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Professional certification of software engineers: The CSDP program

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There’s a generally accepted maxim in the software industry: a well-managed software organization, staffed by qualified software engineering professionals in a mature software engineering environment, can repeatedly deliver software systems that meet their requirements, on time and within budget. But what does it mean to be professionally qualified? And how do you get there? Software engineering certification—in particular, the IEEE Computer Society’s Certified Software Development Professional (CSDP) certification program—is a promising way to address these issues.

**Professional qualifications for software engineers**

Professional qualifications for software engineers include baccalaureate and advanced degrees in software engineering, professional software engineering licensure, and professional software engineering certification.

**Academic qualifications**

In recent years, an increasing number of universities have introduced software engineering degree programs at all levels. In the US, the Accreditation Board for Engineering and Technology accredits software engineering programs (they’re listed at www.abet.org). In some other countries, software engineering programs may be accredited by professional engineering organizations in provinces or states, as in Canada (see appsci.queensu.ca/calendar/accreditation) and Australia (see www.ieaust.org.au/membership/accreditation.html). Other countries deal with software engineering accreditation as part of a national approach to university program quality. For example, the United Kingdom’s Quality Assurance Agency (www.qaa.ac.uk) is responsible for the quality of all university degree programs.

Another approach to assuring quality for university programs in software engineering is to define the curriculum for such programs. The IEEE Computer Society and the ACM have collaborated to produce a recommended curriculum for software engineering undergraduate programs (www.computer.org portal/pages/ieeecs/education/cc2001/index.html). The IEEE CS-ACM software engineering curr-
curriculum, developed by an international team, was explicitly designed to make it usable worldwide.

Professional licensure

In many professions—medicine, law, and architecture, for example—a government-regulated license or charter is a prerequisite for professional practice. Engineers in individual practice must also be licensed or chartered, but large companies normally require that only senior engineers have this credential.

Different countries have varying approaches to licensing and chartering engineers. In the US, engineering licensure is regulated by individual states and governed and administered by professional associations, primarily on the basis of education, experience, and examination results. There are two examinations—a general exam dealing with the fundamentals of engineering, and a principles-and-practice exam dealing with an engineering specialty (see www.ncees.org/licensure/licensure_for_engineers). In other countries, engineering licensure requires approved academic credentials and a peer review of credentials and professional experience. For example, in the UK, the QAA works with the relevant professional societies (IEE, BCS) to assure that the quality of all university computing programs is sufficient to provide the educational foundation for a chartered engineer. An individual with appropriate academic credentials must then apply for chartered status and submit to a face-to-face interview that examines professional experience. In Australia, Chartered Professional Engineer status is awarded to graduates of accredited engineering programs, subject to peer review of an applicant’s credentials and experience.

Although professional licensure for software engineers has received much attention recently in the US and elsewhere, Texas is the only US state thus far that licenses software engineers. Other countries are considering allowing software engineers to apply for Chartered Engineer status within the national frameworks used for other engineering disciplines. Donald Bagert provides a good overview of licensure issues for software engineers.2

Professional certification

According to the Computer Society’s Web site (www.computer.org/certification),

Certification is an occupational designation issued by an organization that provides confirmation of an individual’s qualifications in a specified profession or occupational specialty. Certification is voluntary. That means it is neither a barrier nor a gate to entering or exiting a job. Certification implies an assurance that an individual possesses a specific knowledge or skill level pertaining to an occupation.

Like licensure and chartering, a certification program generally includes education and experience requirements and examination-based verification of specific credentials. However, certification examinations are based on professional practice. This contrasts with examinations required for engineering licensure, which tend to correspond to undergraduate engineering curricula. A certification body (such as a professional society) awards certificates to applicants who meet the certification requirements.

Several international and national standards govern professional certification. Particularly relevant is ISO/IEC 17024 (from the International Organization for Standardization and the International Electrotechnical Commission), which specifies requirements for certification bodies that are independent of any particular area of expertise (see www.moldreporter.org/vol2no6/isoStandard). The European Community has also adopted this standard. In the US, the National Organization for Competency Assurance (www.noca.org) has created a set of standards and an accreditation process for certification programs that has been operating since the late 1970s.

A professional certification effort has three relatively independent dimensions:

■ a characterization of the professional role to be certified,
■ a list of the abilities and skills needed by a professional in that role, and
■ a description of the certification process and its organization.

Explicitly recognizing these dimensions helps to clarify the differences between various approaches. In some approaches, candidates achieve certification by passing one or more tests, such as the IEEE Computer Society’s CSDP exam. In others, candidates are certified only after a peer review of credentials and experience, possibly including a face-to-face in-
terview. Peer-based certification processes are sometimes associated with efforts to classify the skills and experience of software and information professionals, such as the information technology skills frameworks recently adopted in the UK (Skills Framework for the Information Age, www.sfia.org.uk) and Japan (Information Technology Skill Standards, www.ipa.go.jp/about/english).

Licensed professionals may also be certified. For example, a licensed physician may also be certified in internal medicine. Computer hardware and software manufacturers have certification programs that offer certificates linked to specific topics and levels of expertise related to the companies’ products. We use the term professional certification to refer to certification programs for software engineering professionals that represent a broad view of professional qualifications. (See Bagert’s article for a good discussion of the distinction between certification and licensing.)

Note-worthy exam-based software engineering professional certification programs include the IEEE Computer Society’s CSDP program, the International Software Quality Institute certifications (see www.isqi.org), and the examinations administered by the Japan Information-Technology Engineers Examination Center (www.jitec.jp/1_18else/leaflet_english.pdf).

Professional certification’s benefits fall into two broad areas. Benefits to the development organization include

■ improving the organization’s ability to deliver quality software products on time and within budget,
■ establishing minimum education and experience levels for software engineering professionals, and
■ demonstrating the organization’s commitment to software engineering professionalism.

Benefits to the individual professional include

■ demonstrating mastery of the fundamental knowledge required to perform an experienced software engineer’s functions,
■ demonstrating a commitment to the software engineering profession, and
■ assuming responsibility for continuous professional development.

Such benefits can help advance a professional’s career.

IEEE Computer Society CSDP Program

The IEEE Computer Society is one of the world’s leading computing professional societies, with nearly 100,000 members in 157 countries. A large, rapidly growing segment of the Society’s membership consists of software engineers. In the late 1990s, under the leadership of its president Leonard Tripp, the Society launched its “Doing Software Right” effort with the goal of increasing software engineering professionalism. As a result of this effort, the organization formally recognized the need for a professional certification program. Thus, the CSDP program was born. It’s been in existence for several years now and

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**Related URLs**

- Accreditation Board for Engineering and Technology: www.abet.org
- Canadian engineering accreditation: http://appsci.queensu.ca/calendar/accreditation
- Certified Software Development Professional Program (CSDP): www.computer.org/certification
- CSDP Preparation and Study: www.computer.org/portal/pages/ieees/education/certification/Preparation.html
- CSDP Recertification and Professional Development: www.computer.org/portal/pages/ieees/education/certification/continuinged/Index.html
- Curriculum Guidelines for Undergraduate Degree Programs in Software Engineering: http://sites.computer.org/csse
- Int’l Software Quality Institute: www.isqi.org
- Japan Information-Technology Engineers Examination Center: www.jitec.jp/1_18else/leaflet_english.pdf
- Japan Information Technology Promotion Agency: www.ipa.go.jp/about/english
- Skills Framework for the Information Age (UK): www.sfia.org.uk
- Software Engineering Body of Knowledge: www.swebok.org
- UK Quality Assurance Agency: www.qaa.ac.uk
- US engineering licensure examinations: www.ncees.org/licensure/licensure_for_engineers
An engineer is developing a Web presentation layer for a mission-critical project. The technology chosen for the presentation layer is making it difficult to implement the user interface design. The engineer reads about a new technology for creating the type of Web interface the project needs. It is decided that a rapid prototype will be created to perform an initial evaluation of the new technology.

Question: Which of the following criteria is the LEAST important when building the prototype?

a) Exercising the entire breadth of functionality
b) Simulating the operational environment
c) Exercising critical functionality
d) Stepping through source code with a debugger

Figure 1. Sample CSDP exam item.

The Computer Society has certified more than 500 people worldwide. (See www.computer.org/certification for more details.)

Applicants for CSDP certification must have a university or college degree, demonstrate mastery of a body of knowledge by passing an exam, have extensive professional experience developing software, adhere to a code of professional behavior, and commit to continuing professional education.

The examination

Computer Society volunteers developed the CSDP examination in collaboration with the Chauncey Group International, a subsidiary of the Educational Testing Service. The examination development process followed the NCCA standards for certification programs established by the National Organization for Competency Assurance.

Following the NCCA process, the Chauncey Group first worked with a group of industry and academic experts to develop a job analysis survey designed to discern the important knowledge and skills a CSDP would need. Analyzing the survey’s results led to a set of test specifications (see www.computer.org/portal/pages/ieeecs/education/certification/Specifications.html).

Separate groups of industry and academic experts convened several times to develop, review, and confirm test questions derived from the specifications. This NCCA-recommended multilevel review process aimed to produce accurate questions that met acceptable statistical criteria for difficulty and discrimination.

More than 200 software engineering professionals around the world beta-tested the exam, validating its content and providing the data necessary for establishing a passing score. Analysis of the beta-test data showed that the CSDP examination met the NCCA’s fairness, validity, and reliability criteria.

The 3.5-hour test consists of 180 multiple-choice questions drawn from the following knowledge areas:

- professionalism and engineering economics,
- software requirements,
- software design,
- software construction,
- software testing,
- software maintenance,
- software engineering management,
- software configuration management,
- software engineering process,
- software engineering tools and methods,
- software quality.

The test uses 150 questions to assess the candidate’s knowledge and the remaining 30 to validate new questions.

Each question has four possible answers, only one of which is correct. Some questions require the candidate to choose a combination of answers. Most questions don’t require numerical calculation. About 15 percent of the questions are based directly on the IEEE’s Software Engineering Standards (http://standards.ieee.org/software). Figure 1 presents a sample question.

Many prospective certificate holders feel the need for materials and tools that will help them prepare for the examination, so the Computer Society offers an online test preparation course and face-to-face courses. Other materials available include a collection of papers covering the topics on the examination, a compilation of software engineering terminology, a list of recommended references, a reference analysis, and a small sample of examination questions (see www.computer.org/portal/pages/ieeecs/education/certification/RecommendReference.html). The Computer Society Press will soon publish a book containing a much larger and richer set of questions. The Society also recognizes certain outside organizations as “CSDP Registered Education
Recertification

A software engineer in professional practice must take note of and take advantage of the constant industry changes that pertain to his or her practice. This means that software engineers must stay professionally active outside the workplace and seek continuing education.

For this reason, CSDP certification is valid only for three years. To maintain certification, certificate holders must demonstrate professional activity by filing a recertification report demonstrating that they’ve earned 150 Professional Development Units during the last three years. They can earn PDUs through educational activity, publishing, presentations, technical or professional service, and self-study, among other activities. Details are available at the CSDP Web site under “Recertification and Professional Development” (www.computer.org/portal/pages/ieeecs/education/certification/continuinged/Index.html).

Evolution of the CSDP examination

The IEEE Computer Society’s Professional Practices Committee has appointed a certification subcommittee to oversee and administer the examination and update it regularly. This committee, in turn, has organized a series of workshops and working groups responsible for tests evolution. The CSDP body of knowledge was influenced by the IEEE’s Software Engineering Standards (http://standards.ieee.org/software) and by the Software Engineering Body of Knowledge (www.swebok.org), although the development of CSDP was independent of the SWEBOK project. The continuing evolution of SWEBOK will therefore have an impact on the CSDP examination. A committee of Computer Society volunteers is currently working on improving the alignment of the CSDP body of knowledge with SWEBOK.

Professional certification for software engineering professionals is an active topic of discussion among the academic, professional, and industrial software engineering communities. Professional associations around the world have developed certification programs, and several countries have launched certification efforts. As a result, in May 2005, an ISO subcommittee proposed an effort to look at international standards for software engineering professional certification, which will focus even more attention on certification. An international standard would support the portability of certification between countries.

We anticipate that the next five years will see an increasing expectation for software developers to demonstrate their professional competence by presenting internationally recognized qualifications. Certification will play a critical role in the spectrum of qualifications.

References


About the Authors

J. Fernando Naveda is a cofounder and chair of the Department of Software Engineering at Rochester Institute of Technology, the first US university to offer a BS in software engineering. He, along with Stephen Seidman, developed preparation materials for the CSDP program, including a sample examination, an online preparation course, and a software engineering problem book. He is a member of the IEEE Computer Society and a speaker in its Distinguished Visitors Program for Latin America, and he holds an IEEE Computer Society CSDP certificate. He received his PhD in computer and information science from the University of Minnesota, Twin Cities. Contact him at the Dept. of Software Eng., Rochester Inst. of Technology, Rochester, NY 14586; F.Naveda@rit.edu.

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