

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

Pierre Bourque, ing., Ph.D.

École de technologie supérieure, Canada

Coeditor, Guide to the Software Engineering Body of Knowledge

IEEE Computer Society

**8th IEEE/ACIS International Conference on Software
Engineering Research, Management and Applications
(SERA'2010)**

Montreal, May 2010

1

- ⊙ 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

2



- ⊙ 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

3

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?

4

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 the main elements of the ongoing revision of the SWEBOK Guide?
- ⊙ What are some examples of usage of the SWEBOK Guide?
- ⊙ What is the role of the SWEBOK Guide in regard to the maturation of software engineering as a discipline and a recognized profession?

5

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)

6

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.

7

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)

8

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

9

What is a Discipline?

- ⊙ *“A branch of knowledge or teaching”*
 - (HMC 2000)

10

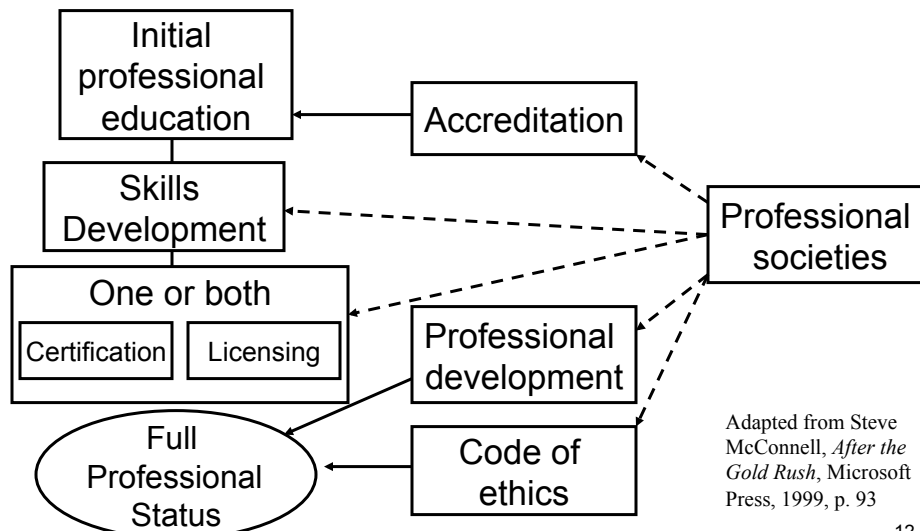
Recognized Profession?

- ◉ 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)

11

Development of a Profession



12



Corporate Support for the SWEBOK Guide (2004 Version) by:



CANADIAN COUNCIL OF PROFESSIONAL ENGINEERS
CONSEIL CANADIEN DES INGÉNIEURS



National Research
Council Canada

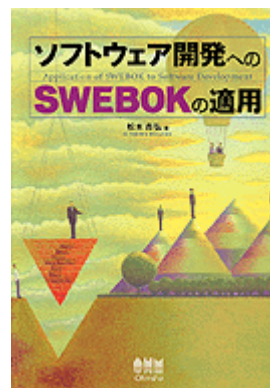
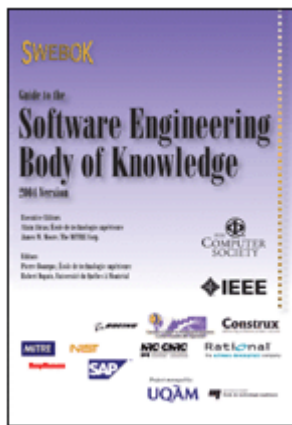
Conseil national
de recherches Canada



Project managed by:



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

15

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

16

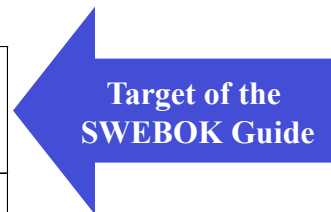
Intended Audience

- ⊙ Public and private organizations
- ⊙ Practicing software engineers
- ⊙ Makers of public policy
- ⊙ Professional societies
- ⊙ Software engineering students
- ⊙ Educators and trainers

17

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

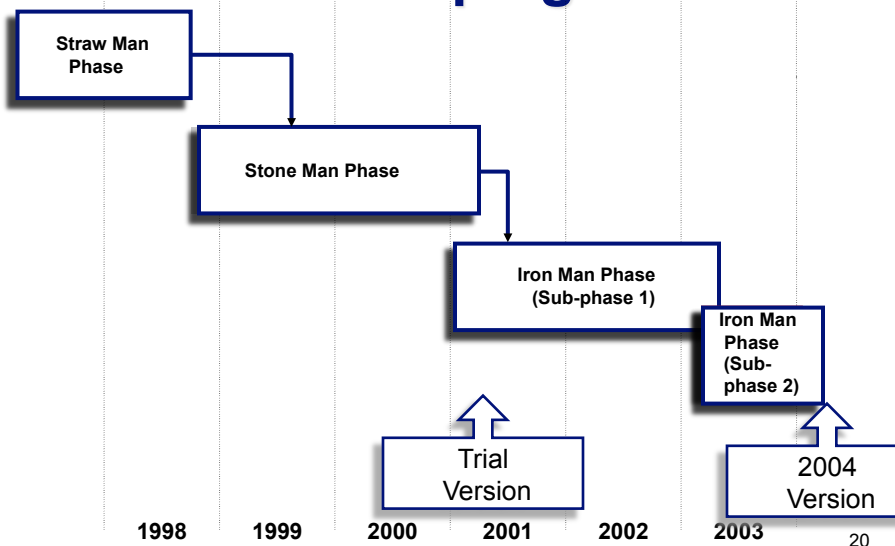
18

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

19

A Three-Phase Approach for Developing the Guide



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*
- ⊙ *Official recognition as ISO Technical Report 19759 in 2005*

21

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

22

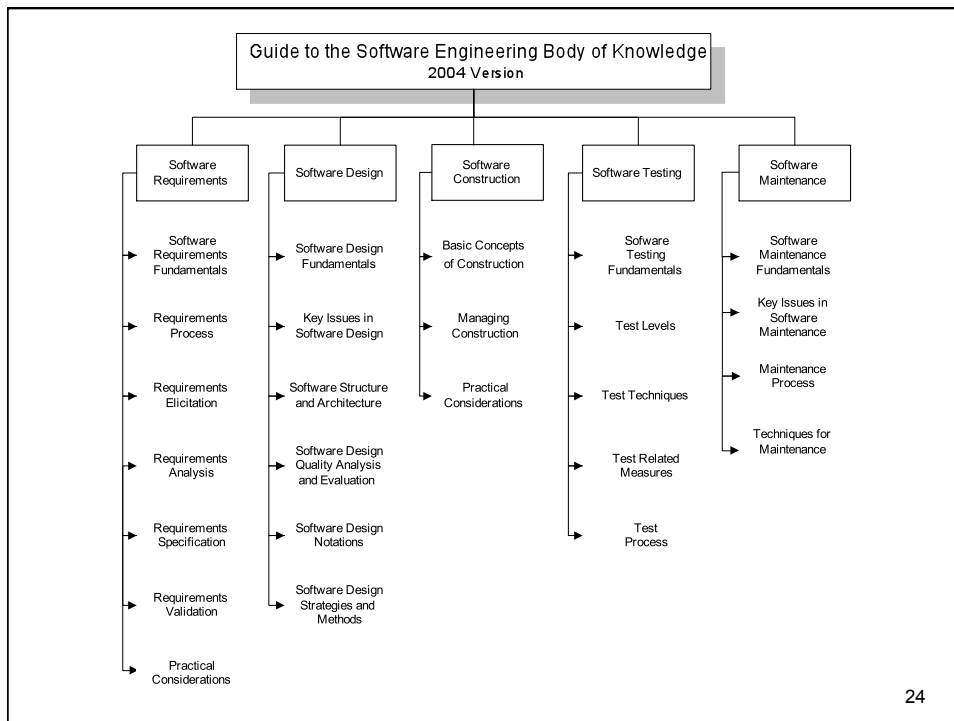
Knowledge Areas and Related Disciplines

- ⊙ 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

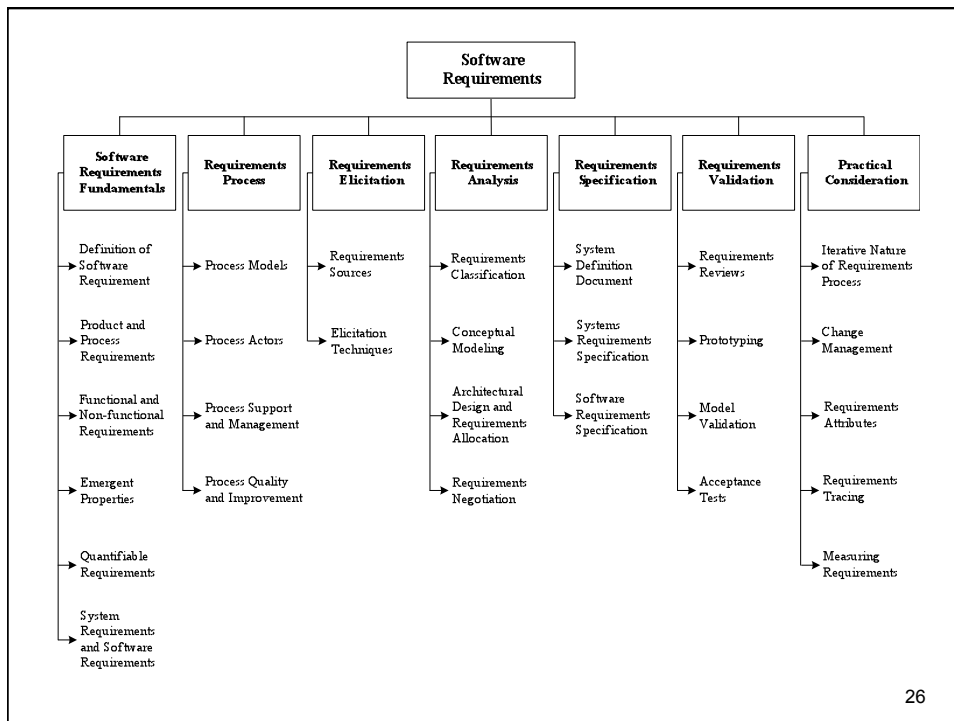
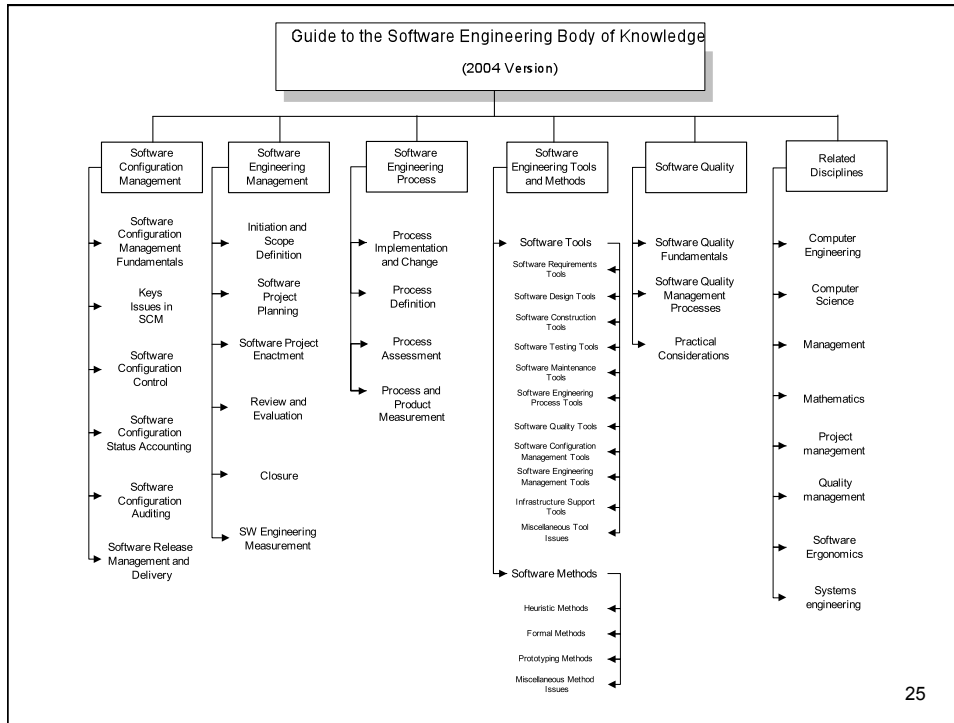
Related Disciplines

- Computer Engineering
- Computer Science
- Mathematics
- Project Management
- Management
- Quality Management
- Software Ergonomics
- Systems Engineering

23



24



Outline of SWEBOK Guide V3 Harmonized with IEEE CS Curriculum and Professional Software Engineering Products

- **Characterizing the Practice of Software Engineering**
 - SW Requirements *
 - SW Design *
 - Add Human-Computer Interface Design
 - SW Construction *
 - SW Testing *
 - Add Human-Computer Interface Testing
 - SW Maintenance *
 - SW CM *
 - SW Eng Management *
 - SW Eng Process *
 - SW Eng Methods (changed name)
 - Distribute tools into other KAs
 - Add material on cross-KA methodologies and their selection
 - SW Quality *
 - SW Eng Professional Practice (Added)
- * Minor additions and changes
- **Required in Educating a Software Engineer**
 - Computer Science Foundations
 - Mathematical Foundations
 - Engineering Foundations
 - Economic Foundations
- **Related Disciplines**
 - Computer Engineering
 - Computer Science (possibly redundant)
 - Mathematics (possibly redundant)
 - Management
 - Project Management
 - Quality Management
 - Software Ergonomics
 - System Engineering

A proposal similar to this will be offered to the SWEBOK consensus process. Of course, that process may result in changes.

SWEBOK Guide V3

- ⊙ 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 certification exam candidates to study from
 - ❖ Reference lists for certification exams and SWEBOK Guide are therefore disjoint
 - ❖ A common list of references is currently baselined

SWEBOK Guide V3 Coeditors

- ◉ Pierre Bourque, École de technologie supérieure, Canada
- ◉ Alain Abran, École de technologie supérieure, Canada
- ◉ Juan Garbajosa, Technical University of Madrid (UPM), Spain
- ◉ Gargi Keeni, Tata Consultancy Services, India
- ◉ Beijun Shen, Shanghai Jiaotong University, China

29

SWEBOK Guide V3 Knowledge Area Coeditors

Software Requirements	Sawyer, Peter and Kotonya, Gerald	Lancaster University	UK
Software Design	Sun, Yanchun	Peking University	China
Software Construction	Peng, Xin	Fudan University	China
Software Testing	Bertolino, Antonia and Marchetti, Eda	Italian National Research Council	Italy
Software Maintenance	April, Alain and Mattson, Mira-Kajko	École de technologie supérieure	Canada
		University of Stockholm	Sweden

30

SWEBOK Guide V3 Knowledge Area Coeditors

Software Configuration Management	April, Alain and Champagne, Roger	École de technologie supérieure, Canada	Canada
Software Engineering Management	McDonald, James	Monmouth University	USA
Software Engineering Process	Reilly, Annette D.	Lockheed Martin	USA
Software Engineering Methods			
Software Quality	Biswas, Durba	Tata Consultancy Services	India

31

SWEBOK Guide V3 Knowledge Area Coeditors

Software Engineering Professional Practice	Sheffield, Aura	Engineering Solutions	USA
Software Engineering Economics	Ebert, Christof	Vector Consulting	Germany
Computing Foundations	Zou, Hengming	Shanghai Jiaotong University	China
Mathematical Foundations	Chaki, Nabendu	University of Calcutta	India
Engineering Foundations			

32

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”

33

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

34

Selected Usage Examples

- ⦿ **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

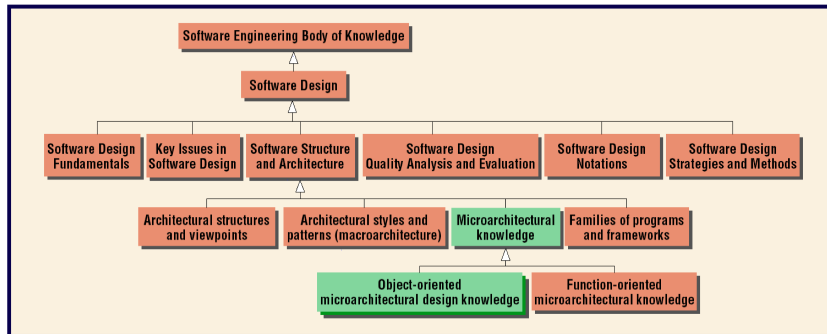


Selected Usage Examples

- ⦿ Graduate Software Engineering 2009
 - ❖ GSwE2009 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. Officially "recognized" by and handed over to the IEEE Computer Society and the ACM.
 - ❖ Available for free at www.gswe2009.org

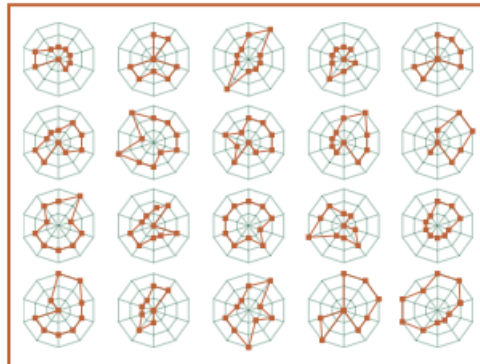
Selected Usage Examples

- ◉ Garzás, J., and Piattini, M. "An Ontology for Microarchitectural Design Knowledge," *IEEE Software* (22:2) 2005, pp. 28-33.
- ◉ Situating a proposed ontology within the SWEBOK Guide



Selected Usage Examples

- ◉ Pyster, A.; Lasfer, K.; Turner, R.; Bernstein, L.; Henry, D., **Master's Degrees in Software Engineering: An Analysis of 28 University Programs**, , *IEEE Software*, Vol. 26, no. 5, Sept.-Oct. 2009 pp.94 – 101.
- ◉ "Radial plots of SWEBOK coverage in 20 of the 28 programs. The circumferential axes correspond to the SWEBOK knowledge areas."



38

Increasing maturity of Software Engineering

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

39

Concluding Remarks

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

40

www.swebok.org

41

References

- Ford, G. and N. E. Gibbs (1996). A Mature Profession of Software Engineering. Pittsburgh, USA, Software Engineering Institute.
- Garzás, J., and Piattini, M. "An Ontology for Microarchitectural Design Knowledge," *IEEE Software* (22:2) 2005, pp. 28-33.
- IEEE (1990). Standard Glossary of Software Engineering Terminology, IEEE.
- HMC (2000). The American Heritage Dictionary of the English Language, Houghton Mifflin Company.
- McConnell, S. (2004). Professional Software Development, Addison-Wesley.
- Pour, G., M. L. Griss, et al. (2000). "The Push to Make Software Engineering Respectable." *IEEE Computer* **33**(5): 35-43.
- Pyster, A.; Lasfer, K.; Turner, R.; Bernstein, L.; Henry, D., Master's Degrees in Software Engineering: An Analysis of 28 University Programs, , *IEEE Software*, Vol. 26, no. 5, Sept.-Oct. 2009 pp.94 – 101.
- Starr, P. (1982). The Social Transformation of American Medicine, BasicBooks.

42