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## Information processing systems — Computer graphics — Graphical Kernel System for Three Dimensions (GKS-3D) functional description

**iTeh STANDARD PREVIEW**

*Systèmes de traitement de l'information — Infographie — Système graphique de base pour  
trois dimensions (GKS-3D) description fonctionnelle*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8805 was prepared by Technical Committee ISO/TC 97, *Information processing systems*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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# Information processing systems - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) functional description

## 0 Introduction iTeh STANDARD PREVIEW (standards.iteh.ai)

The Graphical Kernel System for Three Dimensions (GKS-3D) provides a set of functions for:

- a) definition and display of 2D and 3D graphical data;
- b) storage and manipulation of graphical data;
- c) input of graphically related data.

The main reasons for introducing this International Standard for computer graphics is:

- d) to allow application programs involving graphics to be easily portable between different installations;
- e) to aid the understanding and use of graphics methods by application programmers;
- f) to serve manufacturers of graphics equipment as a guideline in providing useful combinations of graphics capabilities in a device.

In order to reach these main objectives, the GKS-3D design was based on the following requirements:

- g) GKS-3D should include all the capabilities that are essential for the whole spectrum of graphics, from simple passive output to highly interactive applications.
- h) The whole range of graphics devices, including vector and raster devices, microfilm recorders, storage tube displays, refresh displays and colour displays should be controllable by GKS-3D in a uniform way.
- i) GKS-3D should provide all the capabilities required by a majority of applications.

These requirements were used to formulate a number of principles that were used to judge specific design alternatives. Thus it was possible to contribute to the overall design goals while focussing on certain aspects. Five design aspects were identified, each having a group of principles

- j) Design goals: The following principles should not be violated by any technical design:
- 1) consistency: the mandatory requirements of GKS-3D should not be mutually contradictory;
  - 2) compatibility: other standards or commonly accepted rules of practice should not be violated;
  - 3) orthogonality: the functions or modules of GKS-3D should be independent of each other, or the dependency should be structured and well defined.
- k) Functional capabilities: The following principles were used to define the extent of GKS-3D:
- 1) completeness: all functions that a majority of applications want to use on a given level of functionality should be included;
  - 2) minimality: functions that are unnecessary for applications of a given level of functionality should not be provided;
  - 3) compactness: an application should be able to achieve a desired result by a set of functions and parameters that is as small as possible;
  - 4) richness: a rich set of functions offers an extensive range of facilities that stretches beyond the basic functions and includes higher order capabilities.

It is obvious that there is a trade off between the principles in this group. Therefore, the functions of GKS-3D are organized in nine levels. An implementation of GKS-3D provides precisely the functions of one of these levels. While the lowest level contains only a minimal set of functions, higher levels are allowed to extend beyond the basic needs towards greater richness.

- l) User interface design: The following principles were used to define the user interface design:
- 1) user friendliness: GKS-3D should allow the design of a desirable user interface;
  - 2) clarity: the concepts and functional capabilities of GKS-3D should be easily understandable, especially by the application programmer;
  - 3) error handling: failure of system functions or modules, caused by errors of the system itself or by the application program, should be treated in such a way that the error reaction is clearly understandable and informative to the application programmer and that the impact on the system and the application program is as small as possible.

Clarity and sound error handling are essential parts of user friendliness. Error handling is an integral part of GKS-3D. To aid clarity, the system and its state can be presented to the user in an easily comprehensible manner.

Clarity applies not only to the system design but also to the system description. To this end, the GKS-3D specification is divided into a general description, a description of the underlying logical data structures representing the state of the system, and a description of the functions and their effects on these data structures.

- m) Graphics devices: The following principles are associated with the range of graphics devices that can be addressed by GKS-3D:

- 1) device independence: GKS-3D functions should be designed to allow an application program, using these functions, to address facilities of quite different graphics output and input devices without modification of the program structure;
- 2) device richness: the full capabilities of a wide range of different graphics output and input devices should be accessible from the functions of GKS-3D.

These principles led to a fundamental concept underlying the GKS-3D architecture: the concept of multiple independent graphical workstations connected to and driven by GKS-3D. The application program can inquire the capabilities of every workstation. The GKS-3D design includes escape functions that are easily identifiable within an application program and can be used to access special facilities of a particular device.

## Introduction

n) Implementation: The last group of principles is related to the implementation of GKS-3D:

- 1) implementability: it should be possible to support the GKS-3D functions in most host languages, on most operating systems and with most graphics devices;
- 2) language independence: it should be possible to access the facilities of GKS-3D from all International Standard programming languages;
- 3) efficiency: GKS-3D should be capable of being implemented without time consuming algorithms;
- 4) robustness: the operator and application programmer should be protected in the best possible way from hardware or software failure of the system.

The five groups of principles are interconnected. For example, design goals and functional capabilities both contribute to user friendliness. Efficiency is also important when considering response time in an interactive environment. Some principles may be conflicting, such as richness versus minimality, comprehensive error handling versus efficiency, and compactness versus device richness. Compromises needed to be made to achieve the overall design objective: GKS-3D should have an easily comprehensible structure and a set of functions that enables a vast majority of computer graphics users to design portable, device independent application programs addressing the whole range of computer graphics equipment.

o) Relationship to ISO 7942: This International Standard adheres to the following design goals with respect to ISO 7942:

- 1) the relationship between the functions in ISO 7942 and the functions described in this International Standard should be precisely defined and not be implementation dependent;
- 2) the format of functions and their parameters in ISO 7942 will remain unchanged in this International Standard;
- 3) additional functions will be added solely to support the new 3D functionality.

p) Compatibility of Application Programs: a major goal of this International Standard is that application programs written using the functions specified in ISO 7942 will run without modification on implementations conforming to this International Standard and produce the same results on workstations of the same type, subject to the allowable differences as detailed in Annex D. However, it is recognized that in certain situations, especially involving the use of metafiles, this goal cannot always be achieved (see Annex D for further details).

q) Relationship to ISO 9592: This International Standard has the following relationship to ISO 9592 (PHIGS):

The primary emphasis of PHIGS is different from that of GKS/GKS-3D. Unlike GKS/GKS-3D, PHIGS is not restricted to graphics and provides data structure definition and editing facilities which are not necessarily related to graphical output. PHIGS provides data structure facilities which can be rendered as graphical output, rather than being purely directed towards providing graphical output and interaction.

GKS/GKS-3D is oriented towards the direct output of graphical primitives grouped into segments, PHIGS provides data structures which are traversed to produce graphical output. However, the output primitives and their attributes generated at structure traversal time are almost identical to those of GKS-3D.

PHIGS provides the same underlying model of input as GKS-3D. The measure of the pick logical input device is extended to identify the structure element in the PHIGS Central Structure Store which generates the primitive picked by the operator.

Annexes C to H are given for information; they do not form part of the specification.

## 1 Scope and field of application

This International Standard specifies a set of functions for computer graphics programming, the Graphical Kernel System for Three Dimensions (GKS-3D). GKS-3D is a basic graphics system for applications that produce computer generated three dimensional pictures on graphics output devices. It supports operator input and interaction by supplying basic functions for graphical input and picture segmentation. It allows storage and dynamic modification of pictures. A fundamental concept in GKS-3D is the workstation, consisting of a number of input devices and a single output device. Several workstations can be used simultaneously. The application program is allowed to adapt its behaviour at a workstation to make best use of workstation capabilities. This International Standard includes functions for storage on and retrieval from an external graphics file. Also, the functions are organized in upward compatible levels with increasing capabilities.

This International Standard provides application programs with the capability to define and display 3D graphical primitives, specified using 3D coordinates. In addition, the GKS-3D input model provides 3D locator and stroke input.

The output primitives of this International Standard differ from the output primitives of ISO 7942 in the following ways:

- a) the polyline and polymarker primitives are defined by an arbitrary sequence of 3D coordinates;
- b) the text, fill area and cell array primitives remain planar, but may lie in a plane positioned arbitrarily in 3D space;
- c) the fill area set primitive is introduced.

Functions are provided in this International Standard to generate these primitives.

The functions of ISO 7942 can be used in this International Standard. However, the output functions generate instances of 3D primitives — instances that are constrained to lie in a plane. Furthermore, additional capabilities are provided in this International Standard to:

- d) specify views of 3D objects;
- e) obtain information from 3D input devices;
- f) permit workstations to perform hidden line/hidden surface removal (HLHSR).

This International Standard provides no specific functions for controlling such rendering techniques as light source, shading, texturing, and shadow computations. However, workstations may apply these techniques, locally as the primitives and attributes are realized, provided that the general guidelines of Annex D concerning allowable workstation differences are followed.

NOTE - For certain parameters of the functions, GKS-3D defines value ranges as being reserved for registration (see 4.1.2). The meanings of these values will be defined using the established procedures.

GKS-3D defines a language independent nucleus of a graphics system. For integration into a programming language, GKS-3D is embedded in a language dependent layer obeying the particular conventions of that language.

## 2 References

ISO 646, *Information processing - ISO 7-bit coded character set for information interchange.*

ISO 2022, *Information processing - ISO 7-bit and 8-bit coded character sets - Code extension techniques.*

ISO 2382/13, *Data processing - Vocabulary - Part 13: Computer graphics.*

ISO 6093, *Information processing - Representation of numerical values in character strings for information interchange.*

ISO 7942, *Information processing systems - Computer graphics - Graphical Kernel System (GKS) functional description*

ISO 8632, *Information processing systems - Computer graphics - Metafile for the storage and transfer of picture description information*<sup>1)</sup>

- Part 1 : Functional description.
- Part 2 : Character encoding.
- Part 3 : Binary encoding.
- Part 4 : Clear text encoding.

ISO/IEC 8806 *Information processing systems - Computer graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Language Bindings*<sup>2)</sup>

- Part 1 : FORTRAN
- Part 2 : PASCAL
- Part 3 : ADA
- Part 4 : C

ISO/IEC 9592, *Information processing systems - Computer graphics - The Programmer's Hierarchical Interactive Graphics System (PHIGS)*

- Part 1 : Functional description.
- Part 2 : Archive file format
- Part 3 : Clear text encoding of archive file

CIE Recommendations on colour space - supplement to CIE publication 15

CIE 1976 Supplementary standard colour metric of server and coordinate systems

1) Two addenda are being produced which support segmentation and three dimensions.

2) At present at the stage of draft; publication anticipated in due course.



### 3 Definitions

For the purposes of this International Standard the following definitions apply.

NOTE - As far as possible, commonly accepted graphics terminology is used.

**3.1 acknowledgement:** Output to the operator of a logical input device indicating that a trigger has fired.

**3.2 aspect ratio:** The ratio of lengths along the principal axes of an object.

**3.3 aspect source flag (ASF):** A flag indicating whether a particular workstation dependent aspect of a primitive is selected from an attribute bundle, or as an individual attribute selection.

**3.4 aspects of primitives:** Ways in which the appearance of a primitive can vary. Some aspects are controlled directly by primitive attributes, some are controlled indirectly through a bundle table. Primitives inside segments have an aspect controlled through the segment containing them, for example highlighting; primitives outside segments do not.

**3.5 attribute:** Attributes control the properties of output primitives and segments. There are four types of primitive attributes: geometric, non-geometric, viewing and identification. The geometric and non-geometric attributes control the values of aspects of primitives.

**3.6 back plane:** A plane parallel to the view plane whose location is specified as an N coordinate value in the view reference coordinate system. Primitives behind the back plane lie outside the view volume.

**3.7 baseline:** A horizontal line within a character body (see figure 3) which, for many character definitions, has the appearance of being a lower limit of the character shape. A descender passes below this line. All baselines in a font are in the same position in the character bodies.

**3.8 bundle index:** An attribute of an output primitive which is an index into a bundle table. It defines workstation dependent aspects of a primitive.

**3.9 bundle table:** A workstation dependent table specifying aspects of one or more output primitives. GKS-3D has polyline, polymarker, text, fill area, and edge bundle tables.

**3.10 capline:** A horizontal line within a character body (see figure 3) which, for many character definitions, has the appearance of being the upper limit of the character shape. An ascender may pass above this line and in some languages an additional mark (for example an accent) over the character may be defined above this line. All caplines in a font are in the same position in the character bodies.

**3.11 cell array:** An output primitive consisting of a parallelogram of equal sized cells, each of which is a parallelogram and has a single colour.

**3.12 centre of projection:** See Projection Reference Point (PRP).

**3.13 centreline:** A vertical line bisecting the character body (see figure 3).

**3.14 character base vector:** An aspect of text which defines the principal base direction of the text string. It is a two-dimensional vector in the text plane specified in the text output

**3.15 character body:** The rectangle defining the horizontal and vertical limits of an individual character.

**3.16 character expansion factor:** An aspect of text which specifies the deviation of character width from the defined nominal value.

**3.17 character height:** An aspect of text which specifies the nominal height of an upper case character.

**3.18 character set:** A registered interpretation for entries in the character code table (see ISO 2022).

## Definitions

- 3.19 character spacing:** An aspect of text which specifies the fraction of font nominal character height to be added between adjacent character bodies in a string.
- 3.20 character up vector:** An aspect of text which defines the principal up direction of the text string. It is a two-dimensional vector in the text plane specified in the text output function.
- 3.21 character width:** An aspect of text which specifies the nominal width of an upper case character.
- 3.22 choice device:** A GKS-3D logical input device providing a positive integer defining one of a set of alternatives.
- 3.23 CIE:** Abbreviation for the Commission Internationale de L'Eclairage. Used to refer to the CIE universal colour definition system used as a colour model.
- 3.24 CIE  $L^*u^*v^*$  colour model:** A colour model with an approximately uniform colour space for small colour differences and an associated colour difference formula. Its components are  $L^*$  (Lightness) and  $u^*$ ,  $v^*$  (Chromaticity). The coordinates of the associated chromaticity diagram are  $u^*$  and  $v^*$ .
- 3.25 CIE Tristimulus colour colour model:** A colour model allowing the description of all colours within the colour gamut by non-negative tristimulus colour values  $X$ ,  $Y$ ,  $Z$ .
- 3.26 clipping:** Removing those parts of output primitives which lie outside a specified volume.
- 3.27 clipping volume:** Either the normalization viewport clipping volume, the view clipping volume or the intersection of the two. The normalization viewport clipping volume is a rectangular parallelepiped in normalized device coordinates (NDC). The view clipping volume is in the viewing reference coordinate system and is defined by the window, front and back planes, and projectors of the corners of the window. Output primitives within these volumes will not be clipped. Parts of output primitives on the planes forming the edges of these volumes are considered to be within the volume.
- 3.28 colour model:** The method by which the application program describes a colour.
- 3.29 colour table:** A workstation dependent table, in which the entries specify the values defining a particular colour.
- 3.30 coordinate graphics; line graphics:** Computer graphics in which display images are generated from display commands and coordinate data.
- 3.31 device coordinates (DC):** A device dependent coordinate system. In GKS-3D, DC units are metres on a device capable of producing a precisely scaled image, and appropriate workstation dependent units otherwise.
- 3.32 device driver:** The device dependent part of a GKS-3D implementation that supports a physical graphics device. The device driver generates device dependent output and handles device dependent interaction.
- 3.33 device space:** The space defined by the addressable points of a display device.
- 3.34 display device:** A graphics device on which images can be represented. A display device is one possible component of a workstation.
- 3.35 display image; picture:** A collection of output primitives or segments that are represented together at any one time on a display space.
- 3.36 display space:** (1) That portion of the device space corresponding to the area available for displaying images. (2) The working space of an input device such as a digitiser.
- 3.37 echo:** The immediate notification to the operator of the current measure of a logical input device.
- 3.38 echo area; echo volume:** An area or volume, defined in device coordinates, which may be used for the display of a prompt or echo.