptions building on other SEBoK content
  – Links to definitive source references
  – Include variety of viewpoint and definitions if needed
  – Can offer new synthesis and perspective on existing knowledge
  – While not directly creating new knowledge

• Creating none SEBoK material
  – If domain knowledge is either not published, not openly available, not mature or does not exist, working groups should consider creating none SEBoK Products first
  – E.g. INCOSE handbook, Guide to Requirements, Lean SE Enablers, Guide to SE and PM, etc.
  – Conference and Journal papers, workshop reports and other material
  – Add value to this by including in SEBoK
SEBoK 2016

- SEBoK plans for 2016
  - v1.6 March 2016: Content Maturity + Initial MBSE
  - v1.7 Sept 2016: MBSE, Domain extensions, foundations

- Planning for GRCSE update begins
  - IW workshop
  - Information Gathering
  - Review and agree at IS 2016

- Planned outreach
  - IEEE Sys Con, CSER, IIE, ABET, etc.
  - Newsletter, website, webinars, social media, etc.

- Even more involvement and sponsorship
The last version of the SEBoK for the year 2015, version 1.5.1, was released on December 18 2015.

The release includes changes to Part 6: Related Disciplines. The Knowledge Area SE and Software Engineering has been updated to reflect changes to the Guide to the Software Engineering Body of Knowledge (SWEBOK) and new articles have been added on software engineering in the SE life cycle and software engineering features, tools and metrics. The Risk Management article has also been updated with clarifications of the text in Risk Identification and Opportunity and Opportunity Management section.

Finally, two new case studies have also been added to Part 7: SE Implementation Examples. These new examples consider the application of SE principles and practices to the creation and use of complex adaptive systems. This is an area of SE application which was not
The franchise continues......

#who gets killed off in SEBoK v2.0?