The Body of Knowledge and Curriculum to Advance Systems Engineering

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Panelists
Prof. David Olwell, Naval Postgraduate School
Garry Roedler, Lockheed Martin
Prof. Michael Henshaw, Loughborough University

Moderator
Dr. Ricardo Valerdi, MIT (moderator)
1. BKCASE Intro (Valerdi) – 5 min

2. Overview of SEBoK and Description of Parts 1 & 2 (Olwell) – 10 min

3. Description of Parts 3, 5, 6 and 7 (Roedler) – 10 min

4. Description of Part 4 - Applications of SE - SoS, Product SE, Enterprise SE, and Service SE (Henshaw) – 10 min

5. Q&A – 20 min
What is a Body of Knowledge?

1. A complete set of concepts, terms and activities that make up a professional domain

2. The accepted ontology for a specific domain

- Civil Engineering Body of Knowledge (CEBoK)
- Software Engineering Body of Knowledge (SWEBOK)
- Project Management Body of Knowledge (PMBOK)
- Enterprise Architecture Body of Knowledge (EABOK)
- Etc.
Panelists

Prof. David Olwell
- Professor of Systems Engineering, Naval Postgraduate School
- Co-Principal Investigator for BKCASE

Garry Roedler
- Fellow & Engineering Outreach Program Manager, Lockheed Martin
- Editor of ISO/IEC/IEEE 15288, 29148 and 15939; INCOSE CAB Co-chair, ESEP and Founder Recipient

Prof. Michael Henshaw
- Professor of Systems Engineering, Loughborough University
- BAE Systems (17 years)
Terminology

- Wikitize
- BKCASE
- SEBoK
- GRCSE
- Collective intelligence
• BKCASE
• GRCSE
• Need
• Precedent
• Process
• Authors
• Bkcasewiki.org
Part 1: SEBoK 0.5 Introduction
Part 2: Systems (What type of systems exist)
Part 3: Systems Engineering and Management (How)
Part 4: Applications of Systems Engineering (Product, Enterprise, Service, SoS)
Part 5: Enabling Systems Engineering (When, Who)
Part 6: Related Disciplines
Part 7: Systems Engineering Implementation Examples
KA and Topic Structure

• Content within Knowledge Areas/Topics for consistency
  – Items to be included in each Knowledge Areas (aka chapters)
    • Introduction
    • Fundamentals (if applicable)
    • SE Topics (Links to separate Topic articles)
    • Practical Considerations (if applicable)
    • Primary References
    • Additional References
    • Glossary

– Items to be included in each SE topic
  • Introduction
  • Topic Overview and Discussion
  • Ontology (if included, then figures and/or tables)
  • Linkages to other topics
  • Practical Considerations (Pitfalls, Good Practice, etc.) – Transition to table format – see next chart
  • Primary References
  • Additional References
  • Glossary
Part 1: SEBoK 0.5 Introduction

• Context and Purpose of the SEBoK
• Scope of the SEBoK
• SE and Other Engineering Disciplines
• A Short History of SE: Challenge and Response
  • Overview of Systems Engineering Challenges
• Key SE Principles and Practices
• Origins of the SEBoK
• SEBoK Users and Uses
• Another Scope Dimension: Domain-Independent Knowledge
• Intertwined Disciplines and the SEBoK
• Scope and Guidance for the Construction of the SEBoK
• Structure of SEBoK version 0.5
• Next Steps
Part 2: Systems

- Knowledge Area: Systems Overview
  - Topics: What is a System?; System Context; Overview of System Science; System Perspectives

- Knowledge Area: System Concepts
  - Topics: Concepts Related to Systems; Concepts Related to System Relationships; Complexity and Emergence
Part 2: Systems (cont’d)

• Knowledge Area: Types of Systems
  ◦ Topics: Classifications of Systems; Groupings of Systems; System Domains; The Product View of Engineered Systems; The Service View of Engineered Systems; The Enterprise View of Engineered Systems

• Knowledge Area: Representing Systems with Models
  ◦ Topics: What is a Model?; Why Model?; Types of Models; System Modeling Concepts; Modeling Standards

• Knowledge Area: Systems Approach
  ◦ Topics: Overview of the Systems Approach; Exploring a Problem or Opportunity; Systems Analysis Approach; Synthesis of a System; Proving a System; Owning and Making Use of a System; Applying the Systems Approach
Knowledge Area: Systems Challenges

• Topics: Systems Engineering Success Factors; Complex System Challenges; Dynamically Changing Systems; Interoperability and Centric Architectures; Evolutionary Systems
Discussion Topics

1. Overview of Contents

2. Fundamental Concepts and Terms

3. Focus of Parts 3, 5, 6, and 7

At end:

1. Path Forward

2. How You Can Help
SEBoK V0.5 TOC

- Part 1: SEBoK 0.5 Introduction
- Part 2: Systems (What type of systems exist)
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Fundamental Concepts and Terms

• **Concepts**
  – System Structure – System-of-Interest and System Elements
  – Iteration, Recursion, and concurrency of stages and processes
  – Modularity of processes (can be invoked by other processes)
  – May have a blend of process models or types of process models at the same time.
  – Complex Systems and System of Systems need to be addressed consistently throughout

• **Terms**
  – Defer to SEVOCAB when possible
    • It reflects ISO, IEC, IEEE, and PMI terminology for SE and SWE
  – **Enterprise** vs organization
  – Program vs **Project**
  – System Hierarchy Terms
    • System / System-of-interest
    • **System Element** vs. subsystem, component, assembly, unit, ...
      • Note: system element may be HW, SW, people, products, services, ...
  – Roles: Stakeholder, user, customer, end user, operator, administrator, acquirer, supplier, developer, provider, maintainer, ...
    • Still need to resolve
A system is completely composed of a set of interacting system elements.
Iteration and Recursion

**Iteration**

- Stakeholder Requirements Definition Process
  - Outcomes flow to
  
- Requirements Analysis Process
  - Applied to
  - Outcomes used for

- Architectural Design Process
  - Applied to

**Value added to system by iterative application of the same processes**

**Recursion**

- Stakeholder Requirements Definition Process
  - Outcomes flow to
  - Applied to

- Requirements Analysis Process
  - Applied to
  - Outcomes used for

- Architectural Design Process
  - Applied to
  - Outcomes flow to the systems of the system-of-interest

**System-of-interest**

**Value added to system-of-interest by definition of its lower level systems**

- System
Part 3 - Systems Engineering and Management (How)

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- Part 5: Enabling Systems Engineering (When, Who)
- Part 6: Related Disciplines
- Part 7: Systems Engineering Implementation Examples

- Life Cycle Models
- System Definition
- System Realization
- Deployment and Use
- SE Management
- Product and Service Life Management
- SE Standards

Focuses on *How* SE is Conducted; Core Technical and Management Processes, Life Cycle Models and SE-Related Standards
Part 5 - Enabling the Organization to Perform Systems Engineering (When, Who)

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- Part 7: Systems Engineering Implementation Examples

- Strategy to organize to perform SE
- Organizing Individuals to Perform SE
- Organizing Teams, Projects and Programs to Perform SE
- Organizing Businesses and Enterprises to Perform SE

Strategies for organizing for SE; considerations for individuals, groups, and the business/enterprise
Part 6 - Software Engineering, Project Management and Specialty Engineering

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- Part 5: Enabling Systems Engineering (When, Who)

**Part 6: Related Disciplines**

- SE & Software Engineering
- SE & Project Management
- Specialty Disciplines
  - Reliability, Availability, Maintainability
  - System Human Integration
  - Safety
  - Security
  - System Assurance
  - EMI/EMC
  - Manufacturability

Focused on the relationship of SE to other disciplines
Case studies and vignettes provide real-world examples of SE activities; includes links of concepts to activities in the SEBoK
SEBoK V0.5 TOC

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Part 4: Applications of Systems Engineering

• Addresses: How to apply systems engineering to creation and LC management of different types of systems
  – Products systems engineering
    • Consistent with ISO/IEC/IEEE 15288
    • Traditional SE
  – Services systems provisioning
    • Dynamic binding of products and services
    • Multiple providers
  – Enterprise Systems Engineering
    • Systems of processes (business and LC processes)
SoS Engineering

• Definitions and characteristics
  – Types of SoS: Virtual, collaborative, acknowledged, directed
• Architecture and Architecting approaches
  – Interoperability
  – Standards
  – Networks and Network analysis
  – Service view of SoSE
  – Open systems approaches
• Socio-technical aspects (real SoS)
  – Governance
  – Enterprise nature
  – The SoS mindset
  – Difference between SoSE and SE
• Capability Engineering (relationship to..)
• Michael Henshaw
• Judith Dahmann
• Mo Jamshidi
• Charles Dickerson
• +2
Path Forward

• Milestones

✓ May 6 – All comment incorporation determined – “prototype” of comment incorporation; determine any residual resource issues

✓ May 20 – Rough draft ready for incorporation into Wiki (“wikitize” it)

✓ May 20-June 6 – Review and refine rough draft in wiki

✓ June 6-10 – Core team review of wiki

– July 1 – Identify potential breaks and key threads

– July 15 – Lockdown of SEBoK structure

– July 31 – Deadline to provide all figures, diagrams, and images for IP approval

– August 15 – Completion of all writing

– September 15 – Ready for SE community review

Good progress being made – on track for September 15 review
How You Can Help

• Provide key information and references
• Provide case studies or vignettes
• Serve as a reviewer after V0.5 is released for review in September
• Try Bkcasewiki.org and let us know if it meets your needs