Software Engineers: What does industry expect them to know & master?

Alain Abran
P. Bourque, R. Dupuis, J. W. Moore, L. Tripp

SPIN-CHENNAI
India

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www.swebok.org
Presentation Objectives

- Give an overview of an 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
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>
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<tbody>
<tr>
<td>Software Configuration Management</td>
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<td>Software Engineering Management</td>
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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

Professional development Code of ethics

Full Professional Status

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

<table>
<thead>
<tr>
<th>Specialized</th>
<th>Generally Accepted</th>
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<tbody>
<tr>
<td>Advanced</td>
<td>and Research</td>
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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
- C.S.
- ...

www.swebok.org
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)
- **Trial Version**
- **Revision**

Timeline:
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
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
2001 Trial Version

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

- Comments: 1020
- Reviewers: 124
- Countries: 21
- + 7 countries submitted comments through ISO voting process
- Adopted by + 25 ISO participating countries
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

Topic Descriptions

Classification by Vincenti’s Taxonomy

Matrix of Topics & References

Classification by Bloom’s Taxonomy

References

References to Related Disciplines

Not implemented in Trial Version
Figure 1. Breakdown of topics for the Software Construction KA.
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
- Project development process
- 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 recognize software engineering
Example Usages in Education

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

- Course Design/Assessment:
  - A large number of universities
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
Presentation Plan

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Next steps:

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

India: how do you improve the skills & training of software engineers?

- In industry?
- University graduates?
Trial Version (2001)
Presentation Plan

- Project background
- Project development process
- Contents of the Guide
- Usages of the Guide in organizations
- Next steps
- Appendix: Breakdown of topics
Figure 1 Breakdown of topics for the Software Design KA
Software Testing

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 Maintenance

- Fundamentals
  - Definitions and Terminology
  - Nature of Maintenance
  - Need for Maintenance
  - Majority of Maintenance Costs
  - Evolution of Software
  - Categories of Maintenance

- Key Issues in Software Maintenance
  - Technical
  - Management
  - Maintenance Cost and Maintenance Cost Estimation
  - Software Maintenance Measurement

- Maintenance Process
  - Maintenance Process Models
  - Maintenance Activities

- Techniques for Maintenance
  - Program Comprehension
  - Re-engineering
  - Reverse Engineering
  - Impact Analysis
Software Engineering Tools and Methods

I. Software Tools
   - Software Requirements Tools
     - Requirements modeling
     - Traceability
   - Software Design Tools
   - Software Construction Tools
     - Program editors
     - Compilers
     - Interpreters
     - Debuggers
   - Software Testing Tools
     - Test generation
     - Test execution frameworks
     - Test evaluation
     - Test management
     - Performance analysis
   - Software Maintenance Tools
     - Comprehension
     - Re-engineering
   - Software Engineering Process Tools
     - Process modeling
     - Process management
     - Integrated CASE environments
     - Process-centered software engineering environments
   - Software Quality Tools
     - Inspection
     - Static analysis
   - Software Configuration Management Tools
     - Defect, enhancement, issue and problem tracking
     - Version management
     - Release and build
   - Software Engineering Management Tools
     - Project planning and tracking
     - Risk management
     - Measurement
   - Infrastructure Support Tools
     - Interpersonal communication
     - Information retrieval
     - System administrative and support
   - Miscellaneous Tools
     - Issues
     - Tool integration techniques
     - Meta tools
     - Tool evaluation

II. Software Methods
   - Heuristic Methods
     - Structured methods
     - Data-oriented methods
     - Object-oriented methods
     - Domain specific methods
   - Formal Methods
     - Specification languages
     - Refinement
     - Verification
   - Prototyping Methods
     - Styles
     - Prototyping target
     - Evaluation techniques
   - Miscellaneous Method Issues
     - Method evaluation
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
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?

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Geographic Distribution of Reviewers
Trial Version

- USA: 55%
- Europe: 18%
- Canada: 10%
- Australia: 5%
- Asia: 5%
- Latin America: 4%

- 90 reviewers from 25 countries
Education level of reviewers
(Version 0.7)
Number of employees at reviewer location (Version 0.7)
Number of years of practical experience (Version 0,7)

- 0-9: 32%
- 10-19: 38%
- 20-29: 21%
- 30+ (excluding 20-29): 9%