THE GRAPHICS FUTURE IN SCIENTIFIC APPLICATIONS

- Trends and developments in computer graphics -

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ABSTRACT

Computer graphics methods and tools are being used to a great extent in scientific research. The future development in this area will be influenced both by new hardware developments and by software advances. On the hardware sector, the development of the raster technology will lead to the increased use of colour workstations with more local processing power. Colour hardcopy devices for creating plots, slides, or movies will be available at a lower price than today. The first real 3D-workstations appear on the marketplace. One of the main activities on the software sector is the standardization of computer graphics systems, graphical files, and device interfaces. This will lead to more portable graphical application programs and to a common base for computer graphics education.

1. INTRODUCTION

In a scientific environment, computer graphics are used for a broad spectrum of applications, on a large number of different graphical devices, and using a variety of graphics software. The main application areas are:

- Data presentation: Data generated by experiments as well as by computer simulations have to be presented in a way suitable for interpretation by researchers. The presentations also serve for communications between different persons[1)].

- Modelling: The models used as input data for simulation programs are set up under visual control by the operator. The visual representation is an aid to control the validity of the models. Computer graphics also provide the basic tools for the communication with the interactive operator and for his guidance.

- Process control: In some areas of scientific work, complex processes have to be supervised and operated. Process control graphics helps in human perception of the state of the process, especially if the process is in an abnormal state.

- Picture processing and pattern recognition: Data obtained from observations of the objects of the scientific research are digitized and made available to numeric processing. At various stages of this process, a visual representation is generated for perception and judgment by the human user.

The large amount of data to be handled, and the high complexity of the data are main problems when computer graphics are used in scientific applications. The result of a single experiment can easily amount to several hundreds of thousands of data. The data are often structured in a way that an easily comprehensible graphical representation is difficult to find. For instance, the display of different three-dimensional time-varying vector fields in a complex geometry is a difficult problem.

Another problem is a more general one: Nowaday's computer graphics systems neither have a standard user interface nor a standard interface to graphical devices. Thus application programs using computer graphics are not easily convertible or portable between graphics systems, between different installations, or between different graphical devices.

2. MAIN AREAS OF DEVELOPMENT

The developments going on in computer graphics will have a major impact on the use of computer graphics in a scientific environment. Main areas of the current developments in computer graphics are:

- Hardware developments: The main drive will come from colour raster graphics devices, colour hardcopy devices, the increased local processing power available in graphical devices, and devices capable of generating real 3D images.

- Software developments: Here, the progress is governed by the development of standardized interfaces to computer graphics systems. Not only the graphical systems themselves, but also application systems based on them will become more portable.

- Both the increased procession power of the hardware and the development of standardized graphical systems will increase the use of interactive techniques in scientific applications of computer graphics.

2.1 Hardware developments

2.1.1 Colour raster devices

The capabilities of colour raster graphics devices are steadily increasing, while at the same time the cost/benefit ratio is decreasing. In the years to come, this type of displays will in many cases replace the storage tube type displays. The resolution of the display monitors has reached about 1000 x 1000 addressable and displayable points (picture elements, pixels) in commonly available devices. These pixels are refreshed at a rate of more than 30 times per second. Devices are equipped with fast parallel interfaces to the memory of the host computer, increasing the speed of picture generation considerably. The number of colours available for displaying pictures has increased at the same time. Devices that cost some ten thousand dollars can display 256 colours at the same time on the screen; these colours can be selected out of a range of more than 16 million possible colours. Continuously shaded objects can be displayed by such devices. Along with the increased resolution of the monitors and the increased memory capacity of the pixel store (leading to more displayable pixels in more colours), the local processing power of the devices is increasing. Microprocessors and random access memory, together with read only memory, allow for realization of complex functions in the devices themselves. Tasks like area filling, patterning or shading areas, generation of high quality text fonts, local segment store may be delegated to those more intelligent graphics devices. The local segment store for local transformation, change or deletion of segments, i.e., parts of pictures. Performing these functions locally reduces the amount of data that has to be processed and transmitted for picture generation and picture manipulation, and thus reduces the system response time for interactive applications.

2.1.2 Colour hardcopy devices

Along with the displays, hardcopy devices that can create colour hardcopies on paper, overhead transparencies, slides and motion pictures, will be available at a much lower price than today. Up to few years ago, the only colour hardcopy devices were expensive microfilm recorders. They are still used for high quality picture presentations on film or microfilm. For creating computer generated movies or slides, they offer the highest quality possible. However, their high price allows their use only in large computing centers. Lately, hardcopy devices have been developed for usage together with raster colour hardcopy devices, that copy the screen image onto paper or film. The range of such devices begins with the colour printers; they have few (four to six) colours and low resolution. The technology used is either needle-printing with a multi-colour ribbon, or multi-colour inkjet printing. An inkjet plotter is available that creates poster-size shaded colour-drawings of high quality. The other type of hardcopy equipment uses the method of taking a photographic image off a black-and-white screen. With (at least three) different colour filters, three colour images are superimposed on the film, thus creating a colour image of high resolution. The black-and-white screen of the hardcopy device is driven by the video signal of a colour raster display device. A number of different films and cameras can be used. The major film types are: 35 mm film used with a normal reflex camera (both for prints and transparencies), 16 mm film used with a movie camera, 3'' and 8x10'' polaroid film, and 8x10'' transparent polaroid film. Polaroid film allows for instantaneous inspection of the generated pictures. More than one image can be placed side by side on one 8x10'' print. Fast generation of high quality pictures for presentation and documentation purposes, and the possibility to create animated movies at reasonable costs, is the main advantage of raster colour hardcopy systems.

2.1.3 Real 3D devices

In 1981, for the first time a real three-dimensional (3D) graphical display system that is commercially available was introduced. In Europe, the first presentation took place in September, 1983 [2]. For several years, display systems are on the marketplace that perform the reduction from 3D models (mostly wireframe models) onto a two-dimensional display surface in the device itelf, by hardware. The perspective projection is under complete operator control. Experiments have been conducted with pseudo-3D images where two images are produced from two viewpoints in two colours (red and green). The observer has to wear red and green glasses for the perception of the 3D image. With the new 3D system, no glasses are needed. Although black-and-white at present, it is only a matter of technology to present coloured 3D images. When the observer moves his head, he really looks at the images from a different viewpoint.

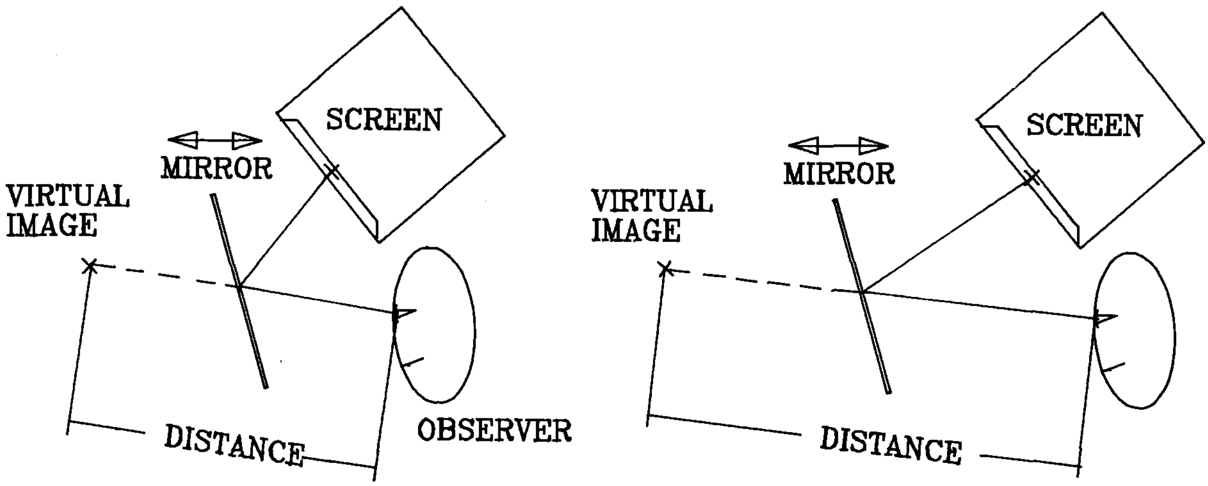

Figure 1: Principle of vibrating mirror 3D device

Because of the novelty of the display technique, the basic method is explained in the following. The user looks into a mirror that reflects the image of a plane 2D screen. The distance at which the observer sees the virtual image of the screen is determined by his distance from the mirror and the distance of the mirror from the screen (see Figure 1). If, while the screen and the observer stay at their place, the mirror is moved, both the distance observer-mirror and the distance mirror-screen will change, and hence the virtual image of the screen will vary in depth. The principle is simple: the mirror is moved back and forth 30 times per second, and for every deflection of the mirror, an image has to be created on the screen that shows those parts of the 3D model that correspond to the actual depth in 3D space. Since for every cycle of the mirror, i.e., in 1/30 second, a large number of 2D images have to be presented on the screen, an advanced technology is needed for the realization of the simple principle. Figure 2 shows the actual arrangement of screen and mirror. Instead of a plane mirror, a flexible mirror is used that is excited by a normal HiFi loudspeaker driven at 30 Hertz.

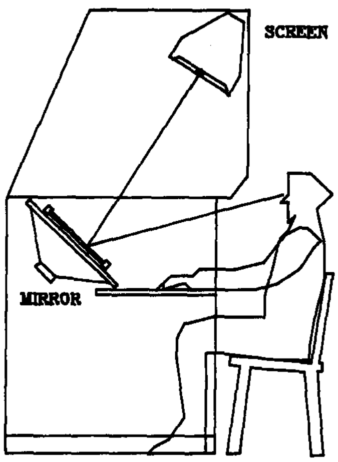

Figure 2: Configuration of 3D workstation (taken from [2])

2.2 Software developments

Here, the development is governed by the development of standardized interfaces to CG systems. Standardization has the following merits:

- The functional capabilities of a basic multi-purpose computer graphics system are described. This leads to the portability and device-independence of application programs based on the standard.

- Both the process of designing the standard and using it stimulated the development of a computer graphics methodology. The underlying model of a standardized system and the concepts applied designing it can only be defined and described on the base of such a methodology.

- Both the functional description of a computer graphics system and a computer graphics methodology needs a terminology accepted by all. The establishment of such a terminology facilitates the communication between researchers designing standards, implementers realizing such standardized systems, and users applying them for their applications.

- A standard puts computer graphics education on a sound common base. The number of concepts and systems that programmers have to learn will be reduced.

- Once a standard in an area is established, new developments and improvements can be compared to the standard, and the progress they make can be evaluated in the light of a present standard.

2.2.1 Graphical Kernel System

The Graphical Kernel System (GKS) is the first international standard for computer graphics [3]. It serves as a base for programming computer graphics applications. GKS covers the most significant parts of the area of generative computer graphics. It also lends itself for use with applications out of the areas of picture analysis and picture processing. GKS offers functions for picture generation, picture presentation, segmentation, transformations and input.

The main concepts of a graphics system are closely related to the tasks of such a system. Among these tasks are:

- generation and representation of pictures;
- routing parts of the pictures created in different user coordinate systems to different workstations and transforming them into the respective device coordinate systems;
- controlling the workstations attached to the system;
- handling input from workstations;
- allowing the structuring of pictures into parts that can be manipulated (displayed, transformed, copied, deleted) separately;
- long time storage of pictures.

An important aspect of a graphics system is the dimensionality of the graphical objects it processes. The current GKS standard defines a purely two-dimensional (2D) system. However, efforts are under way to define a consistent 3D extension. The major GKS concepts are outlined in the following sections:

Output

One of the basic tasks of a graphics system is to generate pictures. The concept corresponding to this task is graphical output. The objects from which a picture is built up are output primitives, given by their geometrical aspects and by the way how they appear on the display surface of a workstation. The way to present objects is controlled by a set of attributes that belong to a primitive (e.g., colour, linewidth). Certain attributes may vary from one workstation to the other. E.g., a line may appear on one workstation black and dashed, on the other one red and solid. These aspects of a primitive are called workstation-dependent attributes. In GKS, functions are present for the creation of primitives and for the setting of attributes (including workstation-dependent attributes).

GKS has output primitives that allow the convenient addressing of line graphics devices as well as special output primitives for addressing raster device capabilities. However, raster primitives will be displayed on line graphics devices as well; and line primitives will be displayed on raster devices. Line drawing primitives are: POLYLINE and POLYMARKER, the text primitive is TEXT, raster primitives are PIXEL ARRAY and FILL AREA, a special escape-primitive function is provided for addressing device capabilities, the GENERALIZED DRAWING PRIMITIVE (GDP). Figure 3 gives an overview over GKS primitives.

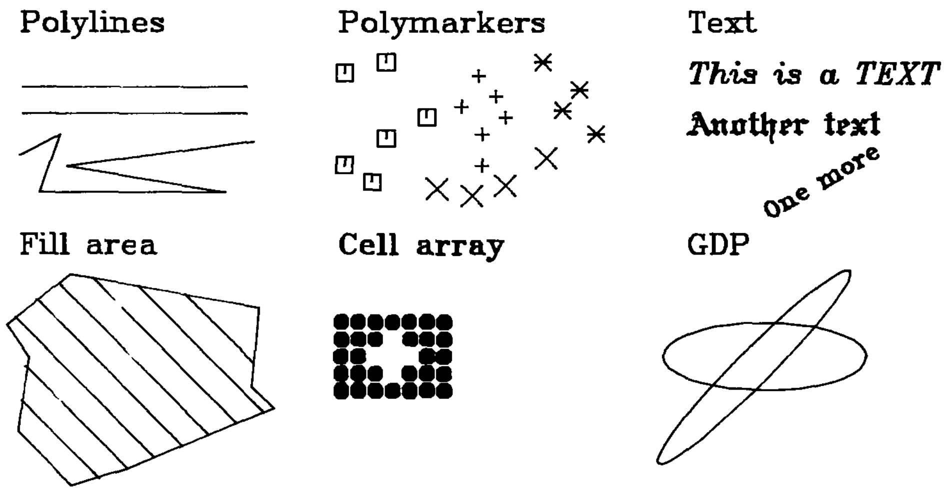

Figure 3: GKS output primitives

Coordinate systems and transformations

The application program can use one or several user coordinate systems that are related to the application for the creation of graphical elements. Output devices that are used for presenting the visual image of the elements, however, normally require the use of a device specific coordinate system. The routing and the transformation of output primitives along this output pipeline is performed by GKS. By using appropriate functions, the output transformations can be controlled by the application program.

Workstations

The output devices and several input devices are assembled into groups called graphical workstations. They usually are operated by a single operator.

A workstation is, e.g., a plotter or a display with a keyboard or a tablet connected to it. The workstation concept is one of the original contributions of GKS to the methodology of graphics system design. The graphical workstations of GKS are an abstraction of physical devices. An abstract graphical workstation can have one display surface and a number of input devices. Output can be sent selectively or in parallel to one or several workstations. Also, input can be obtained from different workstations.

Input

With input, the new dimension of interactivity is added to GKS. The actions of pointing, selecting, sketching, placing or erasing in a direct manner and the instantaneous system response to these actions are truly adapted to the human way of dealing with his environment.

Besides input that is specific for graphical applications (coordinate data or the identification of a part of the picture), GKS also handles alphanumeric input, choice devices like function keys, and value-delivering devices like potentiometer dials. GKS handles input in a device-independent way by defining logical input devices. Each logical input device can be operated in one of three different operating modes (REQUEST, SAMPLE and EVENT). Depending on the mode, input values can be entered by the operator and passed to the application program in different ways: one value at a time, requested by the application program and supplied by an operator action (REQUEST); sampling an input device irrespective of an operator action (SAMPLE); and input values collected in a queue by operator actions (EVENT).

Segmentation

The task of manipulating parts of the pictures leads to the concept of segmentation. A picture is composed of parts called segments that can be displayed, transformed, copied, or deleted independently of each other. Segments can be identified by an operator and their identification passed to the application program. GKS contains a very powerful segment facility, primarily by providing a device-independent segment storage, together with functions for copying segments to workstations or into other segments.

Metafile

The metafile concept results from the need to store pictures for archiving purposes or for transfer to a different location or different system. GKS addresses a metafile called GKS metafile (GKSM) that allows for long-term storage and retrieval of pictures. The metafile interface of GKS adds considerably to the flexibility of the system.

As part of the standard, the GKS document contains a definition of the interface to and from the GKSM. The contents and the format of the GKSM are described in an appendix that is not part of the standard. This separation was done in order to allow for a development of standardized graphics metafile independently of specific systems or devices.

Error handling

GKS contains an error handling facility. All errors expected during system operation are listed. A standard error handling procedure is provided. However, the user can replace it by his own error handling.

GKS levels
The GKS standard defines a powerful computer graphics system that includes output, input and segmentation. In many cases, not all of these facilities are needed within an application area. For this reason, a number of hierarchically ordered subsets, called GKS levels, have been defined. The lowest level merely offers graphical output, very much on the level of the widely used plotter-packages.

2.2.2 3D graphical system

For the majority of computer graphics applications a 2D-system, as GKS in its present form, will be sufficient. All output and input coordinates are two-dimensional. Some applications, however, require 3D-output primitives, like lines or areas in 3D-space, or even 3D-coordinate input.

Now, as the 2D GKS is a draft international standard, it seems that a straightforward extension of GKS to three dimensions (3D) is possible and desirable. Therefore, the ISO working group TC97/SC5/WG2 "Computer Graphics" decided on its Spring '82 meeting that:

"ISO TC97/SC5/WG2 recommends that a 3D subgroup be established with the following terms of reference:

a) to prepare a document setting out the scope, purpose, goals and underlying model of a 3D graphics standard that is an extension to GKS, by October 1982.
b) to start the process of obtaining a work item and a sponsoring body in November 1982.
c) to prepare a document setting out an outline of the functionality of such a standard, by February 1983".

Meanwhile the subgroup has started its work, first models for a 3D GKS-extension have been designed discussed. It can be expected that a 3D computer graphics standard will be available in 1984.

2.2.3 Graphics metafiles

2.2.3.1 Introduction

Graphics metafiles have been used since considerable time for storing and transmitting pictures. During the last years, efforts have been started to standardize graphics metafiles. Main reasons using graphics metafiles are:

- The graphics data must be displayable on a number of different display devices. The user wants to be able to choose among different plotters, output on microfilm or display screens for the representation of his pictures.

- Graphics data must be retainable for later use. They must be stored in a device independent way, so that the output device can be chosen after the generation of the data.

- Graphics data must be transportable, both by transmitting them over lines and by transporting a storage medium, e.g. a magnetic tape.

- Several sources of graphics data exist in most computing environments. Pictures produced as the result of picture processing techniques, of simulation computations or experimental records, using a number of different graphics packages, have to be merged into a uniform representation.

- Finally, some way must be provided for editing graphics data that have previously been produced and stored. Editing means: changing, deleting or adding parts of pictures, modifying the visualisation of parts of pictures, and merging of pictures.

The main impact of graphics metafiles results from the fact that they are able to interconnect various graphical devices and graphics systems in a standardized and straight-forward way. They allow cost-efficient use and sharing of expensive graphical equipment.

2.2.3.2 Proposals of graphics metafiles

In many application areas a variety of graphics metafile formats is being used, together with different graphics systems, and on different levels of functionality. The spectrum reaches from very simple, but very general designs containing few graphics primitives and attributes, to very sophisticated data formats for specific application areas. Examples for recent graphics metafile proposals are:

- GKS metafile, developed together with GKS by the DIN-subcommittee "Computer Graphics" since 1977;

- GSPC metafile, developed by the "Graphics Standards Planning Committee" of ACM-SIGGRAPH, 1979 [4];

- Telidon, a graphics metafile format for routing graphical data to television sets connected to the VIDEOTEX-network, developed by the Canadian Department of Communication, 1980 [5],

- AGF-plotfile, a graphics data exchange format developed by German research centers (and used as the base for the GKS metafile), 1976 [6].

The GSPC metafile, the Videotex metafile, the AGF plotfile as well as lower levels of the GKS metafile are very basic formats for the description of pictures. Another metafile standard that is not a graphics metafile, but a product definition data file for the CAD/CAM field is IGES (Initial Graphics Exchange Specification), developed under the supervision of the US-National Bureau of Standards, ANSI-Standard 1981 [7].

It provides a very complex, application oriented schema for describing CAD/CAM design objects together with their attributes and properties. Although IGES contains graphics entities, the scope of IGES was considered to be sufficiently distinct from the scope of graphics metafiles that up to now both developments were independent of each other. However, CAD-files will sure have an influence on the development of graphics metafiles in the future.

Within the International Standardization Organisation (ISO), working group TC97/SC5/WG2 "Computer Graphics", a metafile subgroup started work on standardizing a graphics metafile. The goal is to create a system-independent graphics metafile that can be used with a wide range of systems and devices. The subgroup can base its work on experiences with various metafiles and with GKS and its metafile. However, the most impact will come from the metafile group of the American National Standards Institute, ANSI X3H33. This group is currently developing a national US standard for a metafile called "Virtual Device Metafile, VDM"[8]. X3H33 is cooperating with the WG2 metafile subgroup; a joint effort has been started to reach an international metafile standard.

The current situation:

- ANSI X3H33 was encouraged to cooperate with WG2, to consider proposed changes to the current VDM draft, and to submit its work to WG2 by the end of 1982;

- agreement was reached to concentrate on a "Basic Metafile" that contains the basic functionality. The minimal set of required functions for a metafile was identified. Later, more complex metafile levels or additional modules can be defined;

- a formal grammar for graphics metafile was sketched, that gives a formal definition of the metafile structure, allows for generation of metafile parsers, and offers a framework for extensions;

- it was agreed that a metafile standard may have different bindings, i.e. coding formats and physical file formats, but that at least one binding should be specified as part of the standard. This could serve as a general communication format.

Based on the latest VDM-proposal and on the suggestions of the WG2-subgroup on metafiles, X3H33 will submit a proposal for a basic device- and system-independent metafile to WG2. I see no major obstacles for processing this proposal into an international standard. However, for higher levels of metafiles, the areas of intersection with other standards (e.g., IGES, OSI[9]) will become larger, and thus agreements will be more difficult to achieve.

Metafiles are the means for transmitting pictures to different locations and devices within a network. With the evolution of both local area networks (LANs) and globe-spanning international networks, a metafile standard becomes an essential tool.

2.2.4 Device interfaces

Whereas GKS defines the application interface of a computer graphics system, the interface between the graphics system and different graphical devices is not yet standardized. This interface is called "Device-independent/device-dependent interface" (DI/DD) or "Virtual device interface" (VDI). GKS and its interfaces are shown in Figure 4.

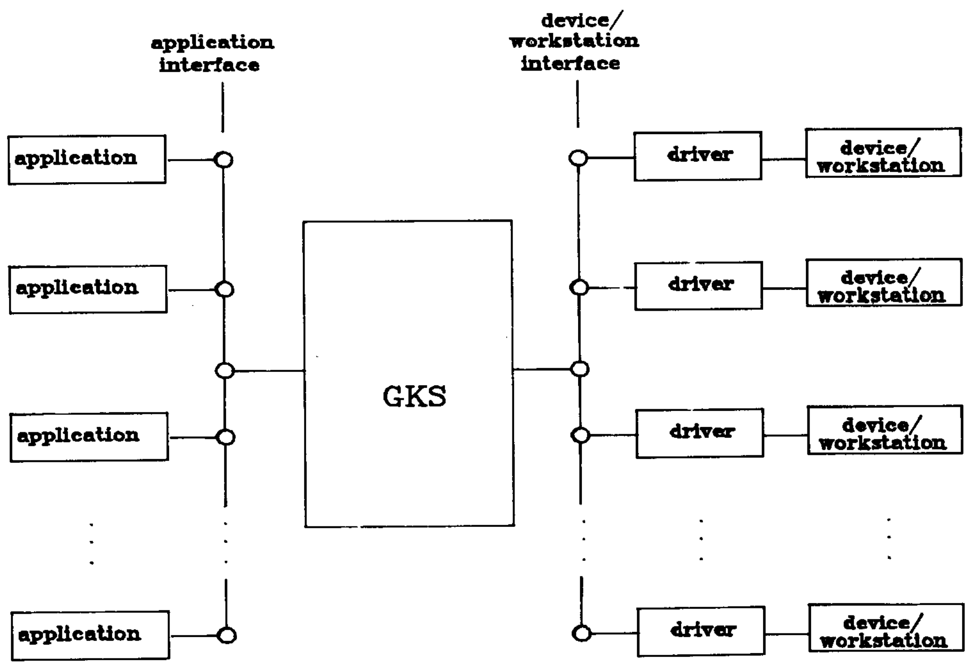

Figure 4: GKS interfaces

The DI/DD interface separates all device-independent parts of a GKS implementation and those parts that are specific for a particular device type. The adaption of the information flowing over the DI/DD interface (in both directions) to the requirements of the hardware, firmware, and software on a device (or workstation), is performed by the device drivers, or workstation drivers. If such an interface could be standardized, computer graphics applications were not only portable on the application interface level, but also plug-compatible at the DI/DD interface. The design of drivers could be standardized and thus greatly facilitated. Also, when graphics systems (presently: GKS) are to be validated and certified, automatic tests could be performed at a standardized DI/DD interface. Addressing a large number of different graphical workstations in a network would be easier if all these devices could use the same DI/DD protocol. Two groups are working on a standard at the DI/DD-interface: A certification working group sponsored by the EEC that bases its work on a GKS DI/DD interface designed by DIN, and ANSI committee X3H33, working on a VDI proposal that is to be used with a range of different graphics systems. In this field, too, international cooperation should lead to one standard supported by all. The expected time frame extends into the year 1984.

3. INFLUENCE ON SCIENTIFIC APPLICATIONS

All the developments, both in the hardware and the software field, will have an influence on the application of computer graphics in a scientific environment. The main trends that can be expected are summarized in the following sections.

3.1 Influence of the hardware developments

The hardware development will result in more colour, mainly in data representation graphics. Using colour opens a new dimension for displaying large amounts of complex data. Representations built up from lines will be augmented by representations built up from coloured areas. Main benefits from colour will be in the enhancement of human perception of data representations and of model images. For the display of transient processes, computer generated movies will be generated easier and cheaper and thus their use will increase. For some application areas, the use of real 3D devices for visualisation of 3D objects will start.

3.2 Influence of the software developments

The new graphical standards will place CG programming on a sound, uniform base. The GKS standard describes the user interface of a CG system that is capable of interfacing to the whole range of graphical devices, from simple plotters to highly interactive workstations.

Using a standardized CG system that addresses different devices in a uniform way, and using a standardized programming language, will make application programs using CG more easily portable and adaptable to different devices.

Since the programmers are trained using the standardized system (just as they are used to a programming language), programming and changing programs will be easier and faster.

Using a standardized data format for the storage and the transportation or transmittal of pictures will ease communication of graphical data between different institutions. The integration of standardized picture exchange procedures into the forthcoming local, national and international computer networks is under way.

3.3 Interactive computer graphics

Both the hardware advances, offering more local processing power and faster interactions at a lower price, and the GKS standardization, allowing to control user interactions in a standardized and device-independent way, will increase the use of interactive graphics. Interactive graphics need resources such as: readily available graphical workstations having bright, flicker-free, high-resolution displays and versatile input devices, reasonable (better: fast) response times and picture generation times, and high quality hardcopy devices. These resources are the base for the development of user-friendly application programs available on different computers and different workstations. The tools are available, and this will stimulate the spreading of interactive techniques.

4. COMPUTER GRAPHICS IS A COMMUNICATION MEANS

Computer graphics is a communication means. The future of computer graphics in scientific applications will, hopefully, ease and increase communication. Of course, the first thought will be the communication between computer and man. Computer-generated graphical output enhances the perception of computer generated data by the human user. With interactive techniques, man-computer communication goes in two ways, and with this kind of communication improved, the tool "computer" can be applied in a more efficient and pleasant way.

Computer graphics can, and will, also improve communications between men. A scientist can present the data he is dealing with by computer graphics methods in a better comprehensible way. Presentation and discussion of scientific results between different researchers working in one field is greatly facilitated by computer graphics presentations. Even more important is the potential benefit from computer graphics for overcoming the communication gap between the scientists and the "normal" citizen. The more complex and extensive the scientific and technological developments get, the more important becomes the dialogue across the borders of the scientific environment. Computer graphics are providing one tool that can help to reach this goal.

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QUESTIONS

DR. U. WAMBACH GSI/6100 DARMSTADT

- Q ---> What are the present day chances, that the American manufacturers will support GKS as a standard?
  Comment added: There are press releases indicating the formation of a working association (INTEL, DEC, TEKTRONIX) which does not support GKS.

- **A ---> They are present in GKS presentations; but only the future will tell. As soon as ANSII sets the standard they might follow.**

MR. PH. GAVILLET CERN

- Q ---> Can you tell where the GKS software package is likely to sit. In the intelligent graphics environnement or in a Main-Frame?

- **A ---> Can be on either one, depending on the local situation and user needs.**

MR. R. BOCK CERN

- Q ---> Does GKS emphasize the area of simple user interface in the standard? It seems that the powerful digital - to - analogue device, graphics, suffers seriously from the fact that special skills are necessary for its use. Skills which casual users are not ready to acquire repeatedly.

- **A ---> The standard foresees user interfaces, but some learning will be necessary to make use of its facilities. Real ease of use could be achieved only by restricting the freedom of representing internally the relevant user data.**

MR. M. TURNILL BNOC GLASGOW

- Q ---> Can the GKS standard cope with hardware designers who have more ideas for implementation

- **A ---> Yes, for about 5 years from now!**

MR. W. MITAROFF INST. F. HOCHENERGIEPHYSIK VIENNA

- Q ---> GKS is a breakthrough by defining for the first time a world-wide standard for a device-independent graphics package. But such packages have been existing before, e.g. the GD3 system for more than 10 years at CERN. That package has a

rather limited applications program interface (reflecting the capabilities of graphics devices from a decade ago), and achieves device independence by a metafile at the lowest level.
1) How does GKS achieve device independence when being able to support both "intelligent" and "dumb" graphics devices?
2) How does GKS, with its sophisticated applications program interface, avoid blowing up the memory space of the program it is supporting?

- **A ---> 1) GKS has a very flexible device interface - the workstation interface. Conceptually, every workstation looks to the application program like a very intelligent workstation. If the real workstations are intelligent, GKS will just pass functions down to them, e.g. "TRANSFORM SEGMENT NO i". For dumb workstations, GKS will have to simulate the workstation above the workstation interface, e.g. "clear screen, redisplay all segments (including the transformed one)".**
2) First, GKS has properly defined subsets that are hierarchically ordered. So, for simple applications, the lowest GKS level with just output and output attributes can be used.
Secondly, the implementer has to design the system in such a way, that an application program using only a few functions is not burdened by system functions that are not used.