ABSTRACT

Users of SAS/GRAPH software in Version 6 of the SAS System will find that most of their programs developed for Version 5 applications will run without modification. However, a number of new features have been implemented that expand the capabilities of the software. Along with these new features, Version 5 to Version 6 compatibility issues will be discussed.

INTRODUCTION

Some of the major enhancements that have been added to Version 6 SAS/GRAPH software include

- support for new device drivers, including Epson and IBM dot matrix printers
- the GIMPORT procedure, a new procedure that allows users to import CGM files from other applications
- help screens that provide device-specific information for obtaining graphics output
- interactive procedures that support RUN-group processing
- DATA Step Graphics Interface (DSGI), a GKS-like graphics language, that creates graphics directly from the DATA step or SCL code
- new GOPTIONS, including the capability to specify default color, height, and font for all graphics text and the ability to preview graphics output on one device as it will appear on another
- new map data sets
- new features for graphics procedures
- windows for viewing and editing PATTERN, AXIS, and SYMBOL statements
- graphics windows that can be sized and moved and allow for scrolling through all the graphs in a single graph catalog
- options for directing output either directly to a device or a file
- the GDEVICE procedure, a new procedure for device catalog management, including the ability to modify device driver attributes.

This paper provides an overview of these new features.

NEW DEVICE DRIVERS AND ENHANCEMENTS TO EXISTING DRIVERS

All devices that were supported on your operating system in Version 5 of SAS/GRAPH software are supported in Version 6. Version 6 also supports several new devices. These include

- Hewlett-Packard LaserJet, PaintJet, and ThinkJet printers
- Epson FX and LQ dot matrix printers (monochrome and color) and compatibles
- IBM Proprinter and IBM Graphics Printer dot matrix printers

- IBM 3582 and Matrix "TT200" ink jet printers
- General Parametrics Videoshow "Display System"

Version 6 of SAS/GRAPH software also provides native device drivers for use with the IBM 4224 graphics printer under the OS/MVS and VM/CMS operating systems. These native language drivers mean that graphics output on the IBM 4224 will be possible without the use of GDDM. For MVS sites, SASWTR cannot be used to spool graphics produced using the IBM4224 driver. An alternate spooler, such as VPS or JES328X, must be used.

Drivers are also available that can produce Computer Graphics Metafiles (CGM files). These files can be transported to other graphics or word processing software.

Version 6 has brought about changes in the Linkable driver, which now uses the Metagraphics driver facility. This change should affect only the installation process. The end user should notice no difference in operation.

THE GIMPORT PROCEDURE

The GIMPORT procedure can be used to import Computer Graphics Metafiles (CGM files). These files can be transported to other graphics or word processing software. Version 6 has brought about changes in the Linkable driver, which now uses the Metagraphics driver facility. This change should affect only the installation process. The end user should notice no difference in operation.

HELP SCREENS FOR GRAPHICS DEVICES

SAS/GRAPH software now provides HELP screens for graphics devices. These screens provide general information on choosing a driver for a particular device, as well as more advanced information on the configuration of devices and system-specific information that will assist in producing graphics output on most devices.

RUN-GROUP PROCESSING

In Version 6 most graphics procedures are interactive. This means that once you invoke a graphics procedure, it remains active until the next DATA or PROC step, or until you issue a QUIT statement to halt the procedure. In previous releases when a graphics procedure was invoked, the procedure ended when a step boundary (DATA, PROC, or RUN statement) was encountered. In Version 6 you can use this RUN-group processing capability to change graphics options and global statements (TITLE, FOOTNOTE, PATTERN, SYMBOL, AXIS, and LEGEND) without ending the procedure and reinvoking it. This affects all graphics jobs whether running interactively or in batch. RUN-group processing makes graphics output more efficient because you invoke the procedure only once to produce multiple graph requests.

RUN-group processing, however, can cause side effects. For example, consider the following code:

PROC GDEVICE BORDER;
RUN;
RUN;
In previous releases the code above would generate one graph, because the second RUN statement had no real effect. In Version 6, this same code will produce two graphs, one for each occurrence of the RUN statement. To disable RUN-group processing, specify the V5COMP option on a GOPTIONS statement.

DATA STEP GRAPHICS INTERFACE (DSGI)

In Version 6 a new feature has been introduced, based on the Graphical Kernel System (GKS). The DATA Step Graphics Interface (DSGI) follows the general rules of GKS and can be considered as a language in its own right. Unlike other graphics produced via SAS/GRAPH software, DSGI creates and displays graphics without the use of graphics procedures. The graphs are produced directly from the DATA step or from SCL code in either SAS/AF™ or SAS/FSP™ software. Although SAS/GRAPH procedures are not required, SAS/GRAPH software must be installed in order to use DSGI because SAS/GRAPH device drivers are used to produce DSGI output. DSGI's most useful function is the production of customized graphs by those who are familiar with GKS programming.

NEW GRAPHICS OPTIONS

Several new graphics options (GOPTIONS) are available in Version 6. They include:

- CTEXT=
- HTEXT=
- FTEXT=
- RESET=
- ROTATE=
- TARGETDEVICE=
- V5COMP.

CTEXT=, HTEXT=, and FTEXT= Options

You can use the CTEXT=, HTEXT=, and FTEXT= graphics options to control the default color, height, and font of text. These options provide users with the following capabilities:

1. You can control the attributes of text without having to specify them individually in global statements (such as TITLE, AXIS, and LEGEND).

2. You can use these options to control the height and font of text that previously could not be controlled, such as labels on pie charts.

For example, you can use the following code to produce a pie chart with labels in the COMPLEX font with a height of 1.5:

```sas
options ctext=1.5 ftext=complex;
title bx='Fonts and Heights on Pie Labels';
proc gchart;
  pie city / sumvar=rate;
run;
```

The graph produced by this program is illustrated in Figure 1.

NEW GRAPHICS OPTIONS

When the CTEXT=, HTEXT=, and FTEXT= options conflict with attributes specified in statements such as TITLE, AXIS, and LEGEND, the local attributes override those specified in the graphics options.

RESET= Option

Use the RESET= graphics option to reset graphics options to their default values and to clear global statements. The value of the RESET= option determines what options and statements are reset. For example, RESET=GOPTIONS causes all graphics options to be set to default values, whereas RESET=GLOBAL causes all global statements (TITLE, FOOTNOTE, PATTERN, SYMBOL, AXIS, and LEGEND) to be cleared. RESET=ALL resets both options and global statements. You can also reset individual types of global statements. For example, RESET=PATTERN resets only PATTERN statements.

ROTATE= Option

In previous versions of SAS/GRAPH software you could use the ROTATE or NORotate graphics option to change the orientation of a graph on certain devices. The orientation produced by the option would depend on the default orientation used by the driver. For example, if the default orientation of the driver is portrait, specifying GOPTIONS ROTATE will cause the graph to be drawn in landscape mode.

In Version 6, you can explicitly specify the orientation with the ROTATE= option. For example, you can now specify ROTATE=LANDSCAPE, which produces the graph in a landscape orientation, irrespective of the default orientation of the driver. Note that you can still specify ROTATE or NORotate (without a value) in a GOPTIONS statement as before, and the orientation will depend on the default orientation.

Additionally, the ROTATE option was only supported by a few device drivers in previous releases. In Version 6, the ROTATE/NORotate graphics option and the ROTATE= graphics option are supported on almost all devices.
TARGETDEVICE = Option

The TARGETDEVICE = graphics option allows you to display a graph on your current output device as it would appear on a different device. This option takes into account such device-related issues as HPPOS and VPOS, aspect ratio, and background color when displaying a graph on your current or preview device. This option is especially useful when working on a graphics terminal to develop an application that will eventually be sent to a printer or plotter. For example, if you eventually plan to produce output on a Hewlett-Packard LaserJet printer, but want to preview the graph on an IBM 3179 terminal, you can specify:

goptions dev=ibm3179 targetdevice=hplj300;

The graph will be displayed on the terminal as it will eventually appear on the printer (using the default orientation and colors of the HPLJ300 driver).

VSCOMP Option

The VSCOMP option allows you to run graphics applications developed in Version 5 of SAS/GRAPH software so that you get the same results in Version 6. This option disables RUN-group processing discussed earlier and may be used to avoid many of the side effects discussed in Compatibility Issues later in this paper. VSCOMP also forces the GCHART procedure to use the midpoints algorithm from Version 5 of SAS/GRAPH software when choosing default midpoints for a chart. Version 6 of SAS/GRAPH software uses a new, more effective midpoints algorithm by default.

NEW MAP DATA SETS

Some data sets that were packaged separately in Version 5 are now a part of SAS/GRAPH software. The world map data sets, containing world and regional maps, are included as part of SAS/GRAPH software.

NEW FEATURES FOR GRAPHICS PROCEDURES

In Version 6, graphics procedures retain the same basic operation. Applications written in previous releases should run similarly with little or no modification. However, there are some new features in Version 6 that will enhance your graphics output with future applications. This section discusses the new features that are available with Version 6 SAS/GRAPH procedures.

The GFONT Procedure

PROC GFONT is available on all operating systems for Version 6. Previously this procedure was not available for minicomputer operating systems. Additionally, fonts, whether Institute-supplied or created by the GFONT procedure, are now stored in SAS catalogs. For this reason, user-written fonts created in previous releases of SAS/GRAPH software must be recreated in Version 6.

PROC GFONT also contains new options that will allow you to take advantage of character kerning and proportional spacing when creating fonts. Kerning is a method of adjusting the space between characters so that part of one character extends over the body of the next.

Another new feature of PROC GFONT is the ability to specify arcs when creating characters. Previously, if you were creating a character that had an arc in it (the letter B, for example), you had to supply all of the points in the arc in your input data set to PROC GFONT. In Version 6 you can include an arc in your font simply by specifying the beginning, ending, and center points of the arc and indicating to PROC GFONT that the points define an arc.

The GCHART Procedure

You can now produce vertical bar charts with a single statistic at the top of each bar by specifying the statistic as an option in the VBAR statement. Valid statistics that may be placed at the top of each bar on vertical bar charts are: CFREQ, CPERCENT, FREQ, MEAN, PERCENT, and SUM.

The GCONTOUR Procedure

The GCONTOUR procedure now fully supports the AXIS statement. This enhancement allows you to specify values for the major tick marks on the axes including the start and end points.

The GPROJECT Procedure

You can now specify the minimum and maximum latitude and longitude that should be included in the projected map data set using the LATMIN=, LATMAX=, LONGMIN=, and LONGMAX= options. This allows you to create a rectangular subset of a map data set, enabling clipping of maps. For example, if you want to create a map that zooms in on a particular area, use these options to subset the data so that only the desired area is mapped.

The GREPLAY Procedure

There are two major changes affecting users of the GREPLAY procedure. First, sample templates that were previously stored in the catalog SASUTL.TEMPLT are now stored in SASHELP.TEMPLT. Also, GREPLAY function key definitions are no longer displayed at the bottom of the screen. However, you can use the keys command to view and modify key definitions.

Enhancements to the LEGEND Statement

In Version 6 the LEGEND statement gives you much more control over the location and appearance of legends. New features include support for special effects such as a three-dimensional block effect behind the legend, a drop shadow behind the legend, and coloring of the legend background. You can also move the legend to any position on the graph, including inside the axes.

title 'Greater Control of Legend Placement';
symbol i=j v=star h=2;
symbol i=1 v=diamond h=2;
legend margin=protect position=(inside top right)
         offset=+0.95 pt, +0.5 pt
         value=(f=swiss)
         label=(h=1.5 f"swiss)
         frame;
proc gplot;
plot goal*day=employee/legend=legend;
run;
Enhancements to the SYMBOL Statement

The SYMBOL statement provides major new features for interpolated lines in Version 6. The l= option can be used to produce box-and-whisker plots. Also, you can use the MODE= option on a SYMBOL statement to control whether data values outside specified axis ranges are included in interpolation calculations.

PATTERN, AXIS, AND SYMBOL WINDOWS

Version 6 provides windows that can be used to view and edit definitions for PATTERN, AXIS, and SYMBOL statements. Each window is invoked in the SAS Display Manager System by typing the name of the statement to be reviewed on any command line.

GRAPHICS WINDOWS

Version 6 provides graphics windows that can be used with the SAS Display Manager System on many graphics terminals to display the graphs within a specified catalog. Graphics windows can be moved and resized like any other window. Devices that support graphics windows are:

- IBM32xx and IBM31xx terminals
- devices that use a windowing environment based on the X Window system
- Digital VT graphics terminals on non-IBM hosts
- Tektronix 41xx and 42xx graphics displays on non-IBM hosts.

If you are using an IBM 3290, 3279, 3278, or 3270 personal computer with programmed symbols, you can only display one graph window at a time. Other devices supporting graph windows may have up to four graph windows at a time.

If you are using a device that supports graph windows and are running in the SAS Display Manager System, you do not have to specify a device driver. A device driver that is suitable for your device is automatically used.

Note that because the border of the graphics window takes up several rows and columns, some graphs that ran under previous releases may not fit in the window in Version 6. To use the entire screen to display a graph, disable the graphics window by specifying:

```
OPTIONS NONWINDOW;
```

NEW WAYS TO DIRECT OUTPUT

Users of SAS/GRAPH software on IBM mainframes may be familiar with using the GACCESS= graphics option to direct output to a file or device when using a protocol converter. In Version 6 on all operating systems, you can use the GACCESS= graphics option in a much wider range of situations to control both the format and destination of output from SAS/GRAPH device drivers. The GACCESS parameter has the form

```
GACCESS=access-method;
```

where access-method refers to a module that controls how or where the output is written.

In most situations, when producing hardcopy output (except for eavesdrop plotters), you should use GSASFILE as the access method. In Version 6 GSASFILE works much as it did in Version 5 in IBM mainframe environments. Specifically, output is written to the file ref GSASFILE, which can point to a physical file or, in some cases, directly to a device or port. Specific details on using GSASFILE to send output directly to a device or port vary across devices and operating systems. For specific information, use the help facility mentioned in Help Screens for Graphics Devices or documentation on using graphics devices for your operating system.

GACCESS=SASGASTD is the standard method (default for many drivers), which writes output to your terminal or display.

SASGAEDT and SASGAFIX are specified when graphics stream files of a particular nature must be created. SASGAEDT adds system line-end characters between each record and is usually used when you are writing a file that you want to edit. A value of SASGAFIX causes fixed-length records to be written out, with the length of the records dictated by the GSFLEN option. SASGAFIX is usually used when you want to write a file that is to be transferred to another computer that requires a fixed-record format. For SASGAEDT and SASGAFIX, it is necessary to use the GSFNAME= option to specify a file ref if you want to route graphics output to a file.

DEVICE CATALOGS AND THE GDEVICE PROCEDURE

Two of the most notable new features of Version 6 SAS/GRAPH software are the addition of device catalogs and a new procedure, PROC GDEVICE, to manage them. Using PROC GDEVICE, you can

- obtain a list of all available drivers
- determine default values (such as graph size, orientation, and colors) used by each driver
- tailor Institute-supplied drivers to your requirements.

Device Catalogs

A device catalog is a SAS catalog with entries containing information used by SAS/GRAPH device drivers. Each entry corresponds to a driver name that you can specify with the DEVICE= option. The information contained in a device entry includes such parameters as the size of the graphics area, resolution of the device, default colors, hardware capabilities used by the driver, and where output
from the driver goes. The catalog SASHELP.DEVICES is supplied by SAS Institute with SAS/GRAPH software and contains entries for all institute-supplied drivers. You can create your own catalog, copy whatever entries you need into it, and modify them if necessary. If you plan to modify any institute-supplied entries, you should copy them to your own catalog before modifying them.

Device catalog entries are used by SAS/GRAPH software to determine how the corresponding driver will produce output. Suppose that you run the following SAS program:

```
goptions dev=hp7475; title 'test'; proc gslide; run;
```

When the GSLIDE procedure is executed, SAS/GRAPH software looks for an entry named HP7475 in available device catalogs. The first catalog searched is GDEVICE9.DEVICES (or GDEVICE0.DEVICES if GDEVICE9.DEVICES does not exist) and the catalogs GDEVICE9.DEVICES through GDEVICE1.DEVICES (also user-supplied) are searched. If HP7475 is not found in any of these catalogs, or the catalogs do not exist, the Institute-supplied catalog SASHELP.DEVICES is searched. When an HP7475 entry is found in one of the catalogs, the driver parameters in that entry are used in determining how the graph is drawn, where it will be sent, and so on. After this information is obtained from the catalog entry, SAS/GRAPH software checks for any options that have been specified in a GOPTIONS statement. These options override any parameters or options specified in the HP7475 device catalog entry. Then using the options and parameters specified in the device catalog and GOPTIONS statements, the graph is generated. This procedure is illustrated in Figure 2.

Figure 3 How Device Catalogs Are Used

Using the GDEVICE Procedure to Examine Catalogs

You can use PROC GDEVICE to examine and modify the contents of device catalogs. For example, to look at the entries that are included in SASHELP.DEVICES, you can submit the following SAS statement:

```
proc gdevice c=sashelp.devices browse;
```

This causes the catalog screen for SASHELP.DEVICES to appear, as shown in Screen 1.

```
Figure 2
```

```
Figure 3
```

Screen 1 Catalog Screen for SASHELP.DEVICES

Each entry on the catalog screen corresponds to a driver name that can be specified in the DEVICE= option. To examine the HP7475 entry, you can scroll down to the entry, place an S next to the entry name, and press ENTER.

A device entry contains several screens. When you select an entry, the DETAIL screen appears over the catalog screen. This is illustrated in Screen 2.

```
Screen 2 DETAIL Screen for HP7475 Entry
```

This screen contains a number of attributes used by the HP7475 driver, including the size of the graphics area, rows and columns, default GACCESS value, and the resolution used by the driver. See Chapter 25, "The GDEVICE Procedure," in SAS/GRAPH Software: Reference, Version 6, First Edition, Volume 2 for details.

The PARAMETERS screen shows more information. You can call up this screen by entering PARAMETERS on the command line of the DETAIL screen. The PARAMETERS screen is illustrated in Screen 3.
Screen 3 PARAMETERS Screen for HP7475 Entry

The PARAMETERS screen contains additional options used by the HP7475 driver, including what prompts the driver issues, what type of handshake is used, and what hardware capabilities of the device should be used.

After returning to the DETAIL screen, you can also access the following screens in the catalog entry by typing the name of the window on the command line of the DETAIL screen:

- the GCOLORS screen, which contains the default colors used by the driver
- the CHARTYPE screen, which contains definitions for the different hardware character sets that can be used by the driver
- the METAGRAPHICS screen, which contains parameters used when building a Metagraphics driver
- the GPROLOG, GEPLOG, GSTART, and GEND screens, where you can specify strings to be sent by the driver at the beginning and end of each graph or record. (These correspond to the GPROLOG=, GEPLOG=, GSTART=, and GEND= graphics options.)

Compatibility Issues

Programs developed for Version 5 of SAS/GRAPH software should perform similarly in Version 6. However, there are a few compatibility issues that should be considered.

Version 5 allows duplicate names for graphics catalog members. For instance, if PROC GPlot is run three times in Version 5 and NAME= is not specified in the PLOT statement, there will be three members in the graphics catalog, each with the default name of GPlot. In Version 6, the same code would produce three members in a catalog, but their names would be GPlot, GPlot1, and GPlot2.

Due to the differences in graphics catalogs in Version 5 and catalogs in Version 6, it is necessary to convert Version 5 graphics catalogs to Version 6 format before using them in Version 6. You can use the VSTO6 procedure to convert Version 5 graphics catalogs to Version 6 catalogs.

For devices that support graphics windows (listed earlier in this paper in GRAPHICS WINDOWS), you will notice some changes in the basic operation when running in the SAS Display Manager System. First, SAS/GRAPH software chooses an appropriate device driver if you do not specify one. Second, the area in which graphics output is displayed will be smaller than it would be outside of the graphics window. In order to avoid this shrinking of the graphics area, specify NOGWINDOW in an OPTIONS statement.

Several Version 6 features that may cause slightly different output can be turned off by specifying the V5COMP option. Refer to RUN-GROUP PROCESSING and The GCHART Procedure for details on the V5COMP option.

CONCLUSION

This paper has presented an overview of many new features available with Version 6 SAS/GRAPH software. The descriptions presented are summaries of the new features. For details on these enhancements, you should refer to SAS/GRAPH Software: Reference.

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