TECHNICAL MEMORANDUM

62

An introduction to GKS: The Graphical Kernel System

A. Ducrot and H. Watkins

Operations Department

August 1982

European Centre for Medium-Range Weather Forecasts
Europäisches Zentrum für mittelfristige Wettervorhersage
Centre européen pour les prévisions météorologiques à moyen

CONTENTS

ABSTRACT

The purpose of this short note is to provide a brief outline of GKS together with some information on the various international meetings which led to the adoption by ISO of GKS as a Draft Proposal. It is not intended as a rigorous guide to GKS, but merely an overview to make reading of the GKS document easier for the reader unfamiliar with the terminology. A glossary of abbreviations used in this note appears as an appendix.

1. INTRODUCTION

The standardisation of graphical software began with the workshop organised by IFIP's WG5.2 at Seillac in May 1976 (1). The workshop considered the grounds for and the objectives of a standard in the field of graphics. A number of problems (current position, entry (2), etc.) pointed to the need for clarification.

The most important result emerging from Seillac 1 was that a standard must include a clear distinction between that part dealing with modelling and that part dealing with display. In addition, the first objective would be to define a graphical nucleus which would allow for the display of an image described in terms of universal co-ordinates. Several working groups went on to design some software. The most comprehensive ones were those by GSPC (3) and DIN (4), known respectively as "Core system" and GKS. The major difference is that GKS is a 2D system and, therefore, considerably smaller than the "Core system".

In 1976, a committee of the British Computer Society suggested that GINO-F be proposed as a standard. As there was not a group within ISO SC5 to which this study could be entrusted, it was decided to set up such a group and that group became WG2. Its first meetings (1977, 1978) dealt primarily with organising the group. Its work would not actually commence until 1979. One committee was asked to study both proposals (GKS and GSPC) and to suggest any amendments which would render them compatible.

In June 1979, GSPC published its second report and was dissolved. Its work was taken up by ANSI X3H3.

At the following meeting (Budapest, October 1979), DIN submitted a new version of GKS 5.1, which incorporated a large number of the amendments required by WG2. NASI presented GSPC 1979 and Norway presented IDIGS. It was decided to start by studying GKS and then to consider another proposal when GKS would have reached the stage of a preliminary draft.

The three following meetings (Tiefenbach, June 1980, Melbourne, January 1981 and Abingdon, October 1981) were dedicated to improving GKS. At each meeting, more than thirty experts considered the various problems indicated by the members of WG2. More than seven new versions of GKS were produced.

At Abingdon, after a consensus was reached on all the remaining problems, WG2 asked SC5 to accept GKS as a preliminary draft standard and to submit it to the vote so as to reach the stage of draft international standard.

Therefore, the whole procedure was completed in five years, which is a relatively short time in this field of activity.

2. PRESENTATION OF GKS 7.0

We will now review some of the characteristics of GKS, with emphasis on the most original and the most controversial ones.

2.1 Graphical workstations and device-independence

One of the major improvements of GKS over its predecessors is the idea of a work station which enables it both to be independent from graphical terminals and to make optimum use of these terminals.

For example, it will be possible to display the same image with different graphical attributes on several terminals.

2.2 Graphical primitives

Images are described with the following primitives:

- polyline
- polymarker
- text
- fill area
- pixel array
- generalised drawing primitive

There are no current positions. There are many problems with current positions (see 5), one being that it implies that each primitive is not self-sufficient and is dependent on the others. The generalised drawing primitive is a graphical primitive which makes it possible to use certain types of software or hardware on a work station to generate curves, circles, etc.

2.3 Pens and attributes

Attributes associated with primitives were the subject of many difficult discussions.

Attributes are divided into two categories:

- geometric attributes, which are global and affected by display transformations.
- non-geometric attributes.

2.3.1 Non-geometric attributes

Non-geometrical attributes may differ from one station to another (on some terminals colours will be used to distinguish between two lines, on others different types of lines will be used). To allow for these differences without too much affecting the necessary device independence, the concept of pens was introduced.

The same primitive will be drawn with the same pen on all the active stations but the representation of that pen, that is the values of the attributes associated with that pen, will differ from one work station to another.

A pen is attached to each of the four following primitives:

Polyline:

- type of line (continuous, dashed, dotted, mixed, etc.)
- line thickness
- colour (index in the table of colours)

Polymarker:

- type of marker (., +, *, O, X, etc.)
- scale factor to be given to the marker
- colour

Text:

- font
- drawing precision (string, character, stroke or vector)
- colour

Fill Area:

- type of interior (hollow, solid, pattern, hatching)
- index associated with the type
- colour

There are no pens associated with the other two primitives. The pixel array has no particular attributes and the generalised drawing primitive uses the pen which would be used by those primitives capable of simulating it.

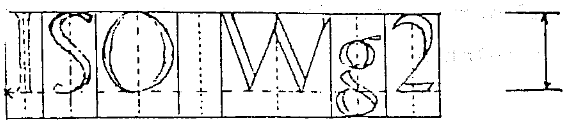
2.3.2 Geometric Attributes

Geometrical attributes concern texts and patterns. They are:

- character height
- character orientation (direction of character height)
- character spacing
- character expansion factor
- character path (left, right, up, down)
- origin of pattern
- size of pattern

Patterns and colours are managed by using the local tables in workstations. Colours are defined by their three components (red, green, blue) and patterns are tables with indices to the colour table.

The extensive range and the obvious complexity of the attributes are entirely justified by the fact that terminals capable of managing these attributes are beginning to appear and that applications are becoming increasingly demanding in respect of the quality of the image produced.

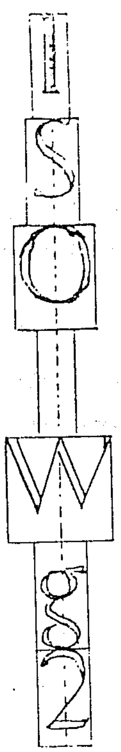


CHARACTER HEIGHT = 1.0, CHARACTER EXP. FACTOR = 1.0, CHARACTER SPACING = 0.0

CHARUP VECTOR = (0,1), CHARACTER PATH = RIGHT

CHARACTER HEIGHT = 0.5, CHARACTER EXP. FACTOR = 1.0, CHARACTER SPACING = 0.0

CHARUP VECTOR = (0,1), CHARACTER PATH = RIGHT



CHARACTER HEIGHT = 1.0

CHARACTER EXP. FACTOR = 1.0

CHARACTER SPACING = 0.0

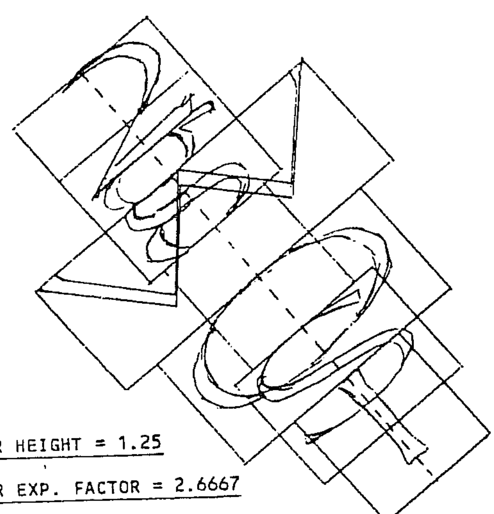
CHARUP VECTOR = (0,1)

CHARACTER PATH = DOWN

X text position

---- base line and/or centre line

cap line = top limit of body in these examples



CHARACTER HEIGHT = 1.25

CHARACTER EXP. FACTOR = 2.6667

CHARACTER SPACING = -0.3333

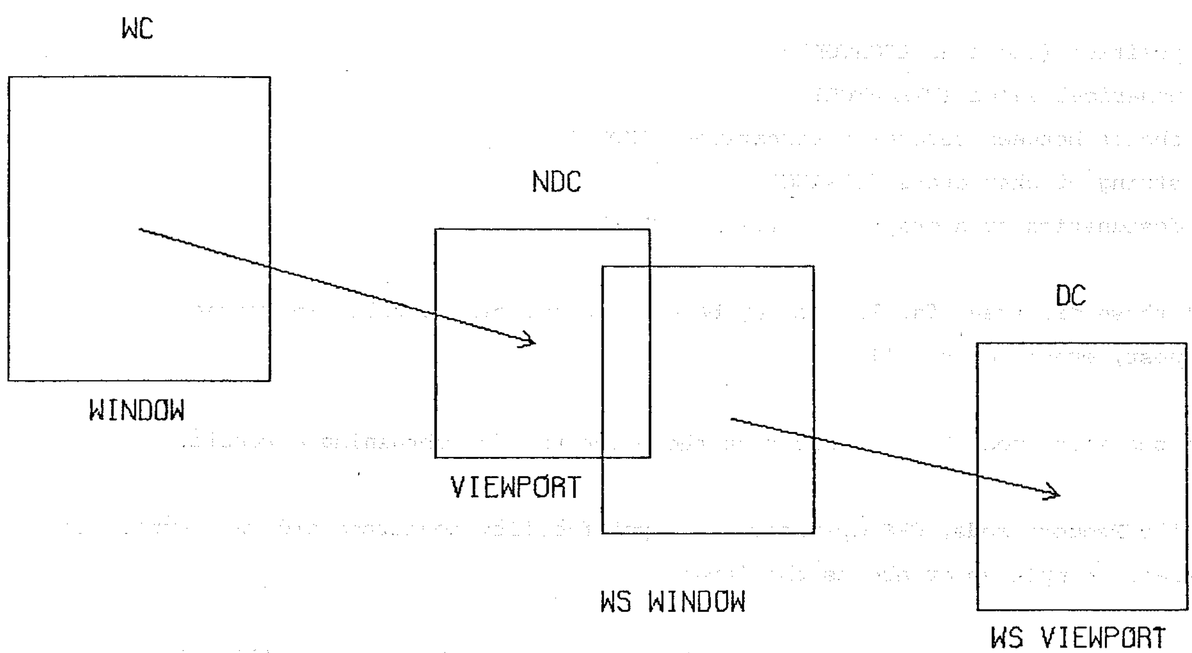
CHARUP VECTOR = (-4,-3)

CHARACTER PATH = UP

2.4 Display

Primitives are described in terms of world coordinates and displayed using the workstation's own coordinate system. Therefore, it is appropriate to define the transformation necessary to switch from one system to the other.

This is effected in two stages:



With these two stages, it is possible to achieve great flexibility and a better adaptation to the facilities provided by the graphical terminal being used. In addition, instead of having a single system of transformation between world coordinates (WC) and normalised device coordinates (NDC), it is possible to define several systems. Only one of them is active as output at a given moment but on the input of a position, the system locates the window containing that position and sends back the corresponding world coordinates. A system of priorities controlled by the program eliminates possible ambiguities.

2.5 Segments

Primitives may be either sent directly to the terminal (which means that they are lost when the screen is updated), or preserved in segments.

Segments may be created, deleted, made visible or invisible, transformed (translated, rotated, scaled, etc.), highlighted, made detectable or undetectable, renamed, inserted.

2.6 Input

This was a major cause of problems. In fact, although agreement was soon reached on the nature of logical input facilities to be provided in GKS, the operating model of these inputs was more difficult to determine. A satisfactory model, however, was presented at Abingdon.

Input facilities are provided for:

- position (known as LOCATOR)
- numerical value (VALUATOR)
- choice between several alternatives (CHOICE)
- string of characters (STRING)
- designation of a graphical element (PICK)

All these different facilities may be used in one of the following modes: request, event, or sampling.

The operating mode has an effect on the procedure for obtaining a result.

In the Request mode, GKS operates the input facility concerned and waits until the operator completes or aborts the input.

In the Sample mode, the value currently delivered by the input facility is returned without any action on the part of the operator.

In the Event mode, GKS maintains a queue containing the events which have arrived. The program may withdraw events from the queue in order of arrival.

2.7 Description of logical input facilities

A logic input facility includes measurement, trigger, initial value, Echo mode, and echo display zone, together with the necessary data for the echo.

Measurement is a value determined by the physical input facility or facilities necessary to carry out that function. Trigger is a physical input facility used to indicate a specific instant.

In the Request mode, the measurement returned is that at the precise moment when the user pushes the trigger. In the Event mode, when the user pushes the trigger, the measurement is stored in the queue together with the identification of the input facility. In the Sample mode, the current value of the measurement is returned.

2.8 Levels of implementation

Two orthogonal axes were defined: input and output. For each axis, three levels were defined:

- 0 Minimum output (no segments)
- 1 Basic output (segments)
- 2 Complete output (segments + specific station which enables them to be kept and inserted into other segments)

- a No input
- b Request mode only
- c Complete input (all modes)

which amount to 9 possible levels.

2.9 "Metafiles"

In addition, in order to enable images to be archived and transported between several sites, the necessary functions were defined for the management of specific graphical workstations enabling the writing and the reading of files. The format of these files is not defined in the GKS standard as it was found that the format differed according to the intended usage. This aspect is being studied by WG2 and should be the subject of further standards.

REFERENCES

1. Guedj, R. and Tucker, H, 1979: Methodology in Computer Graphics, North Holland.
2. Wallace, V.L., 1976: The Semantics of Graphic Input Devices, Computer Graphics, Vol. 10, 1, pp 62-65.
3. Status Report of the Graphics Standard Planning Committee, 1979, Computer Graphics, Vol. 13, 3.
4. GKS 7.0 ISO/TC97/SC5/WG2 N117
5. Hopgood, F.R.A., 1981: "GKS - the first graphics standard", Paper presented at the Seminar on "Graphical Applications in Meteorology", ECMWF 19-23 October 1981.

APPENDIX

Glossary of abbreviations used in this memorandum:

ANSI	American National Standards Institute
DC	Device Coordinates
DIN	Deutsches Institut für Normung
GINO-F	Graphics package from CAD Centre, Cambridge
GKS	Graphical Kernel System
GSPC	Graphics Standard Planning Committee
IFIP	International Federation of Information Processing Societies
ISO	International Standards Organisation
NDC	Normalised Device Coordinate
SC5	Sub-Committee 5 (see note below)
TC97	Technical Committee 97 (see note below)
WC	World Coordinates
WG2	Working Group 2 (see note below)
WG5.2	Working Group 5.2 (see note below)

Note

ISO is split into Technical Committees (TCs) such as TC97, which works on Data Processing. Each TC is split into various sub-committees (SCs), such as SC5 which (in the case of TC97) works on programming languages. In turn, each SC is split into working groups, such as TC97/SC5/WG2, which is concerned with graphics.

Other organisations have different schemes for splitting their work, e.g. IFIP WG5.2 (IFIP's working group on computer aided design).