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Introduction to Software Engineering Standards

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The SPICE Project is an activity of Working Group (WG) 10 of Subcommittee (SC) 7 of the Joint Technical Committee (JTC) 1 of the International Organization for Standards (ISO) and the International Electrotechnical Commission (IEC).

The purpose of this chapter is to describe the context of international standardization activities in which the SPICE documents are being developed.

International standardization

Types of standardization activities

Standards are developed by groups of individuals or organizations to harmonize product specifications, interfaces, processes, terminology, and so on. Standards

*The opinions expressed in this paper are those of the authors.

cover a wide range of topics and are recognized by various groups of individuals and countries.

Standards are—and should—be developed in response to a user, organization, or market need. Some standards are developed in a formal fashion by organizations that are mandated to do so, while others impose themselves on the market.

There are five basic types of standards:

1. Organization standards:	internal company standards (for example)
2. Market standards:	standards that become such because of the market preponderance of a product (for example, the Microsoft Windows* Application Programming Interface and the VHS videotape standards)
3. Professional standards:	standards developed by professional organizations, such as the IEEE, based on professional consensus
4. Industrial standards:	standards developed by industrial associations, where the consensus is at the level of each industrial member (for example, the CD-V videodisk and the CDIF CASE tool interface standards)
5. International standards:	standards developed by international standards bodies, based on international consensus, where the membership consists of national organizations (such as ISO, IEC, ITU)

Standards, in general, represent a *consensus*. This representation means that, for standards' types 3, 4, and 5 above, a substantial majority of individuals, organizations, and/or countries have reached an agreement, usually by compromising on their initial positions. As a result, standards are generally less than technically perfect or optimal from an idealistic perspective.

The value of standards does not decrease, however. On the contrary, standards are an ideal medium to communicate:

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- terminology
- procedures
- models
- benchmarks

The last item is rather significant: a standard can also be a benchmark since it represents the lowest common denominator to which consensus could be attained.

International standardization activities

There are many international standards organizations. Some are focused on *regional* groupings of countries or trade groups, such as the European Union (for example, CEN), while others have a wider international scope. This latter category either has organizations linked to the United Nations or are self-standing organizations, such as the International Telecommunication Union (ITU). Of particular interest to the reader are two of these organizations: ISO and IEC.

The *International Organization for Standardization* (ISO) was founded on 23rd February 1947. The *International Electrotechnical Commission* (IEC) was founded in 1906. Both these organizations had mandates from their respective members to put into place an international standardization framework to facilitate commerce and international exchanges of goods and services. While IEC was initially concentrating on, as its name suggests, standards in the electrical and electronic engineering fields, ISO was founded to address other topics.

In 1987, ISO and IEC decided to establish a *Joint Technical Committee* (JTC), with the mandate of elaborating *Information Technology* (IT) standards.

This Joint Technical Committee, still unique and known as Joint Technical Committee 1 (JTC1), has presently 19 active Subcommittees (SCs). They are listed in Appendix A, along with their areas of responsibilities.

Software engineering standards

The first standard to be published in the area of *software engineering* was a US military standard on software quality assurance in 1972. The publication of this standard was followed in 1976 by an Institute of Electrical and Electronics Engineers (IEEE) standard on Software Quality Assurance Plans. After that, the

IEEE initiated a systematic program of software engineering standards development. This program was, and still is, managed by a Subcommittee.

The IEEE is the organization that currently has published the most comprehensive set of software engineering standards. Twenty-nine standards have been published as of April, 1996, and 13 additional standards were being developed.

In a recent study, T. Matsubara inventoried 550 standards from 76 organizations, pertinent to the software engineering area.[1] There is a considerable overlap between these standards, either because of work duplication between professional, national, and international organizations or because of domain or organization-specific instantiations of standardization on a given software engineering topic: for example, software development, documentation, and testing policies for Navy Mission Critical Systems.

Interestingly enough, as international standards become available in software engineering, many national and transnational organizations are adopting these standards instead of developing their own. This adoption is driven by two factors:

1. the high costs associated with the development of standards
2. the globalization of the world economy.

Types of software engineering standards

Software engineering standards are focused on the following:

TYPE	EXAMPLE	PURPOSE
Process	life-cycle processes, verification, validation, configuration management, measurement, CASE tool selection	describe mechanisms and a set of tasks related to the engineering of software products
Work Products	requirements, design descriptions, documentation	focused on deliverables generated by a given, or a given set of, software processes or tasks
Methods	unit testing, software quality metrics methodology	specify a procedure for performing a given task or process

Measurements	functional size, software process assessment	define software engineering metrics used in measuring processes as well as work products
Formalisms	CASE tool data interchange, diagrams, Petri-Net	define notations and representations that are usually human as well as machine readable
Terminology	standard vocabularies	define the natural language terms used by practitioners and standards writers

While the above taxonomy represents one way of looking at standards, it illustrates the diversity of types of software engineering standards. Not all software engineering standards fall into a specific category. Some could fall into two or more.

Subcommittee 7

The history of ISO/IEC JTC1/SC7

The roots of SC7 go back to ISO/TC97 (Technical Committee 97), established in 1960 for international standardization in the field of *information processing*.

What is now JTC1/SC7 was put into place as one of the Subcommittees of TC97 (Technical Committee 97) in 1963. Its area of work was *Problem definition and analysis* and its first project was to address the standardization of flowcharting techniques and representations. From this work, ISO 1028 *Flowchart symbols for information processing* and ISO 2636 *Information processing—Convention for incorporating flowchart symbols in flowcharts* became standards, with both being published in 1973.

When JTC1 was established in 1987, ISO/TC97 was combined with IEC/TC83 into a JTC1 Subcommittee as the 7th (SC7). The title SC7 was changed to *Software Engineering*. SC7 proposed the title *Information System Technology*, but this title was rejected by JTC1 on the grounds that the title itself could be interpreted extensively, and it might include the entire field in which JTC1 intended to work.

The first SC7 plenary was held in Paris, France in 1987. At the 1996 plenary in Prague, Czechoslovakia, 156 delegates from 17 countries attended.

SC7 organization and program of work

SC7 is presently split into nine active working groups that are mandated to carry on its program of work (see Figure 1.1).

This program of work is a set of standardization projects that are defined by the SC7 Terms of Reference as follows:

> Development of guidelines for the management techniques and standardization of supporting methods and tools necessary for the development and testing of software.

These Terms of Reference are being considered for update to:

> Standardization of processes, supporting tools and supporting technologies for the engineering of software products and systems.

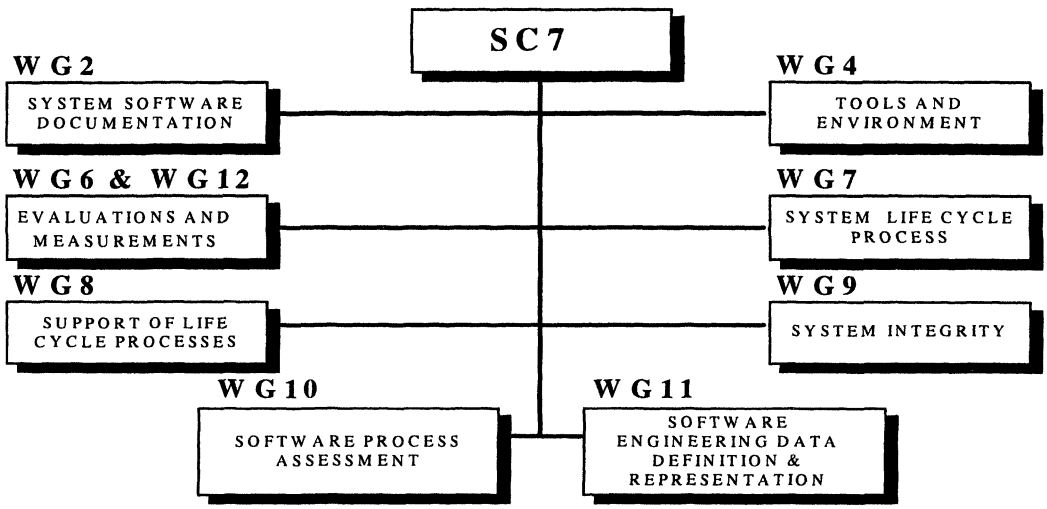

Figure 1.1: Working Groups of SC7.

The key word in these Terms of Reference is *process*. SC7 is a standardization organization that is focused on processes, specifically the processes required for the engineering of software products and systems. These Terms of Reference translate into the projects shown in Figure 1.2.

A more comprehensive list of the projects that constitute the SC7 Program of Work is given, on a Working Group basis, in Appendix B.

The SPICE Project

The SPICE Project is project 07.29 in the SC7 Program of Work. It is a multi-part document—nine parts—that at the time of printing is going through its first formal review as a Proposed Draft Technical Report (PDTR). The next stages of the standardization process are Draft Technical Report and then publication as a Technical Report.

The project will not end there. Since the SPICE documents will be what are called Technical Reports Type 2—Technical Reports that are published when there is doubt that sufficient consensus can be attained—these documents will have to be reballoted after two years to become full International Standards.

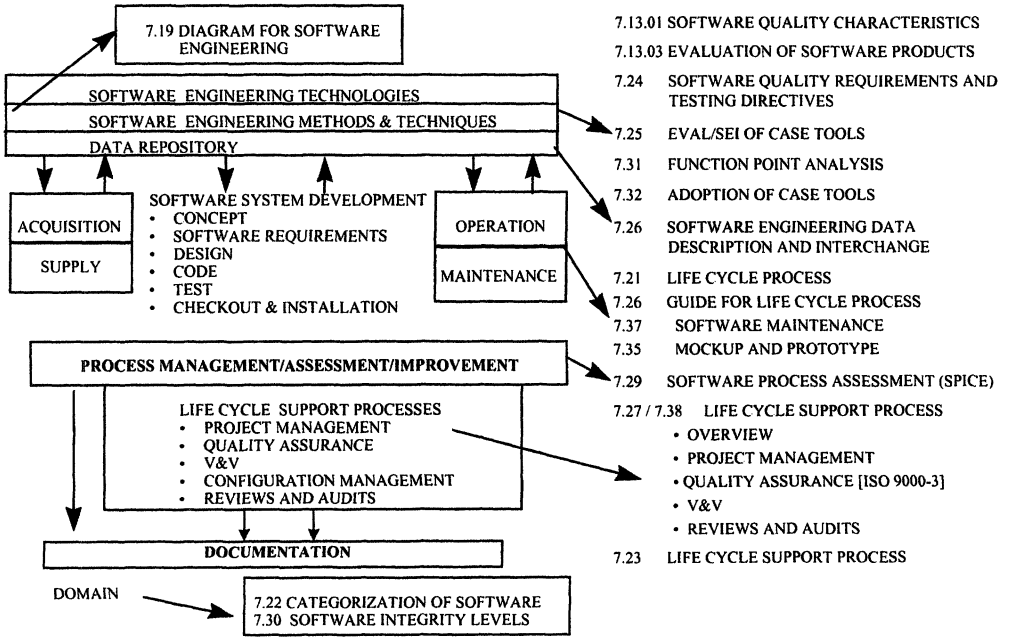

Figure 1.2: SC7 framework and projects.[2]

Conclusions

The Program of Work of SC7 has evolved considerably in the past five years. Participation in its meetings has increased, as well as its production of standards. It is expected that more than 30 software engineering standards will be published by SC7 within the next two years.

SC7 has made considerable efforts to ensure its standards and Program of Work meet customer needs. For instance, SC7 and its Working Groups have put into place a comprehensive set of formal liaisons with professional and industrial associations, including:

- IEEE Computer Society (WG4)
- NATO (WG7)
- European Software Institute (WG10)
- CDIF (WG11)
- International Function Point User Group—IFPUG and European Function Point User Group—EFPUG (WG12).

Members from these organizations can participate as technical experts in the Program of Work of these Working Groups.

As SC7 publishes more standards, their influence on the software engineering profession and industry will increase. Already, standards ISO/IEC 9126 on software product quality characteristics and ISO/IEC 12207 on the software life cycle have made their marks. The SPICE documents will surely contribute greatly to this future influence.

Appendix A: JTC1 Subcommittees and their area of responsibilities

SC	Title	Areas of Responsibilities
1	**Vocabulary**	Standardization of terminology for information technology and related fields.
2	**Coded Character Sets**	Standardization of graphic character sets and their characteristics, associated control functions, their coded representation for information interchange, and code extension techniques.
6	**Telecommunications and Information Exchange Between Systems**	Standardization in the field of telecommunications and Open Systems Interconnection, of system function, procedures and parameters, as well as the conditions for their use, for the four OSI layers that support the Transport Service, to facilitate the transport of both OSI and non-OSI application protocols and multimedia and hypermedia information.
7	***Software Engineering***	***Standardization of processes, supporting tools, and supporting technologies for the engineering of software products and systems.***
8	**Flexible Magnetic Media for Digital Data Interchange**	Standardization for the purpose of digital data interchange of flexible magnetic media, such as tapes, tape cassettes, tape cartridges, and flexible disk cartridges, the recording of data on these media, and algorithms for the lossless compression of data.
14	**Data Element Principles**	Standardization of data elements (including general rules and guidelines for their definition, description, classification, representation, and registration) that are interchanged among information processing systems, and the syntax by which these data elements are associated.
17	**Identification Cards and Related Devices**	Standardization in the area of identification cards and related devices for use in inter-industry applications and international interchange.
18	**Document Processing and Related Communication**	Standardization of document processing and communication and the user-system interface as applied to the fields of publishing and office systems. The term "document" used above describes any representation of information intended for human perception. A document can consist of component objects of different types, textual and nontextual, linked in a linear or nonlinear fashion.
21	**Open Systems Interconnection, Data Management, and Open Distributed Processing**	Standardization of protocols, services, interfaces, and information objects, and of related reference models covering the areas of Open Systems Interconnection, management of data and information resources in both a local and distributed processing environment, Open Distributed Processing, security and management aspects related to the above, and the relationships among these areas. Standardization of related conformance-testing methodologies, description languages and techniques, and registration procedures.
22	**Programming Languages, their Environments and System Software Interfaces**	Standardization of programming languages, their environments, and systems software interfaces, such as specification techniques, and common facilities and interfaces.

23	**Optical Disk Cartridges for Information Interchange**	Standardization of Optical Disk Cartridges for Media and Information Interchange between Information Processing Systems.
24	**Computer Graphics and Image Processing**	Standardization of interfaces, in windowed and nonwindowed environments, for computer graphics, image processing, and interaction with and visual presentation of information.
25	**Interconnection of Information Technology Equipment**	Standardization of interfaces, protocols, and associated interconnecting media for information technology equipment, generally for commercial and residential environments
26	**Microprocessor Systems**	To prepare international standards for microprocessor systems, where the term "microprocessor systems" includes but is not limited to microprocessor assemblies, and the related hardware and software for controlling the flow of signals at the terminals of microprocessor assemblies.
27	**IT Security Techniques**	Standardization of generic methods and techniques for IT security
28	**Office Equipment**	Standardization of Basic Characteristics, performance, test methods, and other related aspects of office equipment and products.
29	**Coding of Audio, Picture, Multimedia, and Hypermedia Information**	Standardization of coded representation of audio, picture, multimedia, and hypermedia information, and sets of compression and control functions for use with such information.
30	**Open EDI**	Standardization in the field of generic information technology standards for open electronic data interchange needed to attain global interoperability among the systems used by organizations. Such interoperability is viewed from both business and information technology perspectives.
31	**Automatic Data Capture**	Standardization of common coding; data format, syntax, and structure; and enabling technologies for individually and uniquely-identifying items and entities without human intervention.

Appendix B: SC7 Program of Work

WG2 System Software Documentation

Scope Development of standards for the documentation of software systems.

Projects		
	07.03.01	User Documentation and Cover Information for Consumer Software Packages [ISO 9127]
	07.03.02	Guidelines for Software Documentation (Revision) [ISO 6592]
	07.18	Guidelines for the Management of Software Documentation [ISO 9294]
	07.39	Software Life Cycle Process—Guidelines for the Content of Software Life Cycle Process Information Products
	07.40	Software User Documentation Process

WG4 Tools and Environment

Scope Development of standards and technical reports for tools and Computer Aided Software/System Engineering (CASE) environments.

Projects		
	07.25	Evaluation and Selection of CASE Tools
	07.32	Adoption of CASE Tools

WG6 Evaluation and Metrics

Scope: Development of standards and technical reports for software products evaluation and metrics for software products and processes.

Projects

07.13.01.01	9126-1, Software Quality Characteristics and Metrics—Part 1: Quality Characteristics and Subcharacteristics
07.13.02.02	9126-2, Software Quality Characteristics and Metrics—Part 2: External Metrics
07.13.03.03	9126-3, Software Quality Characteristics and Metrics—Part 3: Internal Metrics
07.13.02.01	14598-1, Software Product Evaluation—Part 1: General Overview
07.13.02.02	14598-2, Software Product Evaluation—Part 2: Planning and Management
07.13.02.03	14598-3, Software Product Evaluation—Part 3: Process for Developers
07.13.02.04	14598-4, Software Product Evaluation—Part 4: Process for Acquirers
07.13.02.05	14598-5, Software Product Evaluation—Part 5: Process for Evaluators
07.13.05.06	14598-6, Software Product Evaluation—Part 6: Evaluation Modules
07.13.03.07	Software Product Evaluation—Indicators and Metrics
07.24	Software Quality Requirements and Testing [ISO 12229]

	07.36	[14756] Measurement and Rating of Performance of Computer-based Software Systems.

WG7 Life Cycle Management

Scope: Development of standards and technical reports on Life Cycle Management.

Projects	07.21	Life Cycle Process
	07.26	Guidebook for Life Cycle Process
	07.35	Mock-Up and Prototype
	07.37	Software Maintenance
	07.38	System Life Cycle Process

WG8 Support of Life Cycle Processes

Scope: Development of standards and technical reports on Life Cycle Management processes.

Projects	07.23	12220-2, Life Cycle Process—Software Configuration Management
	07.27	Support of Life Cycle Processes
	07.27.02	12220-3, Life Cycle Process—Project Management
	07.27.03	12220-4, Life Cycle Process—Quality Assurance
	07.27.04	12220-5, Life Cycle Process—Verification & Validation
	07.27.05	12220-6, Life Cycle Process—Formal Review and Audits

WG9 Software Integrity

Scope: Preparation of standards, technical reports, and guidance documents related to software integrity at the system and system interface level.

In this context, software integrity is defined as ensuring the containment of risk or confining the risk exposure in software.

Projects		
	07.20.03.01	Mapping of Standards Pertinent to Software Engineering
	07.22	Categorization of Software
	07.30	System and Software Integrity Levels

WG10 Process Assessment

Scope: Development of standards and guidelines covering methods, practices, and application of process assessment in software product procurement, development, delivery, operation, evolution, and related service support.

Organization:		
	SG1	Concepts and Introductory Guide
	SG2	Model for Process Management
	SG3	Rating Processes
	SG4	Guide to Conducting Assessments
	SG5	Construction, Selection, and Use of Assessment Instruments and Tools
	SG6	Qualification and Training of Assessors
	SG7	Guide for Use in Process Improvement

		SG8	Guide for Use in Determining Supplier Process Capability
		SG9	Vocabulary
	Projects	07.29	Software Process Assessment
		07.29.01	Concepts and Introductory Guide
		07.29.02	A Model for Process Management
		07.29.03	Rating Processes
		07.29.04	Guide to Conducting Assessments
		07.29.05	Construction, Selection, and Use of Assessment Instruments and Tools
		07.29.06	Qualification and Training of Assessors
		07.29.07	Guide for Use in Process Improvement
		07.29.08	Guide for Use in Determining Supplier Process Capability
		07.29.09	Vocabulary
WG11	Software Engineering Data Definition and Representation		
	Scope	Development of standards and technical reports to define the data used and produced by software engineering processes, establish representations for communication by both humans and machines, and define data interchange formats.	
	Projects	07.01	Conventions for Incorporating Flowchart Symbols in Flowcharts [ISO 2636]
		07.07	Single Hit Decision Logic Tables [ISO 5806]

07.06	Program Flow for Processing Sequential Files in terms of Record Groups [ISO 6593]
07.08	Documentation Symbols and Conventions for Data, Program, and System Flowcharts, Program Network Charts, and Resources Charts [ISO 5807]
07.11	Program Constructs and Conventions for their Representation [ISO 8631]
07.16	Computer System Configuration Diagram Symbols and Conventions [ISO 8790]
07.19	Diagrams for Software Engineering
07.19.02	Charting Techniques and Representations for Software Development and Maintenance
07.19.02.01	Charting Techniques and Representations for Software Development and Maintenance—Process Flow Diagrams
07.19.02.02	Charting Techniques and Representations for Software Development and Maintenance—State Transition Diagrams
07.28	Software Engineering Data Description and Interchange (SEDDI).
07.28.01	Overview and Architecture
07.28.01.01	Overview
07.28.01.02	Framework
07.28.02	Interchange Formats
07.28.02.01	General Rules

07.28.02.02	Syntax
07.28.02.03	Encoding
07.28.03	Abstract Model
07.28.03.01	Presentation Location
07.28.03.02	Presentation Global
07.28.03.03	Presentation Shapes
07.28.03.04	Foundation Subject Area
07.28.03.05	Common Subject Area
07.28.03.06	Data Definition Subject Area
07.28.03.07	Data Flow Model Subject Area
07.28.03.08	Data Modeling Subject Area
07.28.03.09	State / Event Model Subject Area
07.28.03.10	Physical Relational Data Base Subject Area
07.28.03.11	Project Planning and Scheduling Subject Area
07.28.04	PCTE Schema Definition Sets
07.28.05	IRDS Content Modules

WG12 Functional size measurements

Scope: To establish a set of practical standards for functional size measurement. Functional size measurement is a general term for methods of sizing software from an external viewpoint and encompasses methods such as Function Point Analysis.

Projects		
	07.31	Function Point Analysis
	07.31.01	Definition of Functional Size Measurement

07.31.02	Compliance Assessment of Software Sizing Methods
07.31.03	Verification of a Functional Size Measurement Method
07.31.04	Functional Size Measurement Reference Model
07.31.05	Determination of Functional Domains for use with Functional Size Measurement.

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1. Matsubara, T., ed., *DTR 14399, Information Technology Reference List of Standards Relevant to ISO/IEC JTC1/SC7—Software Engineering,* 1996.

2. Tripp, L., *Presentation on SC7 Product Planning*, 1995.