Paper 090-30

Tips and Tricks: Using SAS/GRAPH® Effectively

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ABSTRACT

SAS/GRAPH is a powerful data visualization tool. This paper examines the powerful components of SAS/GRAPH and highlights techniques for harnessing that power to create effective and attention-grabbing graphs. The components examined include the SAS/GRAPH procedures, graphical global statements, the Output Delivery System (ODS), graph styles, client-rendered graphs, and the Annotate facility. Complete programs using these components and techniques are provided and examined in detail.

INTRODUCTION

Many SAS® products and solutions use SAS/GRAPH to produce graphs, but certain components might be unavailable to SAS programmers who want to customize their graphs. Although there are many programmable components in SAS/GRAPH, this paper focuses on components in SAS/GRAPH procedures (PROCs).

The key to building effective graphs is to understand all the graph construction components that are available to you. With this understanding, you can choose the most appropriate components to construct your graph. This paper gives an overview of SAS/GRAPH components, and highlights specific options used to build a few attention-grabbing graphs. Finally, the paper examines the completed graphs and the tricks used in their construction.

GRAPH CONSTRUCTION COMPONENTS

Graph construction components can be divided into two categories—foundation and building blocks. SAS/GRAPH PROCs and global statements make up the foundation. Options used with PROCs to enhance output appearance, including ODS, graph styles, and the Annotate facility, make up the building blocks.

THE FOUNDATION

The foundation includes SAS/GRAPH PROCs, global statements, and Java graph macros. SAS/GRAPH PROCs generate the different types of graphical output. SAS/GRAPH PROCs use global statements to control and adjust output appearance. The foundation also includes a few Java graphs that are created by SAS macros, and are not associated with SAS/GRAPH PROCs.

SAS/GRAPH PROCs, global statements, and Java graph macros are grouped and defined in the following tables. *Appendix A: Samples from SAS/GRAPH Procedures* includes graphical output for the procedures in the tables.

Charting and Plotting Procedures	
GAREABAR	Produces an area bar chart showing the magnitude of two variables for each category of data (Figure 1 in Appendix A)
GBARLINE	Produces a vertical bar chart with a plot overlay (Figure 2 in Appendix A)
GCHART	Produces a block chart, horizontal and vertical bar chart, pie and donut chart, and star chart (Figure 3 in Appendix A)
GCONTOUR	Produces a plot representing three-dimensional relationships (Figure 4 in Appendix A)
GPLOT	Produces a plot of two or more variables on a set of coordinate axes (Figure 5 in Appendix A)
GRADAR	Produces a radar or star chart showing the relative frequency of data measures (Figure 6 in Appendix A)
G3D	Produces three-dimensional graphs plotting one vertical variable on two horizontal variables (Figure 7 in Appendix A)
G3GRID	Processes a data set for use with the G3D procedure or the GCONTOUR procedure

Mapping Procedures	
GMAP	Produces two- and three-dimensional color maps (Figure 8 in Appendix A)
GPROJECT	Processes map data by converting spherical coordinates into Cartesian coordinates
GREDUCE	Processes a map data set so that it can be reduced to have fewer points in the boundaries
GREMOVE	Processes map data to combine some areas into larger areas and remove shared borders
MAPIMPORT	Imports ESRI shapefiles into traditional SAS/GRAPH map data sets
Note: Several SUGI presentations on mapping tips and tricks are available. Information and examples can be found at http://support.sas.com/rnd/papers/.	

Presentation Procedures	
GANNO	Displays graphs created with Annotate data sets
GPRINT	Converts a text file into graphics output
GREPLAY	Displays and manages graphic output stored in SAS catalogs
GSLIDE	Creates text slides for presentations

Utility Procedures	
GDEVICE	Examines and changes the parameters of graphics device driver entries
GFONT	Displays new and existing SAS/GRAPH fonts and creates user-generated fonts
GIMPORT	Imports graphic output from other software or other machines
GKEYMAP	Creates key maps and device maps to compensate for differences in characters on different systems
GOPTIONS	Displays graphics option settings and values
GTESTIT	Provides a diagnostic tool for installation of SAS/GRAPH software and configuration of your device

Global Statements	
GOPTIONS	Sets default values for many graphics attributes and device parameters
AXIS	Controls the location, values, and appearance of the axes in plots and charts
LEGEND	Controls the location and appearance of legends on plots, maps, and charts
PATTERN	Defines the characteristics of patterns used in graphs
SYMBOL	Defines the characteristics of symbols used with the GBARLINE, GCONTOUR, and GPLOT procedures
FOOTNOTE	Controls the context, appearance, and placement footnote text
NOTE	Controls the context, appearance, and placement of note text
TITLE	Controls the context, appearance, and placement of title text

Java Graph Macros	
DS2CONT	Generates HTML for the Constellation applet that shows interactive node/link diagrams
DS2CSF	Generates HTML for the Rangeview applet that shows a critical success factor diagram
DS2TREE	Generates HTML for the Treeview applet that shows interactive node/link diagrams
Note: Additional information on these macros is found in online help. SAS 9.1.3 contains three sample programs for these macros (gwbconst.sas, gwbcsf.sas, and gwbtree.sas).	

KEY OPTIONS

In order to build a graph, you must first choose which SAS/GRAPH procedure meets your needs. After choosing the procedure, you must decide which options are needed. Finally, you must choose the proper global statements. The completed examples in the section *Building Your Graph: Putting It All Together* focus on the GCHART and GPLOT procedures. In the following code, the procedure and global options needed to produce the completed examples are shown. This code provides the important options and their syntax; the code cannot be run as is because it might contain conflicting options.

PROC GPLOT

```
proc gplot data=mydata anno=myanno;
  plot var1*var2=var3 /
    anno=myanno2 autovref cframe=black
    chref=(black black white black black)
    desc=”My Plot of Var1 and Var2”
    noframe haxis=axis1 nolegend
    name=’plot1’ skipmiss vaxis=axis2 vzero;
```

`anno`	specifies an Annotate data set for plots
`autovref`	draws reference lines at major tick marks on vertical axis
`cframe`	fills axis and frame area with specified color
`chref`	specifies the color of reference lines from horizontal axis
`desc`	specifies the description of the catalog entry (and the HTML description)
`frame/noframe`	specifies if a frame is drawn around the axis area or not
`haxis`	specifies major tick marks for horizontal axis or assigns an axis statement
`legend/nolegend`	specifies a legend or turns the legend off
`name`	specifies the name of the catalog entry
`skipmiss`	breaks a plot line when encountering a missing value
`vaxis`	specifies major tick marks for vertical axis or assigns an axis statement
`vzero`	specifies that tick marks begin at zero on the vertical axis

PROC GCHART

```
proc gchart data=mydata anno=myanno;
  pie3d var1 /
    desc=”My Pie of Var1” discrete explode
    noheading name=”pie3d” slice=outside sumvar=var2
    value=inside;
  hvar var /
    anno=myanno coutline=black descending
    description=”Hbar Chart” discrete noframe
    gaxis=axis4 group=var5 gspace=3 html=htmlvar nolegend
    maxis=axis1 name=’hbar1’ raxis=axis2
    ref=(1 2 3 4 5) space=5 nostats subgroup=var3
    sumvar=var4 width=20;
```

`pie3d` Options

`desc`	specifies the description of the catalog entry (and the HTML description)
`discrete`	treats chart variable as discrete, rather than continuous
`explode`	pulls specified slices out for emphasis
`noheading`	suppresses the heading printed at the top of each page
`name`	specifies the name of the catalog entry
`slice`	controls the position and style of the name for each slice
`sumvar`	specifies the numeric variable for sum or mean calculations
`value`	controls the position and style of the value (chart statistic) for each slice

hbar/vbar Options

anno	specifies an Annotate data set for charts
coutline	specifies a color to outline bars, bar segments, and legend
descending	arranges bars in descending order of the chart statistic value
desc	specifies the description of the catalog entry (and the HTML description)
discrete	treats chart variable as discrete, rather than continuous
frame/noframe	specifies if a frame is drawn around the axis area or not
gaxis	assigns an axis statement to the group axis
group	organizes data by the specified variable value
gspace	specifies spacing between groups of bars
html	specifies the variable containing the HTML data tips and drill-down information
legend/nolegend	specifies a legend or turns the legend off
maxis	assigns an axis statement to the midpoint axis
name	specifies the name of the catalog entry
raxis	specifies major tick marks for response axis or assigns an axis statement
ref	draws reference lines at specified points on the response axis
space	specifies spacing between bars and bar groups
nostat	suppresses the statistics table
subgroup	divides bars into segments according to variable specified
sumvar	specifies the numeric variable for sum or mean calculations
width	specifies the width of bars

GOPTIONS

```
goptions reset=all border cback=’white’ device=gif ftext=’arial/bo’
  ftitle=’arial’ gunit=pct hsize=2 htext=3.25 htitle=6
  iback=”myimage.gif” imagestyle= vsize=5in;
```

border	draws a border around the graphics area
cback	specifies background color
device	specifies graphics device driver
ftext	specifies default font for all text
ftitle	specifies default font for the first TITLE line
gunit	specifies default unit of measure for height specifications
hsize	specifies horizontal size of graphics area
htext	specifies default text height in graphics output
htitle	specifies default text height for the first TITLE line
iback	specifies an image to display in the graph’s background
imagestyle	specifies how to display the background image (FIT or TILE)
reset	resets global options to their defaults and cancels global statements
vsize	specifies vertical size of graphics area

AXIS

```
axis1 color=black label=none major=none
  minor=(height=-.001 number=3)
  offset=(0,0)
  order=(0 to 600 by 100)
   style= value=(angle=90) width=10;
```

color	specifies color for all axis components
label	modifies the axis label
major	modifies the major tick marks
minor	modifies the minor tick marks
offset	specifies the distance from the first and last major tick mark to the ends of the axis
order	specifies the order that data values appear along the axis
style	specifies the line type for the axis line
value	modifies the major tick mark values
width	specifies the axis line thickness

LEGEND

```
legend1 across=4 frame label=none position=(bottom) shape=bar(2,.5);
```

across	specifies the number of columns in the legend entries
frame	draws a frame around the legend
label	modifies a legend label
position	positions the legend on the graph
shape	specifies the size and shape of the legend entries

PATTERN

```
pattern1 value=s color=CX2444c7 value=s;
```

color	specifies the pattern color
value	specifies the pattern (SOLID, EMPTY, or style number)

SYMBOL

```
symbol1 color=CX2554c7 height=1 interpol=join line=1 value=none width=5;
```

color	specifies the color for all symbol items
height	specifies the plot symbol height
interpol	specifies how plot points are connected
line	specifies the plot line type for the GPLOT procedure
value	specifies the plot symbol for data points
width	specifies the thickness of interpolated lines for the GPLOT procedure

FOOTNOTE, NOTE, and TITLE

```
title1 angle=90 bcolor=black box=1 color=white font=”arial/bo”
  height=5pct justify=L “My title”;
```

angle	specifies the baseline angle of the text
bcolor	specifies the box background color if BOX= used
box	specifies which box to draw around text
color	specifies the color for all statement items
font	specifies the text font
height	specifies the text character height
justify	specifies the text string alignment

THE BUILDING BLOCKS

The building blocks enable you to build on the output generated by the PROCs. The building blocks extend output and create dynamic, effective graphs. The building blocks include the Annotate facility, graphics devices, ODS, graph styles, and Web interactivity.

The Annotate Facility

The Annotate facility is one of the most powerful building blocks for enhancing your output. The Annotate facility enables you to generate a special data set of graphics commands from which you can create additional graphics output. This ability enables you to add symbols, colors, labels, images, and other visual enhancements to your graphs. Output from the Annotate facility is combined with SAS/GRAPH procedure output to create custom graphs. Some of the completed examples in the section *Building Your Graph: Putting It All Together* heavily use the Annotate facility.

Following is a simple code fragment that adds three labels and inserts an image into the graph.

```
data work.other_anno;
  length  text $ 40 function color style $ 12;
  retain style '"arial/bo"' position '4' when 'a'
    xsys '3' ysys '3' size 2.5;

  /* create 3 labels */
  function='label';
  x=11;
  y=55; color='red'; text='HIGH'; output;
  y=40; color='orange'; text='MED'; output;
  y=25; color='green'; text='LOW'; output;

  /* annotate the logo/image */
  function='move'; x=3; y=75; output;
  function='image'; x=87; y=90; imgpath='pollenbar.gif'; style='fit'; output;
run;
```

SAS/GRAPH Output

How you decide to deliver your graphics output influences its appearance. ODS is one powerful and flexible way. Graph styles and graphics devices are important elements in the appearance of your ODS output. Non-ODS graphics devices provide another important way to impact the appearance of your graphics output.

ODS

ODS provides incredible flexibility in generating SAS/GRAPH output with a wide range of formatting options, including generating HTML output with GIF, JAVA, JAVAIMG, ACTIVEX, ACTXIMG, and JAVAMETA devices.

The first example uses basic ODS syntax and creates an HTML output file.

```
goptions device=gif;              /*Specify the device to use*/
ods listing close;                /*Close in case of back-to-back programs*/
ods html path="c:\mydir"          /*Specify the directory path for the output file*/
         body="graph.html"        /*Specify the HTML file to be created*/
         style=banker;            /*Specify the ODS Style to use*/
proc gplot data=mydata; plot x*y; run; quit;
ods html close;                   /*Close the output files*/
ods listing;
```

The second example creates an RTF output file.

```
goptions device=activex;            /*Specify the device to use*/
ods rtf file='test.rtf';            /*Specify the RTF file to be created*/
proc gplot data=mydata; plot x*y; run; quit;
ods rtf close;                      /*Close the output files*/
```

Graph Styles

Graph styles are only available on newer devices. A graph style combines graph colors, background colors, images, and fonts into a package with a particular theme, and provides a consistent look for your entire ODS output. A graph style can replace some global statements. To see the list of all graph styles, type the command **odstemplates** on the SAS command line. In the next window, open sashelp.tmplmst and open the Styles folder. Some examples of redefined graph styles include Analysis, Banker, Curve, Gears, Money, and Science (see Figure 10 in Appendix A). The TEMPLATE procedure can be used to modify these predefined graph styles or to create your own styles.

Graphics Device Drivers

Which device driver you choose impacts output appearance. This paper includes examples of six device drivers—GIF, METAJAVA, JAVA, JAVAIMG, ACTIVEX, and ACTXIMG. GIF and METAJAVA produce output that looks like default, non-client output in SAS. The other devices produce newer style output and have newer features available.

Currently, ODS styles is a feature that is only available with client devices, but this could change in a future release. JAVA and ACTIVEX create interactive graphs that run the Java applet or ActiveX control to view the graph. JAVAIMAG and ACTXIMG create a static image of the graph through JAVA or ACTIVEX and can be used with ODS RTF and ODS PDF output.

Non-ODS Device Drivers

Some devices do not work with ODS—GIFANIM is one such device driver. GIFANIM creates animated graphics output. The following code shows how GIFANIM is used:

```
goptions device=gif gsfmode=replace=gsfname=animap hsize=8 vsize=6
         Iteration=2 delay=150 disposal=background;
  <insert graphics proc code for first plot>
goptions gsfmode=append;
  <insert graphics proc code for second plot>
goptions gepilog=’3B’x;
  <insert graphics proc code for final plot>
```

Web Interactivity

In some cases, a graph needs a level of interactivity in a Web browser. The following code creates graphs that have drill-down capabilities and pop-up data tips. By clicking on the graph bars or slices, the drill-down functionality sends you to another Web page. When the pointer hovers over the graph, data tips that pop up to show pertinent information.

Drill-down

The following code provides drill-down capability:

```
data x;
  do age=1 to 10;
    htmlvar=’href=”http://www.sas.com”’;  /*this could be different links*/
    output;
  end; run;
ods html file=’c:\test.html’
  parameters=(“DRILLDOWNMODE”=”URL”);  /*set URL drill-down on*/
goptions dev=activex;
proc gchart data=x; pie age / html=htmlvar; run;  /*set the html var for drill-down*/
ods html close;
```

Data Tips

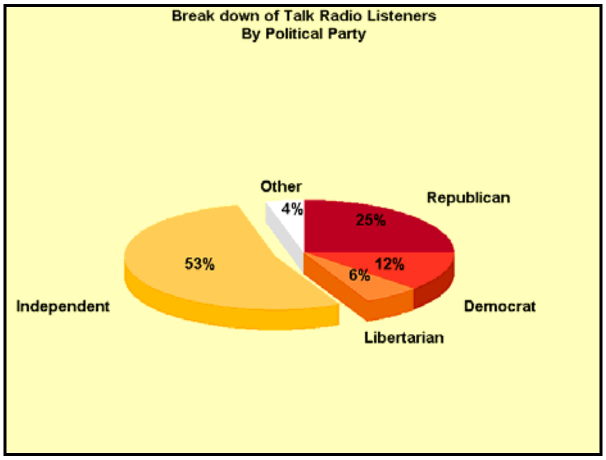
The following code defines data tips:

```
data x;
  do age=1 to 10;
    htmlvar='alt='||quote(
        'age='||trim(left(age)) );
  end; run;
ods html file='c:\test.html';
goptions dev=activex;
proc gchart data=x; pie age / discrete html=htmlvar; run;
ods html close;
```

BUILDING YOUR GRAPH: PUTTING IT ALL TOGETHER

Now that you are familiar with the construction components, you can build effective and attention-grabbing graphs. The following graphs use the foundation and building blocks that were discussed in previous sections of this paper. Highlights of each graph are discussed after the graph; however, the best way to fully understand them is to run the program that produced the graph. Programs are available for download at: http://support.sas.com/rnd/papers/.

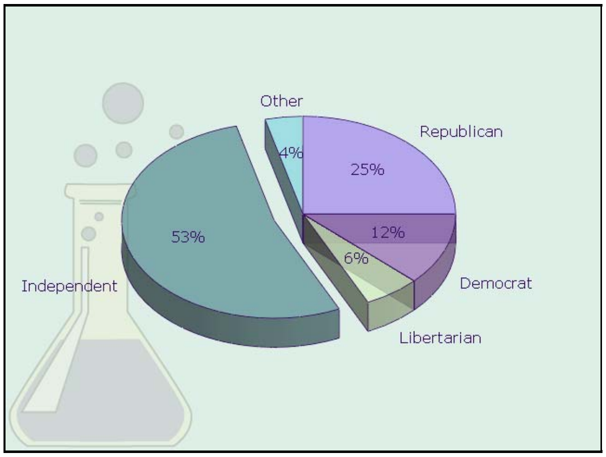
SIMPLE PIE CHART

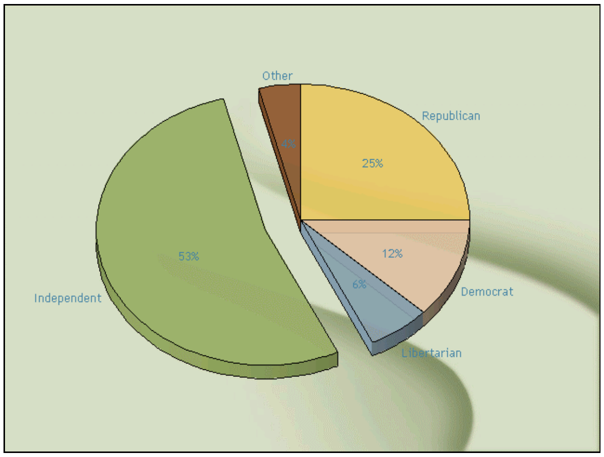


simplepie.sas

Simple graphs can be enhanced by the selection of particular colors and by the method used to position labels. The pie chart is built with the GCHART procedure with the PIE3D statement. PATTERN statements and GOPTIONS set the colors and fonts. A trick to ensure the order and color of the slices in the pie is to assign each slice a numeric value that indicates the slice order. A user-defined format sets the party names on each slice. Other enhancements include exploding the largest slice, using the SLICE option to label the longer party names outside of the pie chart, and using the VALUE option to label the percentage values inside each slice.

SIMPLE PIE CHARTS USING ODS STYLES

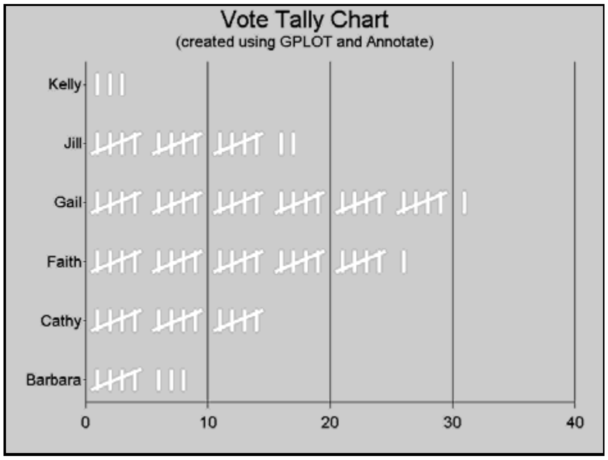




simplepie_style.sas

ODS Styles alleviate the work of picking the right colors, fonts, and background images. The simplepie**.**sas program was modified to use styles and the PATTERN statements and GOPTIONS were removed. Currently, ODS styles work with the JAVA, JAVAIMG, ACTIVEX, and ACTXIMG devices, although this may change in the future. The previous graph output shows two examples produced by this program—the ODS Science style with the ACTIVEX device and the ODS Curve style with the JAVA device.

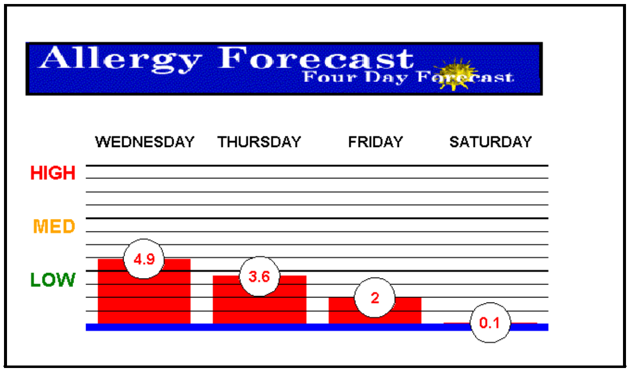
TALLY CHART



tally.sas

The tally chart uses old-fashioned tally marks to create a visually interesting way of showing a simple score. A simple GPLOT procedure generates the basic graph, but the symbol is hidden and an Annotate data set draws the tally marks.

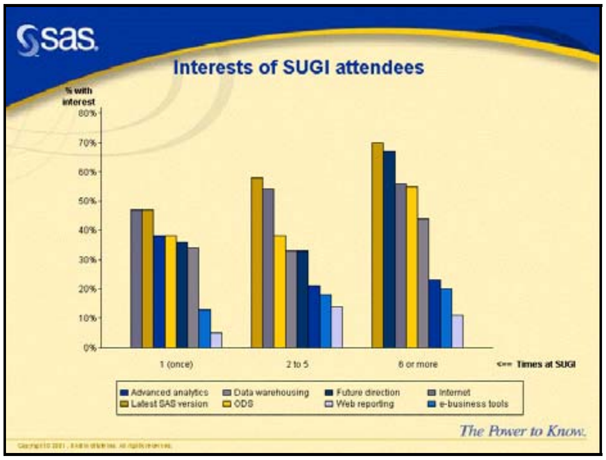
ANNOTATED CHART



annotate.sas

The Annotate facility can significantly improve the WOW factor of any graph. The annotated chart starts with a PROC GCHART VBAR chart and annotates the visuals in the graph. The Annotate facility generates the numbers in the circles on each bar, the HIGH, MED, and LOW axis labels, and the days of the week over the bars. The image at the top is added using the Annotate facility. Special AXIS statements create the bold blue axis and turn off the vertical axis. The REF= option generates the bold horizontal lines. The annotated chart includes pop-up data tips over the bars.

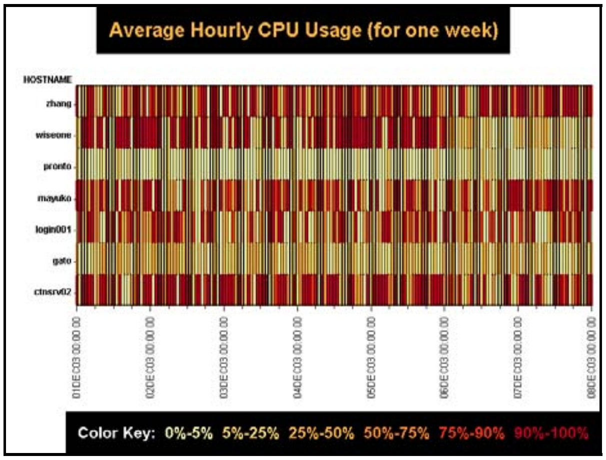
CHART WITH BACKGROUND IMAGE



imageback.sas

Background images are important visual elements that can convey a message or make the graph fit into a themed presentation or report. The chart starts with a **PROC GCHART VBAR** chart that uses the **GROUP** and **SUBGROUP** options to group the bars. The **GOPTIONS IBACK** option adds the background image. The **PATTERN** statement sets colors that blend with the background, and a **LEGEND** statement identifies the values on the bars. In addition, the chart includes pop-up data tips and drill-down functionality.

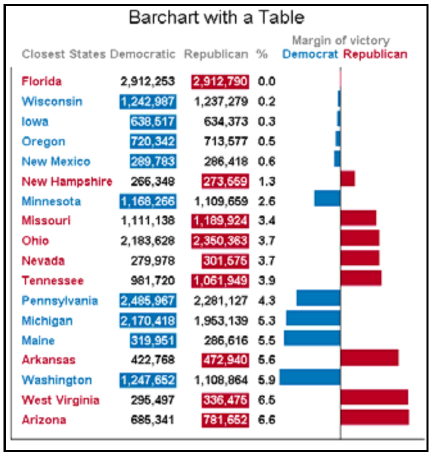
SPECTRUM CHART



spectrum.sas

Packing a lot of information into a single chart is one way to create very effective graphs. The spectrum chart displays one week of CPU usage for seven machines. Tiny line segments show the average hourly CPU usage for each day on each machine. The chart is created with the GPLOT procedure. The trick to creating this chart is the manipulation of the data, along with the use of the GPLOT procedure’s SKIPMISS option. Each machine has a location on the chart that relates to a position on the vertical axis. Three observations are created for each hour on each machine. The response variable is set to a plus and minus offset around the position assigned to the machine. The third value is set to missing. The first two values cause the plot to draw a line segment up and down. The third value (missing) and the SKIPMISS option cause the plot to stop drawing and skip to the next line segment. Graduated colors are chosen for the line segments and footnote text that replaces the legend. Because the vertical axis values are numeric, the Annotate facility places the machine names along the axis.

GRAPHIC TABLE AND CHART



Barchart with a Table

Closest States	Democratic	Republican	%
Florida	2,912,253	2,912,790	0.0
Wisconsin	1,242,987	1,237,279	0.2
Iowa	638,517	634,373	0.3
Oregon	720,342	713,577	0.5
New Mexico	289,783	286,418	0.6
New Hampshire	266,348	273,559	1.3
Minnesota	1,168,266	1,109,659	2.6
Missouri	1,111,138	1,189,924	3.4
Ohio	2,183,628	2,350,363	3.7
Nevada	279,978	301,575	3.7
Tennessee	981,720	1,061,949	3.9
Pennsylvania	2,485,967	2,281,127	4.3
Michigan	2,170,418	1,953,139	5.3
Maine	319,951	286,616	5.5
Arkansas	422,768	472,940	5.6
Washington	1,247,652	1,108,864	5.9
West Virginia	295,497	336,475	6.5
Arizona	685,341	781,652	6.6

gtable.sas

Coupling a table and a graph can emphasize a point. The graph starts with a PROC GCHART HBAR chart and the table is created with the Annotate facility. The graph has data tips and drill-down. The AXIS statement manipulates the graph to accommodate the table.

CONCLUSION

SAS/GRAPH is a powerful data visualization tool and the information in this paper only scratches the surface of its power. By utilizing the construction components discussed, you will discover that effective and attention-grabbing graphs can be built with very little extra effort.

APPENDIX A: SAMPLES FROM SAS/GRAPH PROCEDURES

Horizontal Area Bar Chart

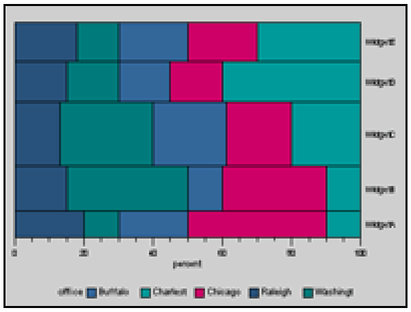


Figure 1. GAREABAR

GBARLINE

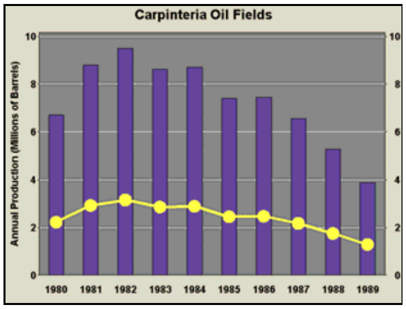
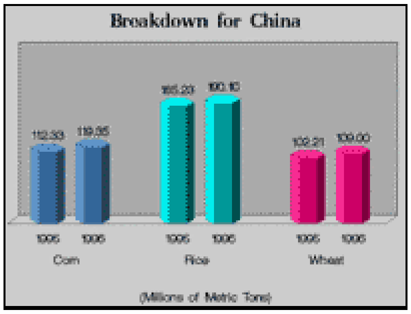
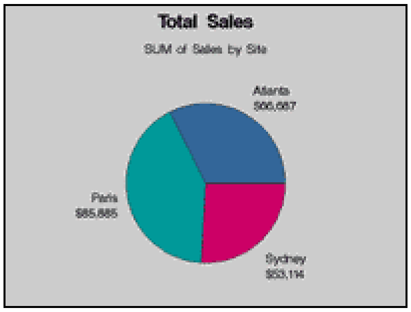


Figure 2. GBARLINE

Vertical Bar Chart



Pie Chart



Pie Chart with Detailed Slices

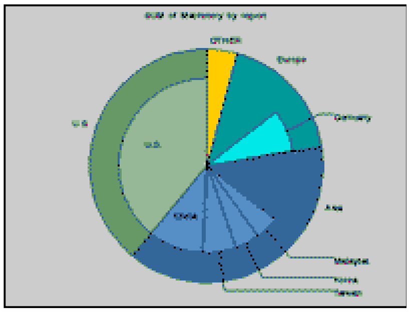


Figure 3. CCHART

Contour Plot

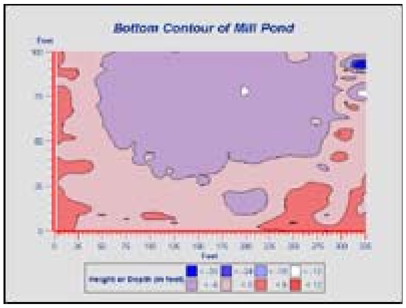
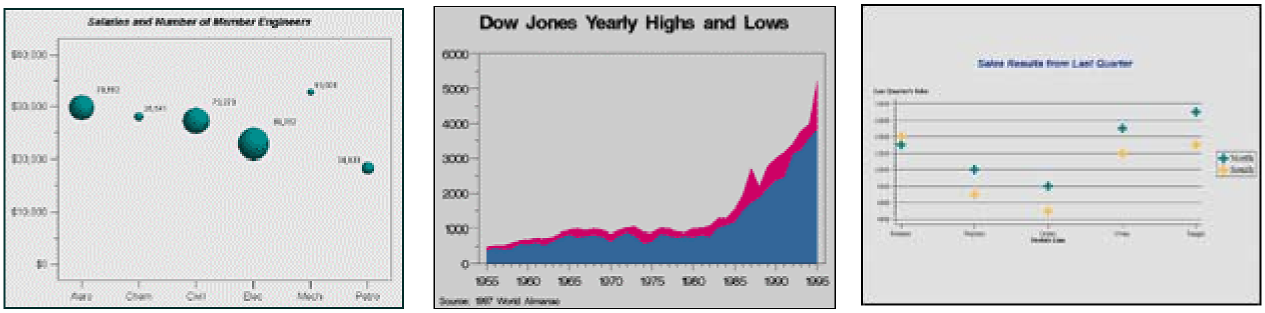


Figure 4. GCONTOUR



Bubble Plot

Area Plot

Scatter Plot

Figure 5. GPLOT

Radar Chart with Filled Polygons

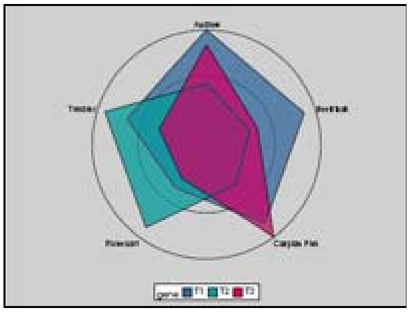


Figure 6. GRADAR

Surface Plot

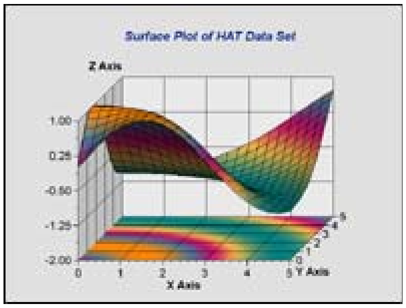
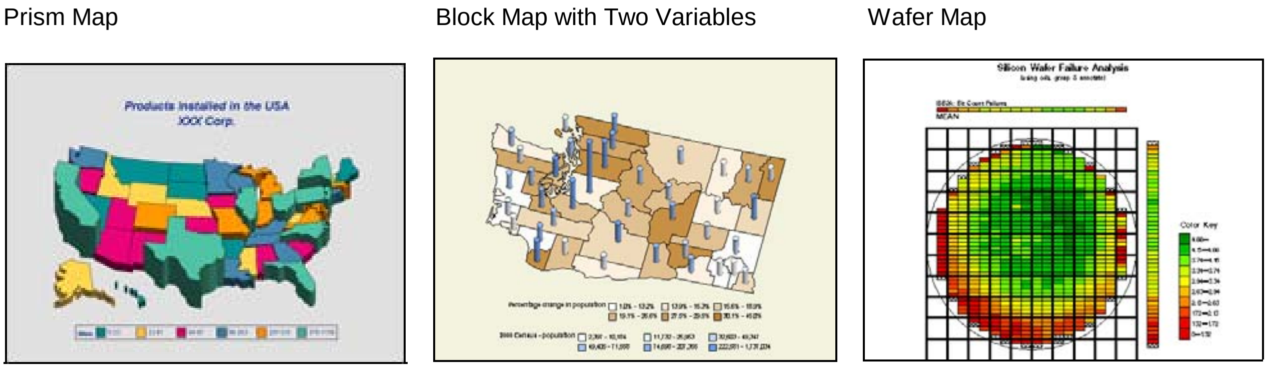


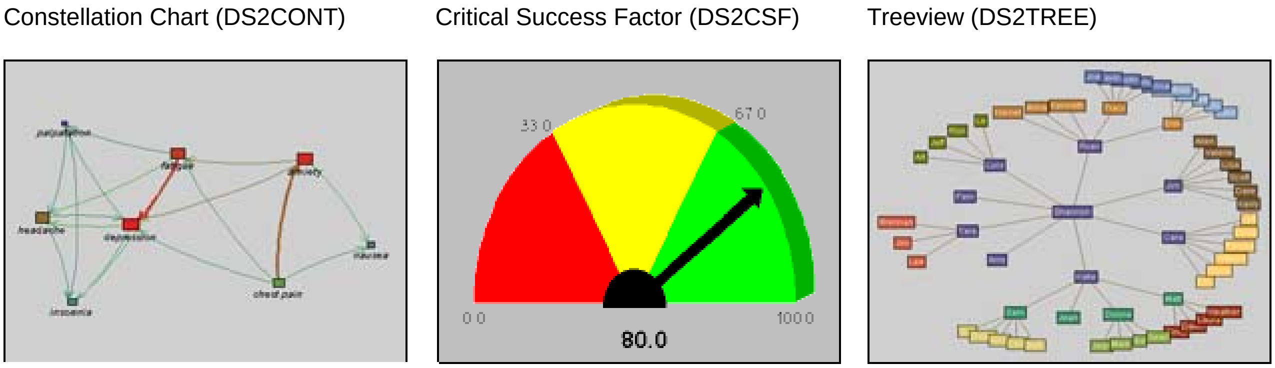
Figure 7. G3D


Prism Map

Block Map with Two Variables

Wafer Map

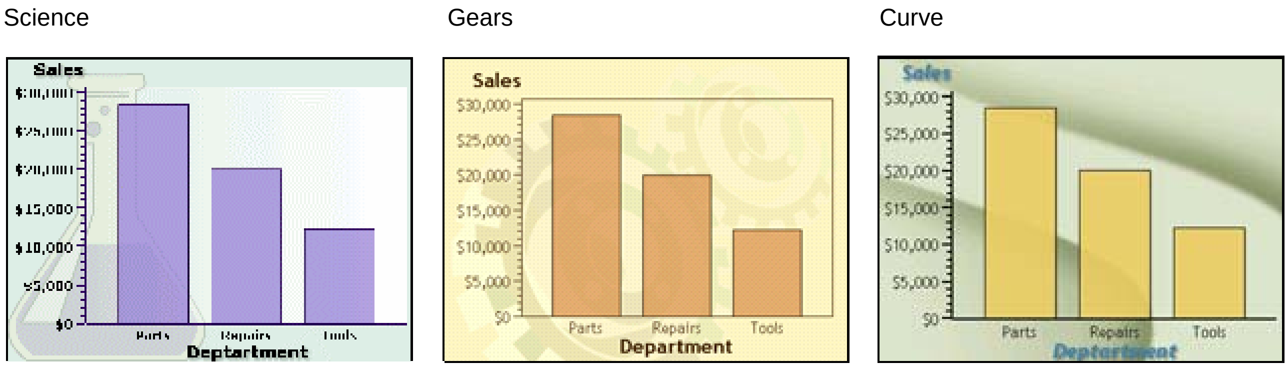
Figure 8. GMAP


Constellation Chart (DS2CONT)

Critical Success Factor (DS2CSF)

Treeview (DS2TREE)

Figure 9. Java Graphs from Macros


Science

Gears

Curve

Figure 10. ODS Styles

ACKNOWLEDGMENTS

A special thanks to Robert Allison of SAS for letting me borrow from creative examples that he had already built.

RESOURCES

Code Samples and Technical Tips (http://support.sas.com/sassamples/index.html).

Massengill, Darrell. 2003. “SAS Mapping: Technologies, Techniques, Tips and Tricks.” SUGI 28 SAS Presents Handout and Example Source Code Download. SAS Institute Inc. Available http://support.sas.com/rnd/papers/.

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SAS Graphing Components, SAS Data Visualization R&D Communities Web site (http://support.sas.com/rnd/datavisualization).

SAS/GRAPH Information (http://www.sas.com/technologies/bi/visualization/index.html)

SAS/GRAPH Software Downloads (http://support.sas.com/download).

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