Status of the Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE) Project

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Timothy L.J Ferris, University of South Australia
Alice Squires, Stevens Institute of Technology, USA
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APCOSE, Seoul
19th Oct 2011
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Agenda

1. Introduction - BKCASE Project background & Overview
2. SEBoK Overview & Status
3. GRCSE Overview & Status
4. Why Now?
5. Conclusion
6. Q&A
What is BKCASE?

• Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE)

• Project to create:
  – Systems Engineering Body of Knowledge (SEBoK)
  – Graduate Reference Curriculum in Systems Engineering (GRCSE™ – pronounced “Gracie”)

• Started in September 2009 by Stevens Institute of Technology and Naval Postgraduate School with primary support from Department of Defense

• Project will run through 2012

• Intended for world-wide use
Our Partners
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<thead>
<tr>
<th>Author</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rick Adcock</td>
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<td>Decisive Analytics Corporation, US</td>
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<td>Sinclair Knight Merz, Australia</td>
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<td>Rolls Royce, UK</td>
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<tr>
<td>Johan Bendz</td>
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<td>Stuart Booth</td>
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<td>UTC Pratt &amp; Whitney, US</td>
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<td>Jeremy Dick</td>
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<td>Massachutts Institute of Technology (MIT), US</td>
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<td>Joseph J. Ekstrom</td>
<td>Brigham Young University, US</td>
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<tr>
<td>Marcia Enos</td>
<td>Lockheed Martin, US</td>
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<tr>
<td>Dick Fairley</td>
<td>IEEE, US (observer)</td>
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<tr>
<td>Alain Faisandier</td>
<td>MAP SYSTEM / AFIS, France</td>
</tr>
<tr>
<td>Tim Ferris</td>
<td>University of South Australia, Australia</td>
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<tr>
<td>Kevin Forsberg</td>
<td>Center for Systems Management, US</td>
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<td>G. Richard Freeman</td>
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<td>Michael Henshaw</td>
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<td>Tom Hilburn</td>
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<tr>
<td>Nicole Hutchison</td>
<td>Stevens Institute of Technology, US</td>
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<td>Peter Jackson</td>
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<td>Scott Jackson</td>
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<tr>
<td>Mo Jamshidi</td>
<td>University of Texas San Antonio, US</td>
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<tr>
<td>Cheryl Jones</td>
<td>United States Army, US</td>
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<tr>
<td>Naohiko Kohtake</td>
<td>Keio University, Japan</td>
</tr>
<tr>
<td>Harold “Bud” Lawson</td>
<td>Lawson Konsult AB, Sweden</td>
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<tr>
<td>Yeaw lip “Alex” Lee</td>
<td>Defence Science and Technology Agency, Singapore</td>
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<tr>
<td>Ray Madachy</td>
<td>Naval Postgraduate School (NPS), US</td>
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<tr>
<td>James Martin</td>
<td>Aerospace Corporation, US</td>
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The Authors Team (3)

<table>
<thead>
<tr>
<th>Author</th>
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<tbody>
<tr>
<td>Greg Mayhew</td>
<td>The Boeing Company, US</td>
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<tr>
<td>Andrew McGettrick</td>
<td>Association for Computing Machinery, UK (observer)</td>
</tr>
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<td>William Miller</td>
<td>INCOSE, US (observer)</td>
</tr>
<tr>
<td>Steve Mitchell</td>
<td>Lockheed Martin, US</td>
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<tr>
<td>Ken Nidiffer</td>
<td>Software Engineering Institute, US</td>
</tr>
<tr>
<td>Dave Olwell</td>
<td>Naval Postgraduate School (NPS), US</td>
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<td>Andrew Pickard</td>
<td>Rolls Royce, US</td>
</tr>
<tr>
<td>Daniel Prun</td>
<td>Ecole Nationale de l’Aviation Civile (ENAC), France</td>
</tr>
<tr>
<td>Art Pyster</td>
<td>Stevens Institute of Technology, US</td>
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<tr>
<td>Garry Roedler</td>
<td>Lockheed Martin, US</td>
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<tr>
<td>Jean-Claude Roussel</td>
<td>European Aeronautic Defence and Space Company (EADS), France</td>
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<td>Thales Group, UK</td>
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<tr>
<td>John Snoderly</td>
<td>Defense Acquisition University, US</td>
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<td>Alice Squires</td>
<td>Stevens Institute of Technology, US</td>
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<td>Bill Stiffer</td>
<td>Raytheon, US</td>
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<td>Massood Towhidnejad</td>
<td>Embry-Riddle Aeronautical University, US</td>
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<tr>
<td>Guilherme Horta Travassos</td>
<td>Federal University of Rio de Janeiro, Brazil</td>
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## The Authors Team (4)

<table>
<thead>
<tr>
<th>Author</th>
<th>Organization</th>
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<tbody>
<tr>
<td>Ricardo Valerdi</td>
<td>Massachusetts Institute of Technology (MIT), US</td>
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<tr>
<td>Mary VanLeer</td>
<td>Arkansas Scholarship Lottery, US</td>
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<td>Qing Wang</td>
<td>Institute of Software Chinese Academy of Sciences, China</td>
</tr>
<tr>
<td>Brian Wells</td>
<td>Raytheon, US</td>
</tr>
<tr>
<td>Brian White</td>
<td>CAU-SES, US</td>
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</table>
BKCASE 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.
Agenda

1. Introduction - BKCASE Project background & Overview

2. SEBoK Overview & Status

3. GRCSE Overview & Status

4. Why Now?

5. Conclusion

6. Q&A
What is the SEBoK?

Describes the boundaries, terminology, content, and structure of SE that are needed to systematically and consistently support:

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Task Description</th>
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</thead>
<tbody>
<tr>
<td>Inform Practice</td>
<td>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</td>
</tr>
<tr>
<td>Inform Research</td>
<td>Inform researchers about the limitations and gaps in current SE knowledge that should help guide their research agenda</td>
</tr>
<tr>
<td>Define Curricula</td>
<td>Define the content that should be common in undergraduate and graduate programs in SE</td>
</tr>
<tr>
<td>Certify Professionals</td>
<td>Certify individuals as qualified to practice systems engineering</td>
</tr>
<tr>
<td>Decide Competencies</td>
<td>Decide which competencies practicing systems engineers should possess in various roles ranging from apprentice to expert</td>
</tr>
</tbody>
</table>

Guide to the literature, not all the content of the literature
SEBoK Structure
(As V 0.5 issued mid-Sep 2011)

- Part 1: Introduction
- Part 2: Systems *(What)*
- 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

SEBoK 0.5 accessible in Wiki format on www.sebokwiki.org
Welcome to the Guide to the Systems Engineering Body of Knowledge (SEBoK), version 0.5.

Introduction

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.
This section provides the « opening » material of the SEBoK. SEBoK is not a copy of all SE Knowledge but rather a guide for finding the literature about SE that has been separately published in books, articles, websites and others resources.
This section describes the basic characteristics of engineered systems and the language for describing them. This is the *What* of SE. What is engineered?
Part 3 - Systems Engineering and Management (How)

- Part 1: Introduction
- Part 2: Systems
- **Part 3: Systems Engineering and Management**
- Part 4: Applications of Systems Engineering
- Part 5: Enabling Systems Engineering
- Part 6: Related Disciplines
- Part 7: 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 4 – Applications of Systems Engineering

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

- Product SE
- Service SE
- Enterprise SE
- Systems of Systems (SoS)

This section focuses on the application of SE on various types of Systems: Product Systems, Services Systems, Enterprise Systems, and Systems of System.
Part 5 – Enabling of Systems Engineering (When, Who)

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

- SE Organizational Strategy
- Enabling Businesses and Enterprises to perform SE
- Enabling Teams to perform SE
- Enabling Individuals to perform SE

Strategies for organizing SE; considerations for individuals, groups, and the business/enterprise
Part 6 – Related Disciplines

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

Focused on the relationship of SE to other disciplines

- SE & Software Engineering
- SE & Project Management
- SE & Specialty Engineering
  - Reliability, Availability and Maintainability
  - Human Systems Integration
  - Safety Engineering
  - Security Engineering
  - System Assurance
  - Resilience Engineering
  - Manufacturability & Producibility
  - Affordability
  - Environmental Analysis
  - ...
Part 7 - Examples

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

  - Matrix of Implementation Examples
  - Case Studies: overview of and reference to existing SE case studies.
  - Vignettes: summary of events related to SE with appropriate references.

Case studies and vignettes provide real-world examples of SE activities; includes links of concepts to activities in the SEBoK
Agenda

1. Introduction - BKCASE Project background & Overview

2. SEBoK Overview & Status

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4. Why Now?

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What is in GRCSE?

• *Guidance for Constructing and Maintaining the Reference Curriculum:* the fundamental principles, assumptions, and context for the reference curriculum authors

• *Entrance Expectations:* what students should be capable of and have experienced before they enter a graduate program

• *Outcomes:* what students should achieve by graduation

• *Architecture:* the structure of a curriculum to accommodate core material, university-specific material, and elective material

• *Core Body of Knowledge:* material that all students should master in a graduate SE program

Not specific courses. Not specific packaging. Adaptation and selective adoption expected and encouraged.
GRCSE Value Proposition

1. There is no authoritative source to guide universities in establishing the outcomes graduating students should achieve with a master’s degree in SE, nor guidance on reasonable entrance expectations, curriculum architecture, or curriculum content.

2. This gap in guidance creates unnecessary inconsistency in student proficiency at graduation, makes it harder for students to select where to attend, and makes it harder for employers to evaluate prospective new graduates.

3. GRCSE will fill that gap, becoming the “go to” reference to develop, modify, and evaluate graduate programs in SE.

GRCSE used GSwE2009 as starting point and made many improvements
GRCSE Structure (V0.5)

Chapters

1. Introduction – explaining the foundations of GRCSE

2. Guiding principles – underlying principles

3. Objectives – description of the expected level of attainment of graduates 3-5 years after graduation. This results from education and experience together.

4. Outcomes – levels of attainment of graduates at the time of graduation. Directly linked to the education experience.

5. Entrance expectations – knowledge assumed of entrants to the program
GRCSE Structure (V0.5)

Chapters

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

7. CorBOK – the core body of knowledge, which is required of all graduates of any relevant program and graduates of particular specializations. This is expressed as levels of achievement using Bloom’s taxonomy of educational outcomes.

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

GRCSE Structure (V0.5)

Appendices

1. Survey of existing programs.

2. Bloom’s taxonomy - a guide to how Bloom’s taxonomy has been used in GRCSE.

3. Mapping of CorBOK and outcomes.

4. Assessment – background information for chapter 8.

5. Competency based curriculum – discussion of issues in designing curriculum to achieve certain competencies.

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

1. Introduction - BKCASE Project background & Overview
2. SEBoK Overview & Status
3. GRCSE Overview & Status
4. Why Now?
5. Conclusion
6. Q&A
Why Now?
Highly Complex Challenges
Successful SE Layered Integrated Framework

BKCASE Essential Foundation

Oversight & Control Activities
(Governance: Policy, Councils, Oversight Boards, etc)

Collaborative Environments & Hierarchical Organizations
(Where SE’s Work)

Standard Systems Engineering Processes
(Tailored to Meet Organizational Needs)

Common Methods, Models & Tools
(Future Will Demand Greater Interoperability)

Common Language
(Obtained Through; Education, Training & Experience)
Practitioners Need to Fill the Gap with Academia

What we need are Systems Engineering professionals who will:

1. Lead others to solve highly complex challenges

2. Possess the breadth of knowledge, skills & abilities required to optimally tailor & execute SE processes that meet individual enterprise needs

3. Understand the implications of actions across all applicable Systems AND Product/Service, Enterprise and Customer Service Realms

4. Effectively design, build & work within the workplace of tomorrow!
Agenda

1. Introduction - BKCASE Project background & Overview

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BKCASE Project Schedule

**Project Milestones**
- Project/SEBoK Kick-Off (Sept/Dec 09)
- SEBoK 0.25 (Sep 10)
- SEBoK 0.5 (Sep 11)
- SEBoK 0.75 (Apr 12)
- SEBoK 1.0 (Sep 12)
- GRCSE Kick Off (Mar 10)
- GRCSE 0.25 (Dec 10)
- GRCSE 0.5 (Dec 11)
- GRCSE 1.0 (Dec 12)

**Project Workshops**
- Workshop II (Mar 10, Daytona, USA)
- Workshop III (IS 10, July 10, Chicago, USA)
- Workshop IV (Oct 10, Toulouse, France)
- Workshop V (IW 11, Jan 11 Phoenix, USA)
- Workshop VI (April 11, Los Angeles, USA)
- Workshop VII (IS11, June 11 Denver, USA)
- Workshop VIII (Oct 11, London, UK)
- Workshop IX (IW12, Jan 12 Daytona, USA)
- Workshop X (April 12, Monterey, USA)
- Workshop XI (IS12, July 12 Roma, Italy)
- Workshop XII (Oct 12, Hoboken, USA)
If We Are Successful…

SEBoK will strongly influence the INCOSE SE Handbook Version 4, the INCOSE SE Professional Certification Program, DoD SE competency efforts, will highlight places where research is needed, become a standard reference for practitioners, and improve the quality and richness of communication among systems engineers worldwide.

GRCSE will clearly distinguish between graduate and undergraduate education in SE and influence the content of both undergraduate and graduate SE programs worldwide.
Questions?

www.BKCASE.org
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Optional Slides...

www.BKCASE.org
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Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE)

BKCASE Project

is supported by SE experts in that shapes and endorses

SE Certification Programs
- ASEP
- CSEP
- ESEP

SE Competency Models

SE Workforce Development Initiatives

SE Knowledge
- Lessons Learned
- Process Best Practices
- Standards
- Proven Techniques

The Boundary of Systems Engineering

that facilitates searching of metadata

pointers

organizes/defines

builds consensus on provides

SE Community

Professional Societies
- INCOSE
- IEEE
- ACM

Government

Industry

Academia

SE Body of Knowledge (SEBoK)

drives

that together create that will maintain

that guides for use by

to develop to author

to define to certify

to develop to guide

to develop to guide

to develop

Consistent Proficiency in SE graduates

that enables that simplifies

SE Masters Program Selection

Evaluation of Job Candidates

resulting in

Graduate Programs in SE

Entrance Expectations

Curriculum Architecture

Defined Student Outcomes

Curriculum Content

SE Textbooks

BKCASE Products

Graduate Reference Curriculum in SE (GRCSE)

http://www.BKCASE.org/about-bkcase/bkcase-story/
SE - Beyond Traditional Realms

Product, Enterprise & Customer Service View Model

Traditional SE Focus

Needs/Rgm’ts

Deliverables

CUSTOMER

PRODUCT/SERVICE

SYSTEMS PROCESS ENGINEERING

ARCHITECTURE

DESIGN, MANUFACTURE & FIELD

SYSTEMS ENGINEERING

CUSTOMER
SE - Beyond Traditional Realms

Product, Enterprise & Customer Service View Model

Expanded SE View

Traditional SE Focus

CPI

SE - Beyond Traditional Realms

Product, Enterprise & Customer Service View Model

CUSTOMER SERVICE

ENTERPRISE

Needs/ Rgm’ts

Strategic Alignment Process

Internal Business Support Systems

Architecture

Expanded SE View

PRODUCT/SERVICE

CPI

Traditional SE Focus

Design, Manufacture & Field

ARCHITECTURE

BUSINESS PROCESS ENGINEERING

SYSTEMS PROCESS ENGINEERING

Deliverables

Systems Engineering

Service After Transfer / Sale

Feedback

Customer Service

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<th>Sub-Level</th>
<th>Competency</th>
<th>Outcome Descriptors</th>
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<td><strong>Knowledge</strong></td>
<td>Knowledge of specifics</td>
<td>Remembering previously learned material. Test observation and recall of information, i.e., “bring to mind the appropriate information;” e.g., dates, events, places, knowledge of major ideas, mastery of subject matter.</td>
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<tr>
<td></td>
<td>Knowledge of terminology</td>
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<td></td>
<td>Knowledge of specific facts</td>
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<td></td>
<td>Knowledge of ways and means of dealing with specifics</td>
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<td></td>
<td>Knowledge of the universals and abstractions in a field</td>
<td>List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name (who, when, where, etc.)</td>
</tr>
<tr>
<td><strong>Comprehension</strong></td>
<td>Translation</td>
<td>Understanding information and ability to grasp meaning of material presented. For example, translate knowledge into new context, interpret facts, compare, contrast, order, group, infer causes, predict consequences, etc.</td>
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<td></td>
<td>Interpretation</td>
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<td></td>
<td>Extrapolation</td>
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<tr>
<td><strong>Application</strong></td>
<td>Application of methods and tools</td>
<td>Ability to use learned material in new and concrete situations; e.g., use information, methods, concepts, theories to solve problems requiring the skills or knowledge presented.</td>
</tr>
<tr>
<td></td>
<td>Use of common techniques and best practices</td>
<td>Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>Analysis of elements</td>
<td>Ability to decompose learned material into constituent parts in order to understand structure of the whole.</td>
</tr>
<tr>
<td></td>
<td>Analysis of relationships</td>
<td>Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer</td>
</tr>
<tr>
<td></td>
<td>Analysis of organizational principles</td>
<td></td>
</tr>
<tr>
<td><strong>Synthesis</strong></td>
<td>Production of a unique communication</td>
<td>Ability to put parts together to form a new whole. This involves the use of existing ideas to create new ones, generalizing from facts, relating knowledge from several areas, and predict, draw conclusions.</td>
</tr>
<tr>
<td></td>
<td>Production of a plan or proposed set of operations</td>
<td>Combine, integrate, modify, rearrange, substitute, plan, create, design, invent, what-if analysis, compose, formulate, prepare, generalize, rewrite</td>
</tr>
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<td>Derivation of a set of abstract relations</td>
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<tr>
<td><strong>Evaluation</strong></td>
<td>Judgments in terms of internal evidence</td>
<td>Ability to pass judgment on value of material within a given context or purpose.</td>
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<td></td>
<td>Judgments in terms of external criteria</td>
<td>Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize</td>
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Example of Cognitive Levels for SE (1)

<table>
<thead>
<tr>
<th>Levels</th>
<th>Competencies</th>
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</table>
| Knowledge (K)   | • The student is able to recite the definitions of “system” and “emergence” and to state the connection between them.  
                  • The student is able to describe the notion of product system architecture and state the impact architecture may have on system development success. |
| Comprehension (CO) | • The student is able to explain, in a very general way, the conditions under which a system development team might choose to use a waterfall (or iterative, incremental, or spiral) life cycle model.  
                           • The student is able to explain the range of cases for which a particular systems modeling approach is applicable. |
| Application (AP) | • Given the operational concept and requirements of a simple system along with a specified budget and required completion time, the student is able to choose, and to provide a rudimentary justification for the choice of a particular life cycle model to address the project, e.g., waterfall, iterative, incremental, or spiral.  
                           • The student is able to construct a simple model of a defined systems which would enable understanding of the relationship of the primary factors included in the model. |
| Analysis (AN)   | • Given a simple requirements document and a domain model for an application, the student is able to critique the domain model.  
                           • Given the operational concept of a system along with a requirements document, a budget, a schedule, a choice of a development process, and a justification of the use of that process for the project, the student is able to find and explain errors in the justification and/or in the choice of process.  
                           • The student can analyse the effectiveness of a simple model of a system to describe the behaviour of that system, and identify errors or weaknesses in the model arising from the assumptions about the system embedded in the model. |
Example of Cognitive Levels for SE (2)

<table>
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<tr>
<th>Levels</th>
<th>Competencies</th>
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| **Synthesis (S)** | • Given a detailed requirements document and a well-constructed domain model for a system, the student is able to design at least one basic architecture for the system.  
• Given an operational concept, requirements, architecture and detailed design documents for a system, the student is able to construct a complete implementation plan and provide a cogent argument that if the implementation of the architecture or detailed design is performed according to the plan, then the result will be a system that satisfies the requirements, fulfils the operational concept, and will be completed within budget and within schedule.  
• The student can develop and use a model of a simple system, where the system is described by an architecture, to determine the capability of the system represented by the model and to explore desirable parameters of model elements. |
| **Evaluation (EV)** | • Given an operational concept, requirements, architecture, detailed design, and implementation plan, including budget and schedule, for a system, as well as a feasibility argument for the implementation plan, the student is able to assess the plan and to either explain why the feasibility argument is valid or why and where it is flawed with regard to any of the claims regarding implementation of the requirements, fulfillment of the operational concept, or ability to be completed within budget and schedule.  
• Given a simple system the student is able to plan a test and evaluation method to perform a verification and validation process of that system against the requirements of the system and the need description associated with the system.  
• OR: Given a simple system and a test and evaluation plan of the system is able to determine that the results that would be produced through use of the test and evaluation plan will yield a useful verification and validation of the system. |