ABSTRACT

The global dominance that US software producers have enjoyed for many years faces many new challenges. The marketplace places increasing emphasis on product interoperability and quality systems. Vendors are being challenged to document compliance with standards which the EC, along with many other countries, have now adopted and enforce.

Proprietary systems have provided an inertial "luxury" which must be overcome. Understanding and satisfying the changing global software market will become crucial to maintaining a significant US market presence. In this paper, we stress that the US software community must increase its awareness of international standards activities, and we advocate strong personal and corporate support for, and involvement in, these important activities.

INTRODUCTION

Demand for the products of the information processing industry - hardware, software, and services - has shown unrelenting growth on a global scale. The software industry in particular is booming. Estimates for the worldwide market are as high as $120 billion for 1990 [1], with explosive growth predicted for the European market [2]. According to the Software Publishers Association, sales of American PC software to Europe increased by nearly $125 million in the first 3 quarters of 1989, up 40% from the same period in 1988, and representing about 70% of the PC software market in each European nation [3]. US-produced software has also made significant inroads into the Japanese market which will likely grow in the near term [4]. But markets and technologies are not static. The present market predominance of US software will not assure future sustained growth any more than did similar dominance in cars, memory chips, consumer electronics, and so many other products for which US producers have seen their markets rapidly decline or evaporate, going to lower cost, higher quality, more innovative or customer-oriented foreign competitors [5].

A crucial factor which will undoubtedly affect the US software industry is the accelerating impetus for common international standards in software engineering, standards that may, if not consistent with US positions, materially hinder industry's ability to market software products and services abroad. The European Council '92 (EC 92) has stated its intent to adopt international standards, including a common set of software engineering standards, for all 12 member nations of the European Economic Community (EEC). Given the size of this market, larger than that of the US, vendors outside of Western Europe will have little choice but to conform to EEC-sanctioned standards. Enforcement will include requirements for product certification and warranty, and purchasers may require certified compliance as a contractual element. US software producers, operating in a more litigious environment, may face greater liabilities and risks under these circumstances. Some, if not most, of these producers prefer that we seek, through active participation in international meetings, to address software quality issues through standards, emphasizing responsible voluntary compliance rather than the imposition of direct legal or contractual requirements. This may be wishful thinking, however. As software becomes more and more an integral part of manufactured products, it will be difficult to insulate the software component from the warranty on the product.

OPEN SYSTEMS

Internationally, there is a strong and growing emphasis on the "open systems" approach which is intended to avoid reliance on vendors' proprietary systems [6]. The Open Systems Interconnect model (OSI), by establishing and defining a set of distinct "layers" involved in information transaction processing, has provided a basis for organizing and standardizing process interactions. Many countries and major computer vendors have adopted, or intend
to adopt, some form of the OSI model, and more detailed technical standards are being formulated by international consensus for interfaces between layers of this model. In the US, the Government OSI Profile (GOSIP) initiative mandates that, beginning in August 1990, procurements must conform to OSI conventions and such companies as IBM and DEC have announced intentions to support OSI standards. Yet, there remain a great many de facto standards based on existing technologies despite rapidly growing interest in OSI among consumers who have been captive to vendor-proprietary architectures and standards. American software producers who fail to respond to these shifting market dynamics may once again find themselves bested by emergent competitors who are ready and willing to adapt and develop products which meet the new requirements. Proprietary systems are not likely to disappear, but the open systems concept is the wave of the future, bringing with it vastly broader opportunities for competition in the development of software-based systems [7].

ISO 9000

Another international imperative that will affect software development is the standardization of quality management systems. Accompanying the worldwide trend towards more stringent customer expectations with regard to quality, there has been a growing realization that product quality derives mostly from process quality - a principle that has been so effectively applied by the Japanese. Consequently, customers are demanding assurance that their suppliers have management systems in place that effectively control, maintain, and continually improve the quality of their products and services. To this end, the International Standards Organization (ISO) has developed the ISO 9000-9004 series of Quality Management and Quality Assurance Standards [8]. These standards are generic; they do not represent a detailed blueprint containing specific, mandated implementation methodologies. Rather, they are a concise, some say too concise, description of the essential elements of management systems for assuring quality in design/development, production, installation, servicing, and final inspection and test that emphasizes the "what" not the "how". Although specific methodologies are left to the user, the standards require them to be documented and their efficacy demonstrable. The generality of the standards makes them applicable to processes, products, and services - including software and software development - and they apply to any organizational entity - entire companies, divisions, R&D facilities, software departments, etc. Of particular significance is that, at the time of this writing, balloting is underway for a software version of ISO 9001, "Part 3: Guidelines for the Application of ISO 9001 to the Development, Supply, and Maintenance of Software". Finally - and most importantly - compliance may be required as a contractual matter by purchasers throughout the term of a contract including delivery, installation, and service.

Enforcement of compliance to the ISO 9000 standards could become a significant barrier to software vendors who will not or cannot document their quality systems and demonstrate their process capability and a marketing advantage to those who can pass the stringent audits and maintain their certification. Compliance is voluntary in the US, but voluntarism will have little practical significance if purchasers, foreign and domestic, require not only compliance, but certification and registration. Starting in 1992, companies in the EC countries and others will require their suppliers to be registered under the EN 29000 series of standards, an ISO 9000 series equivalent. Currently no US organization exists for the registration of software; producers must use Underwriters' Laboratories (UL) which is acting as an agent for the British Standards Institute [9]. The American Society for Quality Control (ASQC) is establishing a registration function which, if approved by ANSI, can be a source for accrediting US registrars for ISO 9000 [10].

Software developers and service providers will be greatly mistaken to assume that they will be excluded from this movement. The US packaged software industry is rapidly changing [11]. Software developers, responding to the demands brought about by networking, are increasingly providing customized applications programs, systems integration, and installation and training services. American companies are becoming intensely aware of the need to forge close partnerships with their suppliers because the suppliers' processes cannot be separated from their own. Thus, consumers will want assurance of the quality of processes as well as products and certified compliance with ISO standards will be part of this.

WHERE TO FROM HERE?

Such imperatives as open systems and the reality of ISO 9000 are in decided contrast to the way standards were established in the past [12]. Previously, standards development was an evolutionary, bottom-up process driven primarily by market dominance. Established practices of one or a few market-dominant companies became industry standards which became national standards which became international standards. International software standardization is becoming technology driven, although it would be naive to suppose that market dominance or nationalistic/regional protectionism will not play a role in future software standardization. Globally dispersed, multinational enterprises will require, indeed demand, standards which support and promote international codification of engineering practices for the design, production, and quality and configuration control of software driven
systems, compatibility between layers and interfaces, interoperability, portability, and vendor independence. As opposed to the traditional bottom-up process of the products setting the standards which only later become formalized, in this new environment, the technological demands of compatible media, software, consumables, and services will shape the standards which will then guide the development of new products and processes. In this non-traditional, top-down process, participation in international standards development from the outset is a necessity. Our extensive set of existing software engineering standards can be a basis for international counterparts, but only if we achieve a high level of domestic harmonization and present a common front. At the same time, we must have realistic expectations regarding the willingness (or unwillingness) of the global community to accept our standards without modifications necessary to meet the needs of the international community.

The US has initiated two important software engineering standards initiatives affecting everyone in the software industry - life cycle management and software quality engineering. The life cycle management process standard defines the essential activities in a software lifecycle but has the unique feature of allowing any life cycle model to be used as long as a mapping to the standard activities is provided. The software quality engineering standard initiative will be more specific than ISO 9000 and be more relevant to the software quality issues. US industry, government agency, and academic support for, and participation in, these important efforts are essential to provide strong, robust standards for internationalization.

INTERNATIONAL SOFTWARE STANDARDS GROUPS

In addition to the activities of the ISO Technical Committee 176, which is responsible for the ISO 9000 series, and its software subcommittee SC2, ISO and the International Electrotechnical Committee (IEC) established the Joint Technical Committee #1 (JTC1) on Information Technology in 1987 from previously existing committees [13]. ANSI represents the US on JTC1 and also serves as its administrative secretariat. Each participating country has a single vote on proposed standards. Of primary importance to software interests is Subcommittee #7 (SC7), Software Engineering, whose mission is to develop, through position inputs from member nations, a set of international standards pertaining to the area of Information Systems Engineering. Four working groups (WGs), each with responsibility for a particular technical area, have been formed under SC7. WG members are individuals who represent their respective member nations. Member nation position inputs, however, are effected at the JTC1 level. SC7 holds an annual plenary meeting in early summer, usually followed later by meetings of the WGs.

Adoption of an international standard takes three to five years. New standards proposals pass through various drafts with increasingly larger review audiences. Ultimately, a consensus draft standard is voted upon by all participating members of SC7 and then JTC1. If approved, the new International Standard becomes enforceable. An alternative and shorter method is to adopt a national standard, but this will occur only if there is sufficient participation and review by international members during the national development process.

With only one vote to cast, the US delegation, must develop a unified position on all proposals. Since ANSI is the official US representative on JTC1, it has created and placed under IEEE technical administration a Technical Advisory Group (TAG) to coordinate US participation in SC7. Some responsibilities of the US SC7 TAG are to:

- initiate and approve US positions for new standards;
- coordinate US positions on drafts being circulated for approval, ISO/IEC questionnaires, plenary agenda items, reports of meetings, etc.;
- recruit technical experts to serve on WGs;
- appoint delegation heads and nominate representatives to international meetings
- establish liaisons with US TAGs in related fields.

Membership on the US SC7 TAG is open to "any USA national person (organizations, companies, government agencies, individuals) who might reasonably be expected to be, or who indicate that they are, directly or materially affected by the committee's work". The TAG meets quarterly in locations throughout the United States. Delegates to the SC7 international annual plenary are selected from TAG members. The US SC7 TAG sends technical experts to the international working group meetings which typically follow the plenary session. An additional option for those who cannot attend meetings is that of a "correspondent" member; such members receive all materials provided to regular participants for review and comment, and, additionally, may also submit items for consideration.

CURRENT AND PROPOSED WORK ITEMS

The development of international software engineering standards is still in its early stages. The emphasis for the next three years will be on establishing a robust and flexible foundation on which to build future standards.
This initial work focuses on the definition of a common development framework with a set terminology and symbols, which entails specific compliance and certification procedures and conditions for warranty. An emphasis on process and process assessment, including metrics, is likely to affect US software producers in a manner similar to Department of Defense specifications.

Standards projects are underway in each of the four SC7 working groups. They concern the fundamental definitions which affect software engineering and include efforts to specify: a generalizable model of the software engineering process; minimal documentation expectations for computerized systems; development diagramming symbols and techniques; software lifecycle processes; software quality characteristics and metrics, and technical specifications, such as requirements, designs, tests, etc. Current activities of the SC7 WGs will most likely provide the technical depth regarding the totality of software quality considerations not addressed by the more generic ISO 9000 series. Table 1 identifies projects assigned to each group and the nationality of its project editor whose primary responsibilities are to coordinate technical content and achieve consensus.

ANTICIPATED IMPACTS

Current standards work items if incorporated into future ISO standards, will affect the domestic and international software markets. Besides supporting open architectures, new standards are likely to establish procedural requirements and to further specify certification criteria which will be used worldwide. Some anticipated impacts of working group projects are:

- Specification of techniques for charting and diagramming and usage of icons will affect internationally accepted CASE tools.
- Proposals for software system documentation have dealt with issues regarding acceptable standards on packaging formats for consumer software.
- New standards are in process to describe the format of interim products of the software development process (e.g., requirements specification, design description, testing documents, user manuals).
- Software engineering and quality management proposals form the foundation that will define the software development process and its management and control. Once adopted (a selection will be made by the EEC for EC '92), software products not developed in accordance with these standards could not be sold to EC countries, NATO, or others who subscribe to them.
- Many member countries want certification or warranty in conjunction with software development standards. Inability to meet certification requirements or to provide satisfactory warranties may exclude products from international, or even domestic, markets.
- Japan is the chief proponent of software quality metrics. Such metrics, if incorporated into standards, may become a basis for warranty and contractual conditions. Software developers who cannot achieve acceptable levels of measured quality will be at a competitive disadvantage.
- The adoption of a reference model will establish a framework for how software is to be developed. There is increasing pressure from member nations to include procurement requirements and consumer usage/packaging requirements into the overall development model. This could affect software development contracts and other third party considerations.

WHAT MUST BE DONE

Given that the US has a great deal at stake in maintaining its competitiveness in international software markets, what must be done to ensure that our interests are represented properly and that there will be fair treatment of all concerned parties at the international level? The answer: participation across all segments of the US computer and software establishment. Industry, professional societies, government agencies, academe, even individual software professionals should be well versed in the current organization of US international participation and become actively involved in its software engineering standards projects. Participants will have the opportunity to present, first-hand, their experiences in project development and the application of state-of-the-art technologies. They will gain first-hand knowledge of pending proposals and be able to influence their development and gauge their potential impact. In the crucial period of the next three years, the US must be an active participant in the standards development arena. Participation provides leadership, information, and feedback. Failure to participate threatens isolation from the international software community. Our technological leadership and expertise will more and more become defined within the context of a coordinated international effort.

In the US, the channel for international participation is ANSI and the IEEE Computer Society. Participation is
entirely voluntary. The nature of our participation is a matter of significant discussion. Indeed, the existing voluntary standards, administered by the private sector, has recently received overwhelming reinforcement and support at a Washington D.C. hearing held in April by the US Department of Commerce (DOC) [14]. The publicized aim of the hearing was to elicit comments from a broad representation of interested parties regarding a DOC proposal to establish a "Standards Council of the United States of America" (SCUSA) which would create "an infrastructure to sustain a cohesive National Standards System" and generally to initiate various actions to improve US participation in international standards-related activities.

A glance at Table 1 shows that there is a strong American presence on the WGs through the influential committee convenorships and project editorships. There is a need, however, for wider participation on the US SC7 TAG. Mailing lists contain hundreds of names but only ten may show at a WG meeting. Furthermore, there is a need to involve experts from a broader spectrum of the American software establishment with more representation from private, consumer-oriented companies and from smaller, entrepreneurial companies. Some of these needs are summarized below:

1) FINANCIAL/CORPORATE SUPPORT. We need industry, government agencies, and academe to provide more support for their technical experts financially and by allotting sufficient time to work on international software standards activities. Various testifiers at the NIST hearing related to government providing additional funding, say, in the form of tax credits and grants. In addition, though, perhaps the private sector should establish and finance, probably through ANSI, a granting agency to support applications from experts from small companies, private individuals, and academics who are not supported by large, usually government, research contracts. The typical academic research contract might not even allow use of funds for standards-related activities.

2) TECHNICAL LEADERSHIP. We need technical experts to assume working group convenorship, project editorship, and other technical leadership positions in key standards activities. This will help to ensure continued US competitiveness in the global software marketplace. Yet, companies anxious to cut costs and conserve precious human resources may not perceive the long term benefits of participation.

3) US TECHNICAL CONSENSUS. We need to develop a broad-based TAG membership who can obtain technical support from a wide spectrum of computer professionals to develop a US consensus position on key standards issues. There must be more attention to harmonizing standards domestically and the attainment of a more unified US position on software standards. Efforts of standards-generating organizations need to be better coordinated, more mutually consistent, more purposefully focused, and ultimately made to conform to approved international standards.

4) INTERNATIONAL AND DOMESTIC MEETING PARTICIPATION. The most effective way to communicate positions on technical issues is through face-to-face meetings with technical experts from both the US and other member countries. We need a stable cadre of American technical experts to attend TAG and international meetings and plenary sessions to establish and capitalize on personal relationships between our experts with their counterparts from a broad spectrum of companies, academe, and other countries.

REFERENCES

[1] International Data Corporation, Framingham, MA. Reported in ref. [2].


