The foundation

Standards specify rules for exchanging information across an interface, permitting the independent development of the entities on both sides of the interface without sacrificing the synergy that comes from having several entities cooperate to solve a problem. Thus, improved technology, less expensive components, and upgraded software can all be incorporated at a pace the developer finds appropriate; system-wide cooperation and coordination is not required.

The five current graphics standards (PHIGS, GKS-3D, GKS, CGI, and CGM) are the foundation on which other, more specialized standards are expected to be based. For example, just this spring a new project was started within X3H3 to develop an application programmer standard for display management (a component of a user interface management system, or window manager). The current work on GKS and CGI will heavily influence this new work.

This special issue opens with an article by George S. Carson and Eileen McGinnis, who describe the initial effort to develop a reference model for computer graphics. A reference model is a tool that both explains how computer graphics fit in with the other so-called Open Systems Interconnection standards and helps us decide

The standards process

Peter R. Bono

Founded in 1918 and headquartered in New York City, the American National Standards Institute is the coordinating organization for America's federated standards system. Its membership includes 900 companies and 200 trade, technical, professional, labor, and consumer organizations.

ANSI does not itself develop standards. Rather, in cooperation with its members, it identifies what standards are required, provides a set of model procedures that standards-writing organizations may follow to attain industry-wide consensus standards, and makes the resulting national and international standards available for purchase by industry, government, and the public.

ISO representative. As the official US member, ANSI manages, coordinates, finances, and administratively supports US participation in the International Organization for Standardization (ISO). It helps govern ISO through membership on its council, executive committee, and technical board, and actively participates in the work of some 1900 ISO technical committees, subcommittees, and working groups.
what functions belong in which standards. Because this work is so preliminary, consensus on a fully elaborated model has not yet been obtained.

The next two articles detail standards at the abstract level of the ‘virtual graphics device.’ Lofton Henderson, Margaret Journey, and Chris Osland describe the purpose, semantics, and syntax of Computer Graphics Metafile, a standard for the transfer of pictures between dissimilar hardware and software environments. Tom Powers, Andrea Franklin, and David Arnold explain Computer Graphics Interface, which is closely related to CGM. CGI is a powerful and complex standard that may become available either as a programmer interface standard or a standard device data stream protocol. Also, the CGI is the first standard to incorporate primitives, attributes, and control functions with the express purpose of supporting bitmapped, raster devices.

3D objects

Standards for defining and viewing 3D graphics objects are the subject of the next two articles. Richard Puk and John McConnell explain GKS-3D, an upwardly compatible extension of GKS, the first ISO and ANSI graphics standard. Most of the additional complexity in GKS-3D is in the specification of the viewing pipeline. David Shuey, David Bailey, and Tom Morrissey then describe PHIGS, a proposed standard that goes beyond GKS-3D and other proposals to support modeling, not just viewing, graphics objects. But this increased power has its price: Until high-performance hardware is available at a low cost, systems supporting PHIGS will be larger, more complex, and more expensive than those supporting GKS alone.

All of the graphics standards for the programmer interface—PHIGS, GKS-3D, GKS, and CGI—are initially specified in terms of their abstract graphics functionality. That is, the semantics of the functions are described but no syntax is specified. To be really useful, however, we must specify the syntax for accessing these standards with the most popular programming languages. These specifications, language bindings, are the subject of the sixth article, by Madeleine Sparks and Julian Gallop. Creating a language binding is a more complex task than might first be thought: Not only must the graphics be right, but the interface to the host language must be appropriate for the language.

The final article, by Mark Skall, focuses on the role of the National Bureau of Standards. Unlike many of our European allies, the United States does not have a comprehensive system of mandatory information processing standards. Nor is there an extensive government program for certifying computer standards. Instead, the US relies on a voluntary system of compliance; the marketplace serves as the enforcement agency. The role of NBS in this system is often misunderstood. Mark’s article explains the statutory responsibilities of NBS and this agency’s contributions to standards testing.

Copies available

Copies of all standards are available from one of two sources in the US, for a copying and handling fee. All ISO documents (WD, DP, DIS, and IS) as well as formally approved ANSI standards (for example, ANSI X3.124-1985, GKS) are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018; (212) 642-4900. All draft X3H3 documents and draft proposed American National Standards are available at AT&T, CalComp, Control Data, Digital Equipment Corp., Data General, Evans and Sutherland, Hewlett-Packard, Honeywell, IBM, Intell, Prime, Sperry, Tektronix, Texas Instruments, and Wang. Also active are large end users like Amoco, McDonnell Douglas, Hughes, and General Motors and government organizations like NBS, Lawrence Livermore Labs, Los Alamos National Lab, and Sandia National Lab.

TC97 and SC21. The international counterpart to X3 is Technical Committee 97. In turn, the TC97 Open Systems Interconnection subcommittee, called Subcommittee 21, has assigned computer graphics to its Working Group 2. Consequently the ISO graphics standards committee is designated ISO/TC97/SC21/WG2.

Other working groups in SC21 deal with OSI Architecture and Reference Models (WG1); Data Base (WG3); OSI Management (WG4); Operating Systems, Virtual Terminal, and File Transfer (WG5); and Common Upper Layer Services and Protocols (WG6).

Included in TC97 as separate subcommittees are Character Sets and Information Coding (SC2), which covers teletext, videotex, picture and image coding, audio coding, and facsimile; Networking Services (SC6); Text and Office Systems (SC18), which covers

ANSIs and FIPSS. As a private, nonprofit organization operating in the public interest, ANSI’s income is derived mainly from membership dues and from the sale of American National Standards. ANSI are developed and used voluntarily. They may become mandatory only when adopted or referenced by government. In the information processing field, many ANSIs are adopted as Federal Information Processing Standards through the National Bureau of Standards. Only a few FIPSSs have testing and validation services associated with them, often administered by NBS or other government agencies. Examples are the Fortran and Cobol compiler validation services.

X3 and CBEMA. X3 is the standards development committee accredited by ANSI for information processing. The committee is administered by CBEMA, the Computer Business Equipment Manufacturers Assn., in Washington, DC. X3 itself has about 30 technical committees, each with about 15 to 80 members.

X3H3. Within X3, technical committee X3H3 is responsible for all computer graphics standards. Currently more than 100 participants, representing about 80 companies, regularly attend X3H3 meetings. Represented on X3H3 are such industry stalwarts as...
office document architecture, office document interchange format, and integrated text and graphics content architectures; and Programming Languages (SC22).

**US TAGs.** Each of these international subcommittees and working groups has a US counterpart within X3. Called Technical Advisory Groups, the primary task of these committees is to develop US standards, but they must also prepare the US position on international standards. This is a partial list of computer graphics TAGs and their corresponding ISO committee: X3H2 for SC21/WG3; X3T5 for SC21/WG1, WG4, WG5, and WG6; X3L2 for SC2; X3V1 for SC18; and several X3Jx committees, each with its own corresponding working group within SC22, including X3J1 for PL/1, X3J2 for Basic, X3J3 for Fortran, X3J4 for Cobol, X3J6 for Pascal, X3J10 for Ada, and X3J11 for C.

**X3/SPARC.** Overseeing all of these technical committees for X3 is the Standards Planning and Requirements Committee. All new project proposals must be approved by SPARC before being voted on by X3. Likewise, all technical committee actions relating to the advancement of a proposed ANSI must be reviewed by SPARC before they can be acted upon by X3 and ANSI. This process is designed to ensure that the standard meets the requirements as originally specified in the project proposal.

**The ANSI process**

I will now describe each stage in the development of an ANSI for computer graphics. The duration of each stage is a function of a number of factors. The principal factors are the number of formal steps that must be followed and the degree of consensus within both X3H3 and X3. The time ranges I give for each stage are for a typical graphics project. Graphics standards are long documents (100 pages minimum to 600 pages or more) and so may take more time to develop than standards in other areas of information processing. Furthermore, each standard is a new one, a factor that contributes to the time it takes to develop a consensus.

**SD-3.** To start a new graphics standards project, X3H3 must draft and approve a project proposal (known as an SD-3, or Standing Document 3). The SD-3 must then be approved by SPARC and is then subject to a vote of X3. Any negative comments resulting from the X3 vote must be responded to before technical work can proceed. This stage can take six months or more.

**Working drafts.** X3H3 prepares a series of working drafts that are circulated and commented upon by X3H3 members. For graphics, this stage typically takes several years.

**dpANS.** When X3H3 believes that the proposed standard is sufficiently stable, it votes to forward the draft for public review, to solicit opinions from outside the committee. If approved, SPARC reviews the document to see that it has met its goals and falls within the scope outlined in the project proposal. X3 then conducts a 30-day ballot (with a possible 15-day reconsideration period) on forwarding the draft to ANSI for announcement of the public review period.

ANSI needs about three to four weeks lead time before public review, so official notification can be given in ANSI's publication, Standards Action. At this point, a document number is assigned (for example, X3.124 is GKS) and the proposal is promoted to the status of a draft proposed American National Standard, or dpANS. It can easily take six to 10 months from the first X3H3 ballot on public review to the start of the public review period.

**Public review.** The initial public review period for X3 draft standards is four months; subsequent public review periods are two months. After each public review, X3H3 prepares responses to the written comments that were submitted, and then votes on whether to approve the responses. If substantial technical changes are made to the document as a result of this process, a new public review cycle begins. This cycle may invite comment on the entire document again, or it may be restricted to those changes made to the previous draft. This stage can take eight months or more, depending on the number of public review cycles. We expect most X3H3 standards, because of their size and complexity, to require at least two public reviews before final approval.

**Final approval by BSR.** When X3H3 has approved a document in response to a public review that results in no more technical changes to the dpANS, X3 commences a six-week ballot on forwarding the dpANS to the ANSI Board of Standards Review for acceptance by ANSI. The BSR does not judge technical merit, but must be assured that ANSI procedures were followed and there is sufficient consensus on the dpANS among the companies and organizations likely to be affected. If BSR approves, it authorizes ANSI to publish the X3 document as an ANSI. This final stage can take six to nine months, depending upon how long it takes the document editor to put the document in a format that is acceptable to ANSI.

**The ISO process**

While similar in intent to the ANSI process, the ISO process differs in many particulars, in the time scale for each stage, and in the voting procedures. Once again, the range of time given for each of the stages represents typical times expected for graphics standards within TC97. For the same reasons already mentioned, these times are probably somewhat longer for graphics projects than for some other TC97 development projects.

**NW1.** In ISO, a new project is started when a subcommittee (like SC21) or a member body (like ANSI) drafts a New Work Item proposal and submits it to TC97 for a three-month letter ballot. Each member country has one vote, to decide if it accepts the definition of the work item, supports the work item,
<table>
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<tr>
<th>Project</th>
<th>ISO status*</th>
<th>ANSI status</th>
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<td>GKS language bindings:</td>
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<td>PHIGS language bindings:</td>
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*There are four formal development stages within ISO: WD = Working Draft (first); DP = Draft Proposal (second); DIS = Draft International Standard (third); IS = International Standard (final).*

and will commit resources to work on it. X3H3 recommends the US position on graphics NWIs, but it is X3 that casts the vote on whether to support the recommendations. The US position is forwarded by X3 to TC97 via ANSI. An NWI is often accompanied by a base document; X3H3 has provided the base documents for CGM, CGI, and PHIGS NWIs. This stage can take five to eight months.

**Working Drafts and Rapporteur Groups.** From the base document, SC21/WG2 prepares working drafts that are circulated for comment by SC21 member bodies. This comment period is usually three months. X3H3 prepares the US comments and forwards them to ANSI via X3 for submission to SC21. WG2 manages the projects by creating Rapporteur Groups (subgroups of the WG) who may hold meetings in between...
the meetings of the WG (at present, the WGs are meeting about every nine to 10 months), by assigning Rapporteurs to lead them, and by assigning document editors for each international standard being developed. This stage can take six to 18 months, depending on how complete the base document is and how much consensus there is among SC21 member bodies.

**DP.** When the working draft is essentially complete and most major issues have been resolved, WG2 can recommend that SC21 register the document as a Draft Proposal. This is accomplished by a three-month SC21 letter ballot to register the working draft as a DP or by resolution at an SC21 meeting. X3H3 prepares the US vote and forwards the vote to SC21 via X3 and ANSI. If successful, an ISO number is assigned to the proposed standard (for example, GKS is ISO 7942; at the draft proposal stage it was known as DP 7942).

Usually, immediately upon registration, the same document is circulated for a three-month DP ballot among SC21 member bodies. X3H3 prepares the US vote and forwards it to SC21 via X3 and ANSI. Member body comments must be responded to by an editing committee, by SC21 during a meeting, or by WG2 during a meeting. Changes will be made to the document, where appropriate, to achieve or improve consensus. Additional DP cycles, requiring three-month ballots within SC21, may be needed. It is the goal of WG2 that this stage not take more than 12 to 14 months.

**DIS.** When consensus has been reached (that is, the document is considered technically stable) and the DP has been put into a format acceptable to ISO, it is circulated by the ISO Central Secretariat for a six-month ballot by TC97 and all ISO member bodies. The document is now called a Draft International Standard and its designator is changed accordingly (for example, GKS was DIS 7942). X3H3 recommends the US vote and comments to X3; X3 actually casts the US ballot. X3 forwards the formal US vote to ISO/CS via ANSI. The DIS stage can take nine to 12 months after the text is received by ISO/CS.

**IS.** Comments from the DIS ballot must be responded to either by an editing committee appointed by the SC21 Secretariat and typically including the Document Editor and the Rapporteur in charge of the standard, by SC21 during a meeting, or by WG2 during a meeting. If the document is technically changed in a substantial way as a result of the DIS vote, another DIS will be required. In general, multiple DIS rounds are to be avoided; that is why a graphics standard will not reach the DIS stage if SC21 still has technical concerns about the content of the standard. The final International Standard text is then submitted to ISO Central Secretariat by the SC21 Secretariat. When the document is approved by ISO Council, it can then be published by ISO. One final time the designator changes form (for example, GKS is known as ISO 7942-1985).

References


Peter R. Bono has chaired the ANSI Accredited Standards Committee on Computer Graphics (ANSI X3H3) since its founding in 1979, and he leads the US delegation to the ISO Working Group on Graphics (ISO TC97/SC21/WG2).

His research interests include computer graphics software, user interface design, and computer graphics standards. He received an AB in mathematics from Harvard College and an MS and PhD in computer and communications sciences from the University of Michigan. He is a member of ACM, ACM-SIGGRAPH, NCGA, and Eurographics.

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