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Abstract: In this paper standards in computer graphics are described. At first the reasons for evolution these standards are given and then the ways of accepting the international standards are presented. Afterwards the evolution phases of the graphical standards under ISO and ANSI are interpreted and current stage of particular standards are given. In proceeding the place of graphical standards and standard proposals in a graphical system are shown. Finally, the position and role of the graphical standards in a modern CAD system is presented.

Povzetek: V članku podamo pregled standardov v računalniški grafiki. Najprej opišemo vzroke za razvoj teh standardov, nato pa prikaženo poti, preko katerih nek predlog lahko postane mednarodni standard. Zatem predstavimo razvojne faze ISO in ANSI standardov ter podamo trenutne razvojne stopnje posameznih standardov za računalniško grafiko. V nadaljevanju opišemo mesto grafičnih standardov oziroma predlogov standardov v grafičnem sistemu. Nazadnje podamo mesto in vlogo grafičnih standardov v modernem CAD sistemu.

1. THE BEGININGS OF STANDARDS DEVELOPMENT

Today, a large number of different graphical hardware and even more different graphical software exist. A big part of this graphical software is **device-dependent**. The consequences are:

1. It is impossible to exchange graphical software between different graphical systems
2. There are problems by installation of old programs on new graphical equipment, although it has been suplied by the same producer, etc.

Because of these problems an idea has been appeared to make a device-independent graphical packet. Advantages of this **device-independent graphical packet** are:

1. It could serve different device generations.
2. Programs could work on different graphical systems.
3. Programmers could immediately work on different graphical systems.
4. Graphical systems are distinguished only by quality, price, and efficiency.

Of course, this device-independent graphical packets have also some weaknesses. **They are slower** than device-dependent and **more memory space is needed.** Because the power of computers is rapidly increasing and their prices are decreasing, advantages of standardization are going over its weaknesses. People, who are opposite to standards in computer graphics, affirm **that standards are against inovations.** It is clear, when a standard is accepted, it could not be changed immediately.

Portability of aplication programs could be achieved in some different ways /ENDE84/:

- with development of computer languages,
- with extension of existing program languages with graphical features or
- with libraries of graphical subroutines which could be linked into application program.

Experts from the field of computer graphics have chosen **the last possibility** by the construction of international device-independent graphical standard. However, it is least elegant of all but it is the best way to awoid confusing in structures of program languages. The place of the device-independent graphical standard in a graphic system is shown by figure 1.

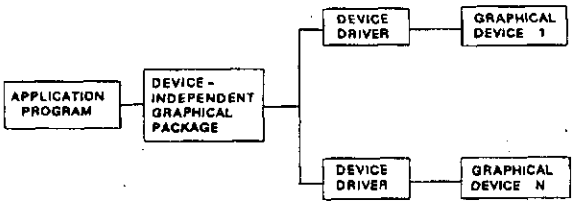

Figure 1. The place of graphical standard in graphical system

The development of graphical standards began in the year 1974, when the **Graphics Standard Planing Committee (GSPC)** was found by **ACM SIGGRAPH** ("Association for Computing Mashinery Special Interest Group on Graphics"). This committee met with other international members, involved in computer graphics in Seillac (France) in 1976. This meeting had a great influence on first draft standard called **Core System**. It was introduced on SIGGRAPH 1977. Two years later, on SIGGRAPH in 1979, an improved version of Core was appeared.

Soon after that a new group has been found by **German Institute for Standards DIN** which has been worked on a new graphical standard basis. The group has been directed by Jose Encarnacao and **it prepared in 1977 a draft standard called GKS** (Graphical Kernel System).

Two propositions were apeared by ISO in 1979: Core and GKS. Working Group WG2 by ISO decided that only efforts on GKS continued. GKS was much more simple, it was 2D, and it was intended for raster devices. On other side Core was 3D and destined for vector devices. The first draft proposal of GKS was made by ISO in 1982. **GKS was accepted as an ISO standard in 1985.**

In 1981 SIGGRAPH GSPC committee was disbanded and passed over to the ANSI X3H3 committee, which was founded in 1979.

GKS has become a basis for many other proposals of standards including **PHIGS, CGM, and CGI.**

IGES, as a standard for transferring CAD/CAM data bases, has been developed in completely another way than Core and GKS (through others ANSI committees). **IGES was accepted as an ANSI standard in 1981.**

2. WHO SETS UP THE STANDARDS?

American National Standard Institute (ANSI) does not set up the standards, but it only whaches over the process, through which the standards are accepted. ANSI has to notice if a standard draft is acceptable by most wide part of industry. Only such standard could be adopted and used in industry and other institutions. ANSI adopts a standard as a national standard when it is acceptable by most companies and organizations.

ANSI consists of by several committees. So the **ANSI X3 is the standards development committee for information processing** and has about 30 committees, each with about 15 to 80 members /BONO86/. One of them is **X3H3 tehnical committee, which is responsible for computer graphics standards.** X3H3 committee consists of 6 subcommittees, which is showed by figure 2 /STRA86/.

More than 100 participants, representing about 80 companies (CalComp, Control Data, DEC, HP, Honeywell, IBM, Intel, Tektronix, TI, etc.), attend X3H3 meetings.

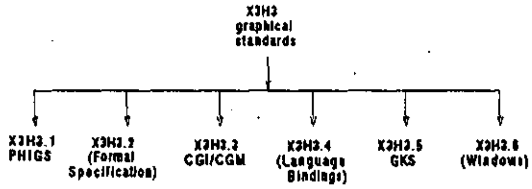

Figure 2. X3H3 Tehnical Committee and its subcommittees

It is similar for **International Organization for Standardization** (ISO). ANSI is only a secretariate in ISO's Technical Commitee TC97. Working Group WG2 in subcommittee SC21 is responsible for graphical standards. Its sign is ISO/TC97/SC21/WG2.

Some standards which are set up by ISO or ANSI, are effective, but others are even ignored. From this point of view standards could be considered as **de facto** and **formal standards** /STRA86/.

For example, IBM's Color Graphics Adapter (CGA) is a de facto display standard for PCs, just as the IBM PC is a de facto standard for personal computers. Neither CGA neither IBM PC was formal standards, but market factors has adopted them as standards.

Among formal standards we distinguish successful and unsuccessful ones. A case of formal standard, which has been widely used, is RS-232-C. On the other hand, who has heard about ANS X3.23 standard for keyboard layout. This standard has been totally eclipsed by de facto standards, first by the IBM Selectric layout and later by PC and AT layouts.

3. DEVELOPMENT PROCESS OF STANDARDS

That a proposal becomes a standard, there are several phases it must go through. It takes much more time for standardization process in computer graphics than for standards from other areas, because the projects are very large and completly new.

Evolution process of an ISO standard

Evolution phases of an ISO standards are /BONO85, BONO86/:

- the first: **New Work Item proposal** (NWI); discussion about new project is started, when subcommittee (like SC21) or a member body (like ANSI) makes a proposal. Representatives of different countries decide if they accept the definition of the work item and if the work is continuing on this proposal. This stage can take 5 to 8 months.
- the second: **Working Draft** (WD); document could be in this stage 6 to 18 months;
- the third: **Draft Proposed** (DP); this stage can take 12 to 14 months;
- the fourth: **Draft International Standard** (DIS); document could take place in this stage for 9 to 12 months;
- the final: **International Standard** (IS).

Evolution process of an ANSI standard

Evolution stages of an ANSI standard differ from stages of an ISO standard and are following:

- the first: **Standing Document 3** (SD-3) is an initial proposal which can take no less than 6 months;
- the second: **Working Drafts**; X3H3 prepares a series of working drafts that are circulated among X3H3 members. This stage typically takes several years.
- the third: **Draft Proposed American National Standard** (dp ANS); this stage takes 6 to 10 months;
- the fourth: **Public Review**; document could be in this stage 8 months or more, which depends on the number of public reviews. At least two public reviews are required by X3H3.
- the final: **Final Approval** takes 6 to 9 months.

The current stage of graphical standards under ISO and ANSI is shown by table 1 /BONO86, SELE87/.

Table 1. The stage of graphical standards project

Project	ISO status	ANSI status
GKS	IS 7942 published in Avgust, 1985.	ANS X3.123-1985. Published in October, 1985.
GKS Fortran	Known as ISO DIS 8651/1. DIS ballot closed in Avgust, 1986.	ANS X3.124.1-1985. Published in October 1985.
GKS Pascal	Known as ISO DIS 8651/2. DIS Ballot closed in August, 1986.	ANS X3.124.2-1987. Public review closed in May, 1987.
GKS Ada	Known as ISO DP 8651/3. Second DP ballot closed in April, 1986.	ANS x3.124.3-198x. Public review closed in 1986.
GKS C	Not yet an ISO standard language. WD available now (SC21/N669).	ANS X3.124.2-198x. Public review will be finished by October,1987.
GKS-3D	Known as ISO DP 8805. Second DP ballot closed in March 1986.	Public review finished in 1986.
GKS-3D Fortran	Known as ISO DP 8806.	Public rewiew finished 1986.
GKS-3D Pascal	Not yet available.	
PHIGS	WD finished in 1986.	ANS X3.144-198x. Second public review finished in 1987.
PHIGS Fortran	WD available. (SC21/N667)	Second public review finished in 1987.
PHIGS Ada	WD available. (SC21/N819)	Public review finished in 1986.
CGM (former VDM)	IS 8632 published in 1987.	ANS X3.122-1986 published in 1986.
CGI (former VDI)	DP began in 1986.	ANS X3.161-198x. Public review finished in Juny, 1987.

4. THE PLACE OF THE GRAPHICAL STANDARDS IN THE GRAPHICAL SYSTEM

Six known standards (suggested or accepted) could be devided into **three chategories** /DEUS84/:

1. **Core, GKS, and PHIGS** represent an **aplication programming interface** (API). This API standards are usually implemented as a set of the external procedures and an application programmer could link them into his application code.
2. **IGES and CGM** are used by **transfering and storing** the graphical information.
3. **CGI** represent an **graphical device interface.**

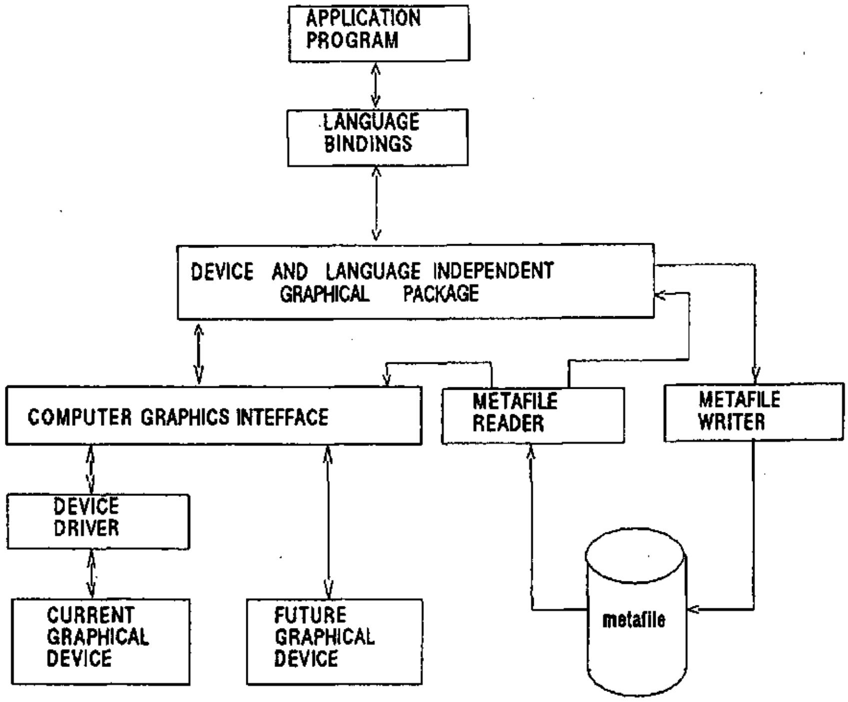

Figure 3. Interfaces of the graphical system

These tree classes could help us by defining common features of current and future standards with regard on performance, price, and usefulness of graphical software and hardware. A comparison and valuation of the graphical standards is not easy, because the majority of them are very complex and because they are comming from different areas. Figure 3 gives a review of the standard graphical interfaces.

The most important part of each language and device independent graphical system is a member of the GKS standards family. These are GKS (Graphical Kernel System) or its 3D extension or a standard for dynamical manipulation with graphical data structures PHIGS (Programmer's Hierarchical Interactive Graphics System). Functions of graphical system are exactly defined by these graphical standards and because of this reason they are also called **functional graphical packets.** They are completly language and device independent.

An aplication programmer is able to access functions of these packets through a **language binding.** It has to adopt language independent functions of graphical packet to design and particularities of each high level program language (ada, C, pascal, fortran, basic).

The communication between a language and device independent graphical packet and graphical workstations is controled by CGI (Computer Graphical Interface). This standard defines functions and format for this communication.

Current graphical devices are not able to receive the CGI format and interpret its functions directly yet, so drivers are needed. But **next-coming graphical devices** are going to be driven by CGI format directly.

In capturing, storing, and transfering of graphical information standard CGM is involved (Computer Graphical Metafile). Pictures are saved into **metafiles,** and are captured from functional graphical packet by **metafile generator.** The metafile contents is interpreted by **metafile interpreter.** Metafile could be interpreted directly by CGI or by functional graphical packet (GKS has particular types of workstations intend for manipulation with metafiles).

In presentation of interfaces of graphical system many authors mark also **connective links** between individual interfaces. They call them interfaces, too. Connective link presents a set of all functions, which the interface on the higher level of hierarhy of graphical system can access from the interface, which is lower.

For example: A connective link between a language binding and a aplication program is an exact declaration of all functions, which aplication programmer can include in his programs. There are declarations of all parameters and their types, which are used in the functions.

5. GRAPHICAL STANDARDS AND THEIR POSITION IN CAD SYSTEM

The most important aplication area of computer graphics is certainly CAD. Graphical system in the CAD system has to care about:

- the graphical presentation of constructed objects and
- about the graphical interaction with an user.

If figure 3 is extended for a CAD aplication, a structure of CAD system is reached and it is shown on figure 4 /ENDE86/. Older CAD systems have been usually put into only one product. Individual pieces of them have been neither evident neither accessible by the user. Trends of next-coming CAD systems are to make the graphical system visible also to the user, so that he could add different graphical devices and transfer graphical data between different graphical systems. But this is possible only, if a graphical system consists of the standard interfaces.

A core of a CAD system includes functions for modeling, presenting, calculating of constructed models, and a modul for interactive dialog with an user. The most important part of a CAD system is a CAD data base, which saves all information about created objects. A core of a CAD system is only a superstructure of the graphical system, which takes care about objects presentation on graphical devices and for graphical interaction with its standard interfaces. A modern CAD system has his own program's interface. So an user can reach the functions of the CAD system from high level program language and has an opportunity to solve and to present his own specific demands.

An exchange of data constructed by core of the CAD system (data are not only graphical) between systems of different supliers could be done by standard CAD data interface. The first such standard is IGES (Initial Graphics Exchange Specification), but just now more new exchange data formats is being developed (PDES, PDDI, SET, STEP) /CAD85, ENDE86, WILS87/.

6. CONCLUSION

All problems of device-dependent graphical software have been solved with introducing the graphical standards. The suppliers of graphical hardware and software are aware of this and today some of these standards are accessible even on PC computers (for example GKS level 2b).

In regard of development phases of graphical standards and their language bindings we can expect, that all GKS language bindings (with exception the language bindings for C, because it is not a standard language yet) will become the international standards in a short time.

The basical request for GKS-3D is fully compatibility with GKS. Currently, there are discusions about compatibility among PHIGS and GKS. It seems, that there will not be a compatibility at all, because GKS uses only one-leveled graphical data structure (segments), while on other hand PHIGS manages with hierarhical data structures, which are suitable for presenting the graphical models. PHIGS is intended for time-demand applications and so it more than likely will not be available on PC computers.

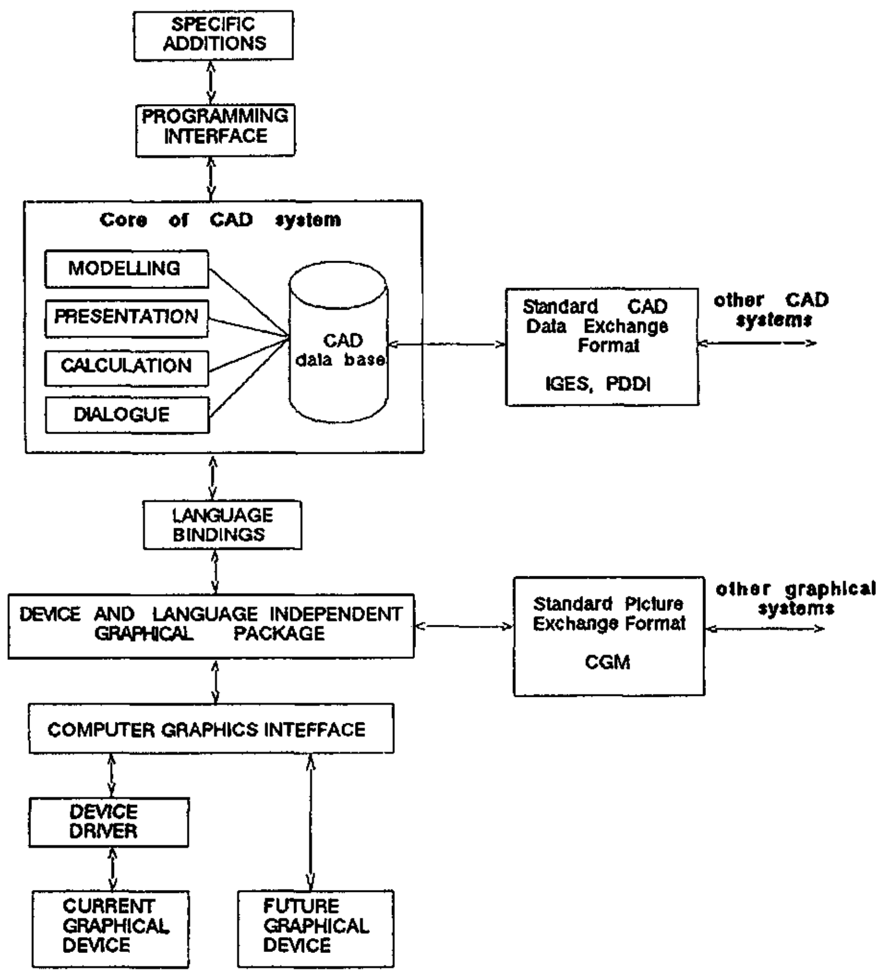

Figure 4. A place of the standards in CAD system

CGM has already become an international standard in its elementary version. The work is proceeding now on an expansion of CGM, that it could support also GKSM (GKS metafile) format (this is format in which GKS saves graphical information through logical workstation MO and MI).

The evolution of CGI has been already started. There is a long way until CGI as an international standard will be accepted, because this standard should not limiting the development of the graphical hardware. So we can expect a great interest and influence of manufacturers of the graphical hardware.

References

BONO85 Bono, P.R., "A Survey of Graphics Standards and Their Role in Information Interchange", IEEE Computer, Vol. 18, No. 10, October 1985

BONO86 Bono, P.R., "Guest Editor's Introduction Graphics Standards", IEEE CG&A, Vol. 6, No. 8, August 1986

CAD85 CADCAM Communications, "A Practical Guide to Exchanging CADCAM Data Using the IGES Format", Department of Trade and Industry, 1985

DEUS84 Deusen, E., "Graphics Standard Handbook", CC exchange, Laguna Beach, 1984

ENDE84 Enderle, G., K. Kansy, and G. Pfaff, "Computer Graphics Programming", Springer-Verlang Berlin, Heidelberg 1984

ENDE86 Enderle, G., "Interfaces for Storage and Communication of Computer Graphics Information", from the book Hopgood,F.R.A, R.J.Hubbold, and D.A. Duce,"Advaces in Computer Graphics", Eurographics Seminars, Springer-Verlang, Heidelberg, 1986

SELE87 Selective Update: "Two draft standards available for public review", IEEE CG & A, Vol.7, No. 3, Mach 1987

STRA86 Straayer, D.H., "Setting Standards", Computer Graphics World, November 1986

WILS87 Wilson, P.R., "A Short History of CAD Data Transfer Standards", IEEE CG&A, Vol.7, No. 6, June 1987