



SSECM: The Software Systems Engineering Competency Model

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Agenda

- What is software systems engineering?
- What is a competency model?
- Why competency models?
- A brief overview of SEBOK Version 1
- A brief overview of SWEBOK Version 3
- Software Systems Engineering Competency Model (SSECM)

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Some Related Activities

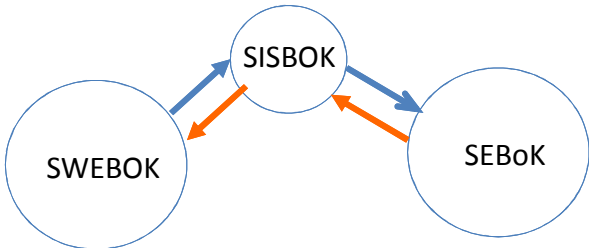
- Chair, IEEE Computer Society PAB-SSE Committee
- Chair, SWEBOK V3 CCB
- Member, BKCASE Board of Governors
- Chair, Computer Society – PMI SWX project
- Chair, Computer Society Competency Models project

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As I Was Saying Last Year . . .

- **SISBOK**: A Systems Engineering Body of Knowledge for Software-Intensive Systems
- SISBOK will bridge the gap between SEBoK and SWEBOK
 - by tailoring the generic knowledge areas of SEBoK to the specifics of engineering large, complex software-intensive systems
 - and by relating the SWEBOK KAs to the tailored SEBoK KAs



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SISBOK Purposes

- Purposes of SISBOK are to provide an integrated BOK that will:
 1. focus the **combined scopes** of SWEBOK and SEBoK on the engineering of large, complex software-intensive systems
 2. provide **guidance to traditional systems engineers** on the application of systems engineering to development and sustainment software-intensive systems
 3. provide **guidance to software engineers** on the application of systems engineering to development and sustainment of software-intensive systems

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The SISBOK Bridge

Systems Engineering Methods Adapted to Software Engineering	Software Engineering Methods Adapted to Systems Engineering
<ul style="list-style-type: none"> ▪ Stakeholder Analysis ▪ Requirements Engineering ▪ Functional Decomposition ▪ Design Constraints ▪ Architectural Design ▪ Design Criteria ▪ Design Tradeoffs ▪ Interface Specification ▪ Traceability ▪ Configuration Management ▪ Systematic Verification And Validation 	<ul style="list-style-type: none"> ▪ Model-Driven Development ▪ UML-SysML ▪ Use Cases ▪ Object-Oriented Design ▪ Iterative Development ▪ Agile Methods ▪ Continuous Integration ▪ Incremental V&V ▪ Process Modeling ▪ Process Improvement

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Two Ten-Things+ for SISBOK

- Two articles in SEBOK*:
 1. Ten Things Systems Engineers Need to Know About Software Engineering
 2. Ten Things Systems Engineers Need to Know About Managing Software Projects

*Systems Engineering and Software Engineering, Part 6 www.sebokwiki.org

- + Teaching Systems Engineering to Software Engineering Students
ASEE Conference Proceedings, Vancouver, 2011

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In The Meantime . . .

- A project to revise ISO/IEC/IEEE Standards 15288 and 12207 has been initiated
 - foundation elements for SISBOK
- A software systems engineering competency model has immediate application
 - as a bridge to SEBOK and other systems engineering endeavors
 - as guidance for practitioners, their managers, HR personnel, curriculum designers and others
 - as a foundation for training, certification, and licensing

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Competency and Competency Models

- Competency includes the knowledge and skills needed to perform a specified activity at a specified level of competency
- Competency levels are discrete points on a continuum of competency
- A competent person typically has different levels of competency for different work activities

- The hierarchy:

Skill Areas

Skills

Activities

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Guidelines for PAB* Competency Models


- A PAB competency model should:
 - be based on demonstrated need
 - be grounded in reference materials
 - specify skills at various levels of competency
 - describe activities, not job roles
 - include technical skills and affective skills
 - include leadership skills but not management skills

* PAB is the Professional Activities Board of the IEEE Computer Society

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PAB Competency Models

- Two PAB competency models are being developed
 - SSECM: software-intensive systems engineering
 - ITCOMP: information technology

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PAB COMP Members

- Dick Fairley, SSECM leader
- Ken Nidiffer
- Mark Ardis
- Massood Towhidnejad
- Tom Hilburn
- Chuck Walrad, ITCOMP leader
- Other ITCOMP members

Volunteers Needed!

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Intended Audiences for PAB Competency Models

- *Computing Practitioners*: self-evaluation, self-improvement, career planning, guidance in selecting academic programs and training classes, discussions with leaders and supervisors.
- *Managers of computing practitioners*: select skills at various skill levels and group them into job roles and job descriptions, establish performance criteria, objective basis for performance evaluations, counseling on career paths for individual practitioners.
- *Work force planners*: develop skills inventories, perform gap analysis, prepare workforce development plans, define career ladders, and select and hire employees, contract personnel, and contractor organizations.

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Intended Audiences (2)

- *Curriculum developers*: develop training materials and academic classes, assess programs degree.
- *The IEEE Computer Society*: develop certification programs, standards, and curriculum models; provide services to industry; assist schools and industry; provide authoritative credentials and credibility for the computing professions.
- *Other professional societies*: determine common interests, overlaps, and boundaries.
- *Legislative and legal bodies*: guidance for licensing criteria.

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Intended Audiences (3)

- *Regulatory agencies:* guidance in establishing regulations that impact the health, safety, and welfare of the general population.
- *Society at large:* increase the number of competent computing professionals.
- *Others:* novel uses not envisioned by the PAB.

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SSECM Foundations

- Bodies of Knowledge:
 - SWEBOK V3 & SEBoK V1
- Standards
 - IEEE Standard 12207-2008(?)
 - IEEE Standard 15288-2008(?)
- Reference curricula
 - SE2004
 - GSwE
 - GRCSE

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SEBoK and SWEBOK URLs

SEBoK URL: www.bkcasewiki.org

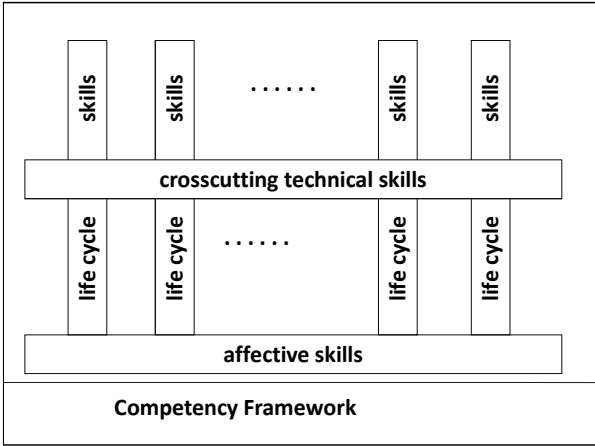
SWEBOK 2004 URL: www.swebok.org

SWEBOK V3 URL: <http://computer.centraldesktop.com/swebokv3review/>

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PAB Competency Framework



The diagram illustrates the PAB Competency Framework as a layered structure. At the base is a wide box labeled "Competency Framework". Above this are two horizontal bars: the top one is labeled "affective skills" and the one below it is labeled "crosscutting technical skills". Above the "crosscutting technical skills" bar are four vertical bars, each labeled "skills", with an ellipsis between the second and third bars. Above the "affective skills" bar are four vertical bars, each labeled "life cycle", with an ellipsis between the second and third bars.

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Affective Skills

- Aptitude
- Initiative
- Enthusiasm
- Work ethic
- Willingness
- Communication skills
- Team participation
- Trustworthiness
- Technical leadership skills

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Software Systems Engineering *Life Cycle* Skill Areas

- Process Models & Life Cycle Models
- SSECM Systems Engineering
- Software Requirement Engineering
- Software Design
- Software Construction
- Software Systems Verification and Validation
- Software Systems Sustainability

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The SSECM System Engineering Skill Area

- SSECM-SE skills include:
 - System Life Cycle Models
 - System Engineering Processes
 - System Requirements Engineering
 - System Design
 - Allocation and Flowdown
 - Component Engineering
 - System Verification and Validation
 - System Sustainability

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Software Systems Engineering *Crosscutting* Skill Areas

- Models and Methods
- Security Engineering
- Configuration Management
- Quality Assurance and Quality Control
- Measurement and Improvement (Process and Product)
- Domain Engineering

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Example: Requirements Engineering Skill Area


- Requirements Engineering Skills include:
 - Requirements Process
 - Requirements Elicitation
 - Requirements Analysis
 - Requirements Specification
 - Requirements Verification and Validation
 - Requirements Management

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Skill Area: Requirements Engineering	L1	L2	L3	L4	L5
Skill levels	Technician	Entry Level	Practitioner	Technical Leader	Industry Leader
Requirements process	1. Follows and applies defined processes for requirements engineering with guidance (F)	1. Assists requirements management through the use of appropriate tools (A) 2. Assists with traceability analysis (A)	1. Implements requirement engineering plans for projects (P) 2. Applies elements of the selected requirements process (P) 3. Supports impact analysis to determine effect of changes on schedule, budget, staffing, and technology (A) 4. Supervises traceability work activities (P/L)	1. Prepares requirement engineering plans for projects (L) 2. Selects elements of the requirements process from existing organizational assets (P/L) 3. Conducts impact analysis to determine effect of changes on schedule, budget, staffing, and technology (P/L) 4. Specifies traceability items, tools, and techniques (L)	1. Creates new guidelines, templates, tools, and techniques for requirement engineering (M) 2. Sets strategy and direction for the requirements process across projects and functional units of an organization (M) 3. Creates new ways to engage stakeholders, management team and developers in requirements work activities (M) 4. Analyzes traceability effectiveness and develops new methods and tools (M)

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Some Key Words

- Technician: follows defined processes
- Entry Level: assists
- Practitioner: assist, practice, lead
- Technical Leader: practice, lead
- Industry Leader: mastery

An individual who is competent at a given competency level for an activity will also be competent to perform at all lower levels for that activity

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Knowledge, Experience, and Competency

- Knowledge and experience are the basic elements of competency
- Knowledge can be gained in many ways
 - degree programs are one way to gain knowledge
 - but not the only way
- Variety of experiences is more important than length of experience

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Knowledge, Experience, and Degree Programs

EXAMPLES ONLY – NOT PRESCRIPTIVE

- A technician might have an associate degree and/or some certifications
- An entry-level practitioner might have a bachelors degree and 2 to 4 years of experience
- A practitioner might have a bachelors or masters degree and 4 to 10 years of experience
- A technical leader might have a bachelors or masters degree and 10 or more years of experience
- An industry leader might have a masters or doctorate degree and 20 or more years of experience

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Using SSECM to Assess Degree Programs

- An associates degree should prepare a technician to be competent at the technician level in one or several skill areas
- A bachelors degree should prepare an entry-level practitioner to be competent at the entry-level in all skill areas of software engineering
- Similarly, a masters degree program should cover the skill areas at the practitioner level
 - and perhaps some at the technical leader level

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Summary

- What is software systems engineering?
- What is a competency model?
- Why competency models?
- A brief overview of SEBOK Version 1
- A brief overview of SWEBOK Version 3
- Software Systems Engineering Competency Model (SSECM)

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Questions?

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