

# The Path To Software Engineering Professionalism

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# Overview

- IEEE Computer Society (IEEE-CS)
- Software Engineering Professionalism
- Software Engineering Body of Knowledge
- Curriculum
- Accreditation
- Code of Ethics
- Certification

# IEEE Computer Society

- IEEE (Institute of Electrical and Electronics Engineers):
  - 370,000 members, including more than 80,000 students, in over 160 countries.
  - Publishes 30% of the world's technical literature within its scope of interest.
- With more than 80,000 members, the Computer Society is the largest of IEEE's 38 technical societies.

- The IEEE-CS is the world's oldest and largest association of computing professionals.
- Its vision is to be ... "the leading provider of technical information and services personalized to the world's computing communities."

# IEEE-CS Products & Services

- Chapters: 143 student and 157 professional chapters worldwide
- Educational Activities: computing curricula, accreditation activities, and continuing education offerings
- Publications
  - 14 Magazines
  - 17 Transactions (new in 2008 – **Services Computing, Learning Technologies, Haptics**)
- Conferences: over 150 sponsored or cosponsored meetings annually

- Standards:

- 12 standards committees, including *Software and Systems Engineering Standards* (S2ESC, which has 27 active working groups)
- Active participation in ISO/IEC software and systems engineering standards development
- Harmonization of ISO and IEEE software engineering standards

- Technical activities: 2 councils (including Software Engineering), 40 technical committees and councils, 3 task forces

- Professionalism

- Professional development:
  - 1300 technical courses delivered through distance learning
  - 500 electronic books
- Software engineering professionalism



# What is a software engineer?

- Is it simply programming?
- According to the US Bureau of Labor Statistics,
  - **Computer systems software engineers** primarily write, modify, test, and develop software to meet the needs of a particular customer. They develop software systems for control and automation in manufacturing, business, and other areas.

# The Future of SwE

- From Grady Booch, *The Future of Software*
  - Technical aspects
    - Dominance of components
    - Codification of reference architectures
    - Evolution of virtual teams
    - Acceptance of well-defined processes
  - Non-technical aspects
    - Impact of legal issues
    - Scarcity of skilled workers

- “Software Engineering” will have no future unless we accept the fact that only a small fraction of software developers are qualified to be called “software engineers” and agree on standards that distinguish those who are qualified from the rest of us.” (attributed to David Parnas)

# Software Engineering Tasks (David Parnas)

- Analyze the intended application
- Participate in the design of the computer system configuration
- Analyze the performance of a proposed design
- Design the basic structure of the software
- Analyze the software structure for desired characteristics
- Implement the software
- Integrate new software
- Perform systematic and statistical testing
- Revise and enhance software systems

# Programmer vs Software Engineer

## *Programmer*

Writing *code*

Using techniques  
learned from individual  
*experience*

Building products that  
*work*

## *Software Engineer*

Developing *systems*,  
often large and highly  
complex

Applying widely  
accepted techniques  
based on *proven  
knowledge*

Building products that  
*you can depend on*

# Is SwE an engineering profession?

- What characterizes an engineering profession?
  - Body of knowledge
    - Development and maintenance of BoK
    - Influence of BoK on university curricula
  - Entrance control
    - Quality of university programs
    - Licensure and certification
  - Code of ethics

# Some Milestones

- **Body of Knowledge:**

- IEEE-CS Guide to the Software Engineering **Body of Knowledge (SWEBOK)**, was published in 2004. It is available in book form and on the web. Translations to other languages are available.
- IEEE-CS/ACM **Software Engineering Curriculum** was published in 2004.

- **Entrance Control**

- **Universities**

- Rochester Institute of Technology granted the first Software Engineering **bachelor's degrees** (first cycle) in the US in 2001. SwE first and second cycle programs levels are now offered by many universities in many countries.
- In several countries, there are now mechanisms for **accrediting university curricula** in software engineering.

- **Licensure**

- US (Texas)
- Canada (Alberta, British Columbia, Ontario)
- Chartered status is available for software engineers in the UK and Australia

→ ***Certification***

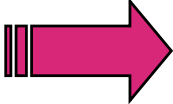
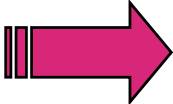
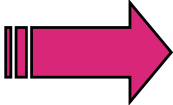
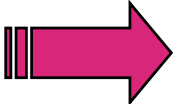
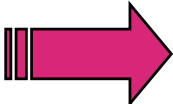
→ CSDP, CSDA

→ ***Code of Ethics***

→ ACM/IEEE-CS Software Engineering Code of Ethics  
was completed in 1998.



# The role played by IEEE-CS

- |   |  |                      |
|---|--|----------------------|
| • Documenting the SwE body of knowledge                   |   | SWEBOK               |
| • Developing SE curricula                                 |   | SE volume of CC 2001 |
| • Supporting SE program accreditation                     |   | CSAB and ABET        |
| • Creating a code of ethics                               |   | SwE code of ethics   |
| • Creating a certification program for software engineers |  | CSDP/CSDA            |

# SWEBOK Project

- The SWEBOK Guide provides a consistent view of SwE:
  - Defining education and training requirements
  - Classifying SwE jobs
  - Developing performance evaluation policies
- SWEBOK development process:
  - Review of published literature
  - Identification of generally accepted knowledge (“*what software engineers should know*”)
  - Organization of knowledge
  - Categorization of knowledge by topics

- The focus is on building consensus on SE core knowledge
- SWEBOK development involved 500 SE professionals from 41 countries
- Support from companies including Boeing and Rational
- Government support (US, Canada)
- The SWEBOK Guide has been recognized internationally as an ISO/IEC technical report
- Any engineering BOK is subject to constant technological change
  - Revision underway; new version due in 2009

# Revision Plans

- The next version of the SWEBOK Guide will have a broadened scope that covers:
  - SE 2004 curriculum
  - Certifications
- New Knowledge Areas:
  - Mathematical Foundations
  - Computing Foundations
  - Engineering Foundations
  - Engineering Economy Foundations
  - Professional Practice
- Some additions and realignment of material in the existing ten knowledge areas

## SWEBOK is divided into the following knowledge areas

Software requirements	Software design
Software construction	Software testing
Configuration management	SE management
SE tools and methods	SE process
SE maintenance	SE quality

<http://www.swebok.org>

# SWEBOK Uptake

- SWEBOK influenced the *Software Engineering 2004* volume of the joint IEEE-CS/ACM *Computing Curriculum* series
- Some universities are organizing their SwE curricula around SWEBOK
- The IEEE-CS SE Online Portal is structured around the SWEBOK knowledge areas
- SWEBOK provides the taxonomical basis for VSEK, a German software engineering competence center ([www.software-kompetenz.de](http://www.software-kompetenz.de))
- ISO has adopted the Guide as a framework for software engineering knowledge (ISO/IEC TR 19759)
- SWEBOK contributed to provincial licensing programs of the Canadian Council of Professional Engineers
- SWEBOK has been translated into Japanese, Chinese, Spanish, French, Russian, and Hungarian
- 155,000 Google hits on “SWEBOK” in May 2007
- Construx, Inc. rewrote position descriptions using the Guide and structures its professional development around the Guide

# Software Engineering Curricula

- For many years, IEEE-CS has worked with ACM to produce recommendations for undergraduate (first-cycle) computing curricula (CS, IS, IT, ...).
- In 2004, the joint task force produced recommendations for undergraduate software engineering curricula (see <http://sites.computer.org/ccse>).
- There is an ongoing effort to develop recommendations for SwE Master's programs (second cycle).

# Accreditation of SE Undergraduate Programs

- Accreditation is public recognition
  - that a program meets specified criteria
  - That its graduates have the knowledge needed to perform effectively
- The US approach to computing/engineering accreditation
  - Criteria for computing programs are developed by CSAB (formerly known as the Computer Science Accreditation Board)
  - Accreditation is done through the Engineering Accreditation Commission of ABET (formerly known as the Accreditation Board for Engineering and Technology)
- Other countries have different approaches to ensuring program quality



- Importance of accreditation to institution
  - Recognizes institution's missions and goals
  - Promotes best practices in education
  - Involves faculty in evaluation and planning
- Importance of accreditation to profession
  - Demonstrates that graduates have met the educational requirements to enter the profession
  - Provides an opportunity for the profession to guide the educational process so that it reflects current and future needs

# SwE Code of Ethics and Professional Practice

- A code defines ethical and professional obligations against which peers, the public, and legal bodies can measure a software developer's behavior.
- Functions of code
  - Build confidence of customers
  - Inspire software engineers to higher levels of conduct
  - Educate software engineers about their obligations to society, customer, and self
  - Support positive actions
  - Deter negative actions

# Certification

- Certification: formal recognition that an individual has demonstrated comprehension of (and proficiency within) a specified body of knowledge at a point in time.
  - It is **peer recognition** of knowledge
  - It is not licensure.
    - **Licensure**: authorization granted by government body for an individual or organization to practice a business or occupation. It is often the case that an individual may not practice a profession without a license.
  - Certification is **voluntary**.

# Types of Certification

- Broad-based professional certification: mastery of a broad body of knowledge in an area  
→ E.g. medical specialties, accounting, computer security
- Product-based certification: mastery of a body of knowledge relating to a particular product or set of products  
→ E.g. Microsoft, Cisco, Oracle

# Professional certification

- Professional certifications are usually founded on
  - A code of ethics: *IEEE-CS/ACM Software Engineering Code of Ethics*
  - A specified body of knowledge: *IEEE-CS Guide to the Software Engineering Body of Knowledge*
  - A set of professional practice standards: *IEEE and international standards on software engineering*
- ... and supported by appropriate training programs and materials.

# IEEE-CS SE certification efforts

- Two distinct broad-based professional software engineering certification programs
  - CSDP (2002): directed at professionals with four years of experience
  - CSDA (2008): directed at beginning professionals who have just completed undergraduate (first-cycle) study
  - CSDA should be considered as a first step toward CSDP.

# Motivations for individuals

- Mark of Excellence
  - demonstrates that you have the knowledge to ensure that recognized principles and practices of software engineering are being used
- Recognition
  - allows customers to be confident of your suitability for a task or project
- Investment
  - certification is an investment in your career and the future of your employer
- Continuous improvement
  - remaining certified requires you to continue your education and involvement in software engineering-related work and activities.
  - Your skills will remain current and you will retain the flexibility to work on different projects or for different companies.

# Motivations for employers

- Competition in the Marketplace:  
companies and organizations that hire certified individuals will have a workforce proficient in principles and practices of software engineering



# CSDP Requirements

- Education
  - Baccalaureate or equivalent university degree
- Experience
  - 9,000 hours of experience in 6 of the 10 software engineering knowledge areas
  - The knowledge areas map to the SWEBOK areas
- Proof of professionalism
  - Review and acknowledge the Software Engineering Code of Ethics and Professional Practice

# CSDP Examination Topics

## *Business Practices and Engineering Economics (3-4%)*

- Economics
- Ethics
- Professional Practice
- Standards

## *Software Requirements (13-15%)*

- Requirements engineering process
- Requirements elicitation
- Requirements analysis
- SW requirements specification
- Requirements validation
- Requirements management

## *Software Design (22-24%)*

- SW design concepts
- SW architecture
- SW design quality analysis and evaluation
- SW design notations and documentation
- SW design strategies and methods
- Human factors in SW design
- SW and system safety

### *Software Construction (10-12%)*

- Construction planning
- Code design
- Data design and management
- Error processing
- Source code organization
- Code documentation
- Construction QA
- System integration and deployment
- Code tuning
- Construction tools

### *Software Testing (15-17%)*

- Types of tests
- Test levels
- Testing strategies
- Test design
- Test coverage of code
- Test coverage of specifications
- Test execution
- Test documentation
- Test management

### *Software Maintenance (3-5%)*

- SW maintainability
- SW maintenance process
- SW maintenance measurement
- SW maintenance planning
- SW maintenance management
- SW maintenance documentation

### *Software Configuration Mgmt (3-4%)*

- Management of SCM process
- SW configuration identification
- SW configuration control
- SW configuration status accounting
- SW configuration auditing
- SW release management and delivery

### *Software Engineering Management (10-12%)*

- Measurement
- Organization management and coordination
- Initiation and scope definition
- Planning
- Software acquisition
- Enactment
- Risk management
- Review and evaluation
- Project closeout
- Post-closure activities

### *Software Engineering Process (2-4%)*

- Process infrastructure
- Process measurement
- Process definition
- Qualitative process analysis
- Process implementation and change

### *Software Engineering Tools and Methods (2-4%)*

- Management tools and methods
- Development tools and methods
- Maintenance tools and methods
- Support tools and methods

### *Software Quality (6-8%)*

- SW quality concepts
- Planning for SQA and V&V
- Methods for SQA and V&V
- Measurement applied to SQA and V&V

# CSDA Requirements

- Education
  - Since the examination is based on the SE curriculum recommendations, those who have a first-cycle degree in SE or CS are best positioned to take the examination.
  - However, there are no formal education requirements.
- Experience
  - No requirement
- Proof of professionalism
  - Review and acknowledge the Software Engineering Code of Ethics and Professional Practice

# Examination structure

- Written Examination
  - Four hours long
  - Multiple-choice questions selected from a pool of questions across each of the knowledge areas
  - Total of 180 questions on the examination

# Job Analysis

- A draft task/knowledge list is developed by a core group.
- Subject matter experts then review and revise the draft list, then develop and review a survey that is sent to industry.
- At least 300 completed surveys submitted and analyzed and a report is prepared.



# Examination Specifications

- Examination Specifications Meeting
  - Subject matter experts review the results of the job analysis survey and assign a weight to each task and knowledge item.
  - The examination specification is then formally defined.

# Item Development

- Item Writing
  - Subject matter experts are chosen based on their familiarity with the content.
  - The expert group is chosen to represent the community.
- Item Review
  - Another group of subject matter experts reviews and edits items for content.

# Examination Form Development

- Examination forms are assembled by the test development vendor.
- Forms are reviewed by subject matter experts for clarity, accuracy, overlap, cueing, sensitivity and key accuracy.

# Validation

The examination is then tested to assure it measures what it set out to measure.

- Beta Testing

- Approved exam forms are delivered on CBT. Beta testers should be representative. Most should be in the targeted experience and education range.

- Preliminary Item Analysis

- Ensures that the correct key is used and items are performing as expected.

- Cut Score Meeting

- A new group of subject matter experts meets to set a scaled passing score for one form.

The examination is then ready for public release.

# Examination Delivery

- Closed book, calculators provided
- Computer-based test; results available immediately
- Hundreds of examination sites, including Lisbon (see [www.2test.com](http://www.2test.com) for a full list)

# Preparation for the Examination

- Focus on areas needing the most review, depending on level of expertise in areas covered by SWEBOK
- Study from the suggested reference material (see [www2.computer.org/portal/web/certification](http://www2.computer.org/portal/web/certification))
- Take a refresher course
- Unless your background covers most of the BOK, allow three months of 2-4 hours a week for study
- Self-study guide (Seidman & Naveda)
- CSDA online learning system

# Related Resource: SEVocab

- Systems and software engineering vocabulary
- <http://www.computer.org/sevocab/>
- Provides access to 4100 authoritative definitions of systems and software engineering terms
- Definitions may be reprinted (with attribution).
- Currency of database will be maintained by a vocabulary standards project coordinated between IEEE and ISO/IEC JTC1/SC 7.
- Sources:
  - IEEE standards
  - ISO/IEC standards
  - PMBOK® Guide, Third edition
  - Other sources

# Re-certification for CSDP

- Required every 3 years
- Requires 30 re-certification credits and fee (currently \$ US 150)
- Credit summary:
  - 3 credits/year for employment in SW engineering
  - 2 credits/semester hour for graduate courses
  - 5-10 credits for publishing a paper in the field
  - 0.3 credits/hour for preparing/giving a presentation
  - 3-5 credits for professional committee membership
  - Other possibilities: self-study, writing questions for CSDP exam



# Current Examination Fees

- CSDA
  - US \$400
- CSDP
  - Application fee: US \$100
  - Test
    - US \$350 (IEEE/IEEE-CS members)
    - US \$450 (non-members)

# Numbers

- As of July 2008
  - there are 738 CSDP certificate holders
  - There are 215 CSDA certificate holders

# ISO/IEC Standard for SE Certification Schemes

- Since 2004, an effort has been underway to develop an international standard
  - A working group within ISO/IEC JTC1 SC7
  - The standard (ISO/IEC 24773) was published in September 2008.

- The standard can be regarded as a reference document for SE certification schemes
- A conforming certification scheme will have to be based on a body of knowledge and a code of ethics and professional conduct.
- The body of knowledge must be mapped to SWEBOK.

- The working group will produce a guide to the standard that will give examples of conforming schemes.
- Examples will include
  - CSDP
  - The Japanese system of government examinations
  - The Australian scheme for certifying computer professionals