The Maturation of Software Engineering as a Discipline and a Recognized Profession

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- One of Canada’s leading schools of Engineering
- ÉTS motto is ‘Engineering for Industry’.
- Roughly 5000 students, 125 professors, 25 internal senior lecturers and approximately 200 external lecturers.
- In 2005 only students completed about 2400 paid industrial internships in over 900 companies.
- A member of the Université du Québec network of establishments.
- Located in downtown Montreal
Institute of Electrical and Electronics Engineers (IEEE):
- 375000 members in 160 countries.
- Publishes 30% of the world’s technical literature within its scope of interest.

The Computer Society is the largest of IEEE’s 38 technical societies:
- 85000 members, 40% outside the US.
- Founded in 1946

Questions Addressed in the Presentation
- What is a discipline?
- What are the components of a recognized profession?
- How does software engineering stand in regard to the components of a recognized profession?
- Is software engineering truly an engineering discipline?
Questions Addressed in the Presentation

- How does software engineering relate to computer science, to computer engineering, to project management?
- Is licensing necessary to be a recognized profession?
- Give an overview of the Guide to the Software Engineering Body of Knowledge (SWEBOK)?
- What are some examples of usage of the SWEBOK Guide?
- Discuss the role of the SWEBOK Guide in regard to the maturation of software engineering as a discipline and a recognized profession?

What is Engineering?

- A traditional definition of engineering is:
  - “The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.”
  - (HMC 2000)
What is Engineering?

- A more encompassing view is:
  - “The application of a systematic, disciplined, quantifiable approach to structures, machines, products, systems or processes.”
  - (IEEE 1990)
- This view of engineering as being more than “applied science and mathematics” implies that an engineering discipline has a body of knowledge of its own which differs from the body of knowledge of its underlying scientific discipline.

What is Software Engineering?

- “(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).”
  - (IEEE 1990)
Computer science is the underlying discipline of software engineering

- Fundamental goals of computer science and software engineering differ:
  - Science as a whole seeks to better understand and explain various phenomena.
  - Artefacts are the product of engineering
- Ever-increasing depth and breadth of knowledge in computer science enables the establishment of software engineering as a discipline in itself
  - Occurred in the 19th and early 20th century for most “traditional engineering disciplines”
- Differing and of course overlapping bodies of knowledge

What is a Discipline?

- “A branch of knowledge or teaching”
  - (HMC 2000)
Recognized Profession?

- Knowledge and competence validated by the community of peers
- Consensually validated knowledge resting on rational and/or scientific grounds
- Judgment and advice oriented toward a set of substantive values
  - (Starr, 1982)

Development of a Profession

- Initial professional education
- Skills Development
- One or both Certification Licensing
- Full Professional Status
- Accreditation
- Professional societies
- Professional development
- Code of ethics

Adapted from Steve McConnell, *After the Gold Rush*, Microsoft Press, 1999, p. 93
Corporate Support for the SWEBOK Guide by:

Boeing

MITRE

NIST

Rational

Raytheon

SAP

Project managed by:

Université du Québec
École de technologie supérieure

UQÀM

2004 Version
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

- 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

Categories of Knowledge in the SWEBOK

<table>
<thead>
<tr>
<th>Specialized</th>
<th>Generally Accepted</th>
<th>Advanced and Research</th>
</tr>
</thead>
</table>

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
Three Underlying Principles of the Project

- **Transparency**: the development process is itself published and fully documented
- **Consensus-building**: the development process is designed to build, over time, consensus in industry, among professional societies and standards-setting bodies and in academia
- Available **free** on the web at least in one format on www.swebok.org

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

2004 Version

1998 1999 2000 2001 2002 2003
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

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
### 2010 Version

- **Reference material**
  - Not well commented in previous review cycles
  - Few documented examples of usage of the current SWEBOK reference list
  - Current list is much too long in terms of the number of references for CSDA and CSDP exam candidates to study from
  - Reference lists for CSDA, CSDP and SWEBOK are therefore currently disjoint
  - A common list of references is currently in the advanced stages
  - Reference matrix will be moved to a separate artifact
Number of Hits of SWEBOK (As of 14 April 2010)

- books.google.com identifies over 390 books citing “SWEBOK”
- scholar.google.com identifies over 2100 hits for “SWEBOK”
- Google.com identifies over 52000 hits for “SWEBOK”
- IEEE Xplore identifies 412 hits for “SWEBOK”

Selected Usage Examples

- ISO/IEC 24773:2008 Software engineering -- Certification of software engineering professionals -- Comparison framework
  - Establish a framework for comparison of schemes for certifying persons as software engineering professionals
  - Facilitate the comparison of national and international certification schemes of software engineering professionals
  - SWEBOK Guide is used as a baseline for comparison of bodies of knowledge in the certification schemes
IEEE Computer Society Certification Summary

- **CSDP**: Designed for mid-career SW professionals (4+ years) looking to advance in their field and confirm their knowledge of development practices

- **CSDA**: Designed to provide entry-level SW professionals (< 2 years) with a baseline knowledge of fundamental development practices and a growth path to the CSDP and beyond

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CS Certification and Courseware Roadmap


- **CSDA Preparation Courses**: New - Q1’10
- **CSDP Preparation Courses**: New - Q1’10
- **CSDM Specialty Courses**: 2010-11

Target: Mid-career professionals

Launched: 2008

Target: SW Engineering graduates and entry-level professionals

Refreshed: Q1’10

Target: Mid-career professionals

Launched: 2002

Licensed Software Engineer (US)

2010-11

Target: Specialists (Architecture, Security)

Certified Software Development Engineer

Certified Software Development Specialist

Certified Software Development Specialist
Who Benefits?

- **Individuals**: SW development professionals looking to confirm and grow their knowledge of established development practices and advance in their careers

- **Employers**:
  - Recognize the benefits of adopting standardized SW practices
  - Can use the CSDA/P as a hiring tool, or as an assessment of individual’s knowledge

- **Academia**:
  - Schools that use SWEBOK as a foundation for courseware
  - Graduating SW eng. Students

- **Gov’t**:
  - Contractor qualification selection
  - CSDP is covered under US GI Bill with $400 reimbursement

For More Information

**Computer Society Certifications**:
www.computer.org/certification
Email: certification@computer.org

**CSDA Certification**
www.computer.org/csdia
Email: csda@computer.org

**CSDP Certification**
www.computer.org/csdp
Email: csdp@computer.org
Selected Usage Examples

- Graduate Software Engineering 2009
  - SwE2009 is a model which provides guidelines and recommendations for any master’s level program in software engineering worldwide
  - Primary source for the body of knowledge taught in the curriculum for software engineering is the SWEBOK Guide
  - Principal sponsor is the US Office of the Secretary of Defense
  - Available for free at www.gswe2009.org

  - Show Figure 3 in the paper.
  - Show Figure 4 in the paper.
  - Show Table 1 in the paper.
Selected Usage Examples

- Situating a proposed ontology within the SWEBOK Guide

![Software Engineering Body of Knowledge Diagram]

Selected Usage Examples

- VSEK – Virtual Software Competence Center
- A German knowledge and experience sharing site for German software development companies
- Adopts the SWEBOK Guide breakdown of topics to classify it’s entries
- Contains over 4000 entries on software engineering topics
- Show [www.software-kompetenz.de/en](http://www.software-kompetenz.de/en)
Increasing maturity of Software Engineering

<table>
<thead>
<tr>
<th>Infrastructure component</th>
<th>(Ford et al. 1996)</th>
<th>(Pour et al. 2000)</th>
<th>(McConnell 2004a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial professional education</td>
<td>Ad hoc</td>
<td>Ad hoc moving toward established</td>
<td>Ad hoc moving toward established</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Ad hoc</td>
<td>Ad hoc moving toward established</td>
<td>Established</td>
</tr>
<tr>
<td>Skills development</td>
<td>Ad hoc</td>
<td>Ad hoc</td>
<td>Established</td>
</tr>
<tr>
<td>Certification</td>
<td>Ad hoc</td>
<td>Non-existent moving to ad hoc</td>
<td>Established</td>
</tr>
<tr>
<td>Licensing</td>
<td>Ad hoc</td>
<td>Ad hoc moving toward established</td>
<td>Ad hoc</td>
</tr>
<tr>
<td>Professional development</td>
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<td>Ad hoc moving toward established</td>
</tr>
<tr>
<td>Professional societies</td>
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<td>Established moving toward maturing</td>
<td>Established, moving toward maturing</td>
</tr>
<tr>
<td>Code of ethics</td>
<td>Ad hoc</td>
<td>Ad hoc moving toward established</td>
<td>Established</td>
</tr>
<tr>
<td>Recognised body of knowledge</td>
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<td>Established moving toward maturing</td>
<td>N/A</td>
</tr>
<tr>
<td>Organisational certification</td>
<td>N/A</td>
<td>N/A</td>
<td>Established toward maturing</td>
</tr>
</tbody>
</table>

Concluding Remarks

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