An international Consensus on the Software Engineering Body of Knowledge

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Presentation Objectives

- Give an overview of this international consensus on the “core body of knowledge” of software engineering
- Briefly present the development process used to reach this consensus
- Briefly present usages of SWEBOK Guide
- Next steps
  - Including links to System Engineering
Presentation Plan

- Project background
  - Project development process
  - Contents of the Guide
  - Usages of the Guide in organizations
  - Next steps
Guide to the Software Engineering Body of Knowledge (SWEBOK®)

- Project initiated by the IEEE CS
- International participation from industry, professional societies, standards bodies, academia, authors
- Over 500 hundred software engineering professionals have been involved
- Release of Ironman Version in 2004

® Registered in U.S. Patent Office
2004 SWEBOK Guide

- Endorsed by the project’s Industrial Advisory Board
- Approved by the IEEE Computer Society Board of Governors
- Adopted as ISO Technical Report 19759
  - Available on www.swebok.org
  - To be published in book format by the IEEE Computer Society Press
SWEBOK Guide = 10 Knowledge Areas

Mapped TO ISO/IEC 12207:1995 processes

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Design</th>
<th>Construction</th>
<th>Testing</th>
<th>Maintenance</th>
</tr>
</thead>
</table>

**Primary Processes**

**Supporting Processes**
What is Software Engineering?

- IEEE 610.12:
  - “(1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software.
  - (2) The study of approaches as in (1).”
Recognized Profession?

- Starr*: 
  - Knowledge and competence validated by the community of peers
  - Consensually validated knowledge rests on rational, scientific grounds
  - Judgment and advice oriented toward a set of substantive values

Development of a Profession

Initial professional education

Skills Development

One or both
- Certification
- Licensing

Accreditation

Professional societies

Full Professional Status

Professional development

Code of ethics

Adapted from Steve McConnell, *After the Gold Rush*, Microsoft Press, 1999, p. 93
Presentation Plan

- Project background
- **Project development process**
- Contents of the Guide
- Applications of the Guide in organizations
- Next steps
Project Objectives

- Characterize the contents of the Software Engineering Body of Knowledge
- Provide a topical access to the Software Engineering Body of Knowledge
- Promote a consistent view of software engineering worldwide
Project Objectives

- Clarify the place of, and set the boundary of, software engineering with respect to other disciplines (computer science, project management, computer engineering, mathematics, etc.)

- Provide a foundation for curriculum development and individual certification and licensing material
Intended Audience

- Public and private organizations
- Practicing software engineers
- Makers of public policy
- Professional societies
- Software engineering students
- Educators and trainers
What was out of scope?

- Not a curriculum development effort
- Not an all-inclusive description of the sum of knowledge in the field
- Not all categories of knowledge
Categories of Knowledge in the SWEBOK

| Specialized | Generally Accepted | Advanced and Research |

Target of the SWEBOK Guide

«Applicable to most projects, most of the time, and widespread consensus about their value and usefulness»

Project Management Institute - PMI

- North American Bachelor’s degree + 4 years of experience
Knowledge of a Software Engineer

- Application domain knowledge
- Advanced SE Knowledge
- Specialized SE Knowledge
- Guide to the SWEBOK Stoneman
- Maths
- ...
Three Underlying Principles of the Project

- **Transparency**: the development process is itself published and fully documented

- **Consensus-building**: the development process was designed to build, over time, consensus in industry, among professional societies and standards-setting bodies and in academia

- Available *free* on the web
Project Team

- Editorial Team of the Guide
- Industrial Advisory Board
- Associate Editors of the Knowledge Areas
- Reviewers
Roles of the Industrial Advisory Board

- Provide input to ensure relevance to various audiences
- Review and approve strategy and deliverables
- Oversee development process
- Assist in promoting the Guide to the Software Engineering Body of Knowledge
- Lend credibility to the project
A Three-Phase Approach for Developing the Guide

- Straw Man Phase
- Stone Man Phase
- Iron Man Phase (Sub-phase 1)
  - Iron Man Phase (Sub-phase 2)

Experimentation and Trial Usage

- Trial Version
  - Revision
    - 2004 Version
  - 2003

Years:
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
Version Review Process

- Transparency and consensus-building
  - All intermediate versions of documents published and archived on www.swebok.org
  - All comments made public as well as the identity of the reviewers
  - Detailed comment disposition reports
Data on reviewers

Trial Version

- Version 0.1: 33
- Version 0.5: 195
- Version 0.7: 378
  - + ISO reviews from 5 countries
Reviewers (2004 Version)

- Registered reviewers: 573
- Number of countries: 55
- Number of comments: 1020
- Number of reviewers submitting comments: 124
- Number of represented countries: 21
- + 7 countries submitted comments through ISO voting process
- Adopted by + 25 ISO participating countries

**Years in the field**

- 0-9 years: 17
- 10-19 years: 48
- 20-29 years: 44
- 30-39 years: 13
- 40-49 years: 2

**Years in industry**

- 0-9 years: 47
- 10-19 years: 41
- 20-29 years: 28
- 30-39 years: 8
Project Overview
Presentation Plan

- Project background
- Project development process

Contents of the Guide

- Applications of the Guide
- Next steps
Deliverables:

- **Consensus** on a list of Knowledge Areas
- **Consensus** on a list of *topics and relevant reference materials* for each Knowledge Area
- **Consensus** on a list of Related Disciplines
Knowledge Areas and Related Disciplines

- Software Requirements
- Software Design
- Software Construction
- Software Testing
- Software Maintenance
- Software Configuration Management
- Software Eng. Management
- Software Eng. Tools & Methods
- Software Engineering Process
- Software Quality

Related Disciplines

- Computer Engineering
- Computer Science
- Mathematics
- Project Management
- Management
- Quality Management
- Software Ergonomics
- Systems Engineering
Knowledge Area Description

Classification of Topics

Matrix of Topics & References

References

Topic Descriptions

Classification by Vincenti’s Taxonomy

Classification by Bloom’s Taxonomy

References to Related Disciplines

Not implemented in Trial Version
Guide to the Software Engineering Body of Knowledge
2004 Version

Software Requirements
- Software Requirements Fundamentals
- Requirements Process
- Requirements Elicitation
- Requirements Analysis
- Requirements Specification
- Requirements Validation
- Practical Considerations

Software Design
- Software Design Fundamentals
- Key Issues in Software Design
- Software Structure and Architecture
- Software Design Quality Analysis and Evaluation
- Software Design Notations
- Software Design Strategies and Methods

Software Construction
- Basic Concepts of Construction
- Managing Construction
- Practical Considerations

Software Testing
- Software Testing Fundamentals
- Test Levels
- Test Techniques
- Test Related Measures
- Test Process

Software Maintenance
- Software Maintenance Fundamentals
- Key Issues in Software Maintenance
- Maintenance Process
- Techniques for Maintenance
Software Requirements

Software Requirements Fundamentals
- Definition of Software Requirement
- Product and Process Requirements
- Functional and Non-functional Requirements
- Emergent Properties
- Quantifiable Requirements
- System Requirements and Software Requirements

Requirements Process
- Process Models
- Process Actors
- Process Support and Management
- Process Quality and Improvement

Requirements Elicitation
- Requirements Sources
- Elicitation Techniques

Requirements Analysis
- Requirements Classification
- Conceptual Modeling
- Architectural Design and Requirements Allocation
- Requirements Negotiation

Requirements Specification
- System Definition Document
- Systems Requirements Specification
- Software Requirements Specification

Requirements Validation
- Requirements Reviews
- Prototyping
- Model Validation
- Acceptance Tests

Practical Consideration
- Iterative Nature of Requirements Process
- Change Management
- Requirements Attributes
- Requirements Tracing
- Measuring Requirements
Summary of changes in 2004 Version

- Structural improvements in breakdown of topics: Software Construction, Management, Quality, Process
- Better representation of text in topic breakdown: Software Requirements, Testing, Maintenance
- Standardization of the contents of the chapters:
  - topic breakdown, terminology, reference citations and writing style
Summary of changes in 2004 Version

- Better representation of standards in chapters and a new Appendix devoted to standards
- Updating of reference material
- Handling of trial usage feedback
- Handling of reviewers comments
- New chapter on Related Disciplines (instead of an appendix)
Presentation Plan

- Project background
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- Contents of the Guide
- Applications of the Guide in organizations
- Next steps
Applications of the Guide

- Licensing & Certification
  - IEEE CS CSDP exam and program
  - Input in accreditation of software engineering programs in engineering faculties - CCPE
  - Ordre des ingénieurs du Québec:
    - Input to certify software engineers
Example Usages in Education

Program Design/Assessment:
- National Technological University
- Monash University
- CRISTEL project

Course Design/Assessment:
- A large number of universities
  - École de technologie supérieure
Applications of the Guide

- Industry & Government
  - Job description
    - Bombardier Transportation
  - Career planning
    - Construx
  - Input to Policy making
    - Turkish Industry Survey
Applications of the Guide

- Professional development
  - Security Industry Automation Corporation
  - Construx

- Dissiminations of standards
  - Introducing standards in software engineering curriculum
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Evolution process for the Guide

- Copyright belongs to the IEEE
- Transition to self-supporting, volunteer-led process—i.e. self-funded.
- Coordination with related IEEE-CS projects (internal and external)
- Time-boxed block updates
- Involvement with stakeholder groups
- Openness and transparency
- Technical excellence
Next Steps

Research to strengthen the foundations of a body of knowledge:

- Vincenti’s classification of engineering knowledge
  - Fundamental design principles
  - Criteria and specifications
  - Theoretical tools
  - Quantitative data
  - Practical considerations
  - Design instrumentalities

- Ontology of software engineering
Next Steps

Being investigated at ISO level:

- Certification of software engineers
  - ISO standard on content of certification
  - ISO recognized certifying bodies
  - International portability of certification of software engineers
Next steps

Consensus on the core body of knowledge is key in all disciplines and pivotal for the evolution toward a professional status

- INCOSE
  - Building a System Engineering Body of Knowledge - SEBOK
www.swebok.org
Presentation Plan

- Project background
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- Contents of the Guide
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- Appendix: Breakdown of topics
Figure 1  Breakdown of topics for the Software Design KA
Figure 1. Breakdown of topics for the Software Construction KA.
1. Software Testing Fundamentals
   - Testing-Related Terminology
   - Keys Issues
   - Relationships of Testing to Other Activities

2. Test Levels
   - The Target of the Test
   - Objectives of Testing

3. Test Techniques
   - Based on tester's intuition and experience
     - Specification-based
     - Code-based
     - Fault-based
     - Usage-based
     - Based on nature of application
     - Selecting and Combining Techniques

4. Test Related Measures
   - Evaluation of the Program Under Test
   - Evaluation of the Tests Performed

5. Test Process
   - Management Concerns
   - Test Activities
Software Configuration Management

1. Software Configuration Management Fundamentals
   - Identifying Items to be Controlled
   - Software Configuration Items
   - Software Configuration Item Relationships
   - Software Versions
   - Baseline
   - Acquiring Software Configuration Items
   - Software Library

2. Keys Issues in SCM
   - Organizational Context for SCM
   - Constraints and Guidance for SCM
   - Planning for SCM
   - SCM Organization and Responsibilities
   - SCM Resources and Schedules
   - Tool Selection and Implementation
   - Vendor/Subcontractor Control
   - Interface Control
   - Software Configuration Management Plan
   - Surveillance of Software Configuration Management
   - SCM Measures and Measurement
   - In-Process Audits of SCM

3. Software Configuration Control
   - Requesting, Evaluating and Approving Software Changes
   - Software Configuration Control Board
   - Software Change Request Process
   - Implementing Software Changes
   - Deviations and Waivers

4. Software Configuration Status Accounting
   - Software Configuration Status Information
   - Software Configuration Status Reporting

5. Software Configuration Auditing
   - Software Functional Configuration Audit
   - Software Physical Configuration Audit
   - In-Process Audits of a Software Baseline

6. Software Release Management and Delivery
   - Software Building
   - Software Release Management
List of Knowledge Areas

- Software Requirements
- Software Design
- Software Construction
- Software Testing
- Software Maintenance
- Software Configuration Management
- Software Quality
- Software Engineering Tools & Methods
- Software Engineering Process
- Software Engineering Management
Formal resolutions

- Industrial Advisory Board (2001)
- IEEE CS Board of Governors (2001)
  - "The Board of Governors of the IEEE Computer Society accepts the Guide to the Software Engineering Body of Knowledge (Trial Version) as fulfilling its development requirements and is ready for field trials for a period of two years"
- IEEE CS Board of Governors (Feb. 2004)
  - Officially approved the 2004 Version
- ISO Technical Report 19759 (upcoming)
Trial Version Review Process

Version 0.1

Limited number of domain experts

Review Cycle 1

Version 0.5

Selected users

Review cycle 2

Version 0.7

Community

Review Cycle 3

Version 0.9

Limited number of domain experts

Selected users

Community
Trial Version (2001)
Stone Man Version 0.5
Review Results

Option 1
Choose one or more from the following lists:

Choose a Knowledge Area
Choose a Review Viewpoint
Choose a Question
See Detailed Questionnaire

Search

Option 2
View all responses for a reviewer:

Choose a Reviewer
Search

Option 3
Enter the Unique Identifier of the Response:
Comment Resolution

Guide to the SWEBOK - Stone Man Version 0.5
Review Results Report

Knowledge Area: Software design
Review Viewpoint: Researchers

Question 1:
Do you find that the breakdowns of topics comply with the requirement of being sound and reasonable?

Unique Reviewer Response Identifier: 280
Reviewer Response: Yes
Reviewers: Du, Weichang | Marcos, Esperanza | Rodeiro Iglesias, Javier
Response Disposition: No disposition yet
Disposition Rationale:

Unique Reviewer Response Identifier: 281
Reviewer Response: The distinction between architectural and detailed design is traditional but perhaps becoming unmanageable as the size of a typical program/system grows
Reviewers: Sanden, Bo
Response Disposition: No disposition yet
Disposition Rationale:

Unique Reviewer Response Identifier: 282
Reviewer Response: The inclusion of structure charts under architectural design suggests that we are
Response Disposition: No disposition yet
Disposition Rationale:
Geographic Distribution of Reviewers
Trial Version

- USA: 55%
- Europe: 18%
  - 90 reviewers from 25 countries
- Canada: 10%
- Australia: 5%
- Asia: 5%
- Latin America: 4%
Education level of reviewers (Version 0.7)

- 39% Masters
- 34% Ph.D.
- 24% Bach
- 3% Other
Number of employees at reviewer location (Version 0.7)

- 0-50: 31%
- 50-500: 32%
- Over 500: 37%
Number of years of practical experience (Version 0.7)

- 0-9: 32%
- 10-19: 21%
- 20-29: 9%
- 38%