Paper TU07

Easy, Elegant, and Effective SAS® Graphs: Inform and Influence with Your Data

LeRoy Bessler, Assurant Health, Milwaukee, USA, bessler@execpc.com

Abstract

Are you an existing SAS/GRAPH® user who would like to create charts that are more communication-effective? Or are you one of those software users who process their data with the SAS System, but then export the output to some other tool to graph it? This tutorial assumes no prior knowledge of SAS/GRAPH. It cuts through all the documentation and bypasses the problem of "Options OverChoice" to empower you to make elegant and effective pie charts, bar charts, and trend charts—to get them right from the start. You will come away with widely applicable design principles and examples, and with supporting code that you can understand, and can point at your own data when you get back to the office. Once comfortable with the most powerful graphics tool available, you will find that SAS/GRAPH lets you overcome all the design and functional barriers of Excel graphics. SAS/GRAPH *can* be easy, and, based on good design and good examples, communication-effective use of SAS/GRAPH gives you The Power to Show: to inform and influence, to reveal and persuade.

Introduction

This is a tutorial about effective visual communication of information, taught with examples and with all—and only—the code required. It is impossible to present all options available for the SAS/GRAPH statements used, and all assignment possibilities for the options. If code must be modified to suit your situation, please see the vendor-provided documentation. Code presented here was used with Release 8.2 of the SAS System. My scope is limited to graphs likely to be applicable for management reports and presentations. The code is also available via email in a zip file. The presentation includes explanation of the code, but here in the paper are only a few comments in or near the code. Later in the paper are: (a) general discussion of all syntax used in the examples; (b) Common Preliminary Code not listed in the examples; (c) code to generate the input data; (d) information about graphic device drivers; and (e) how to web publish your graphs.

Notes: The ambivalent spelling "colour" vs. "color" reflects original development and publication of the code and paper in the USA. When the figures were inserted in the prior two-column edition of this paper, they were published at a width of 8.25 centimeters. Upon conversion to the one-column format for this edition, the figure sizes were unchanged to keep the paper within the limit of 20 pages.

Easy, Elegant, and Effective—The Power of Simplicity

Easy. The example code should work for you, by pointing it at your data and making obvious adaptive modifications to a few statements.

Elegant. The defaults of software are not intended to be elegant. They are intended only to work, and they usually give an acceptable result if you do not have high expectations. To get a better result requires customization. However, customization that decorates, or needlessly complicates, does not yield elegance. Simplicity is almost always a key to elegance. Complexity can yield elegance, if it incorporates only what is essential to communication.

Effective. "Effective" always means "It works." But here I mean "communication-effective". Needless complexity, confusion, and distortion are common obstacles to effective graphic communication. Graphs accelerate inferences and decisions, but precise data (often tabular) assures reliable inferences and decisions. The designs here combine quickly interpreted pictures and as much precision as possible.

The Power of Simplicity. The design style used here is simple. Traditional graphic paraphernalia, from the early graphic production era of grid paper, pen, and ink, are stripped away. My focus is on the data, and what it shows. "Let the data talk." The graph design should reveal the data and its characteristics, and it should persuade the viewer—if there is a legitimate inference to be drawn. It should inform and influence. An elegant effective background or "graphic style" is a plain solid colour having sufficient contrast with all of the foreground.

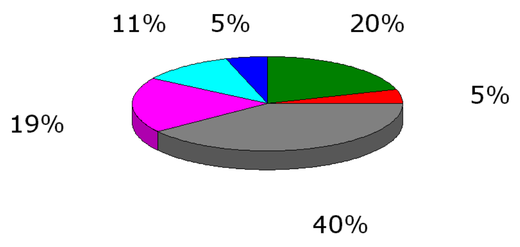
Fonts and Colours

For titles and footnotes, the Georgia font is used. For graph "body" text, which often must be smaller, the Verdana font is used. These Windows TrueType fonts were designed by Matthew Carter for improved readability on the web. For the web, it is best to use the Browser-Safe subset of RGB colours. For more about them, please see References 1 and 2. A software default colour list is specified by the device driver. A "personal default" colour (or font) can be specified by GOPTIONS CTEXT= (or FTEXT=) in the Common Preliminary Code.

The Main Event: Examples of What To Do (and What Not To). "I will show you something different from your shadow at morning striding behind you or your shadow at evening rising to meet you." (T.S. Eliot)

I recommend some examples that graphic users/viewers are not accustomed to producing/seeing. You may have a boss or a client who insists on graphs in a more familiar format. Take what you like, and leave the rest. I say: "The customer is always right, even when the customer is wrong." One can challenge a person to consider change, but if change is rejected, it's time to accept rejection and move on. SAS tool defaults, and Excel with its wide and easy use (but limited flexibility), set expectations for the norm and the appropriate in graphic design. Enhancements to software usually add complexity to graphics. However, in graphics, subtraction can add value. Try it.

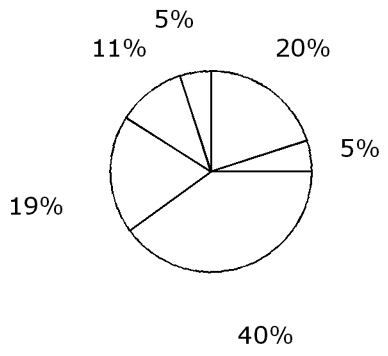
Figure 1: 3D Pie Chart.
Always Distorts Apparent Relative Size of Slices.



5% slice at rear is twice as big as 5% slice at right
11% slice is almost as big as 19% slice

I did not deliberately pick the values and the arrangement. The above is a problem encountered with real business data, with the slices ordered by the software default algorithm (which uses the sort order of the suppressed slice names).

Figure 2: 2D Pie Chart. Simpler is Better.
Always Presents Accurate Relative Size of Slices.



Here is the code used to create Figure 2:

```
title2 h=1.00 f='Georgia'
j=L '  Figure 2: ' c=CX0000FF '2D Pie Chart. Simpler is Better.'
j=L '  Always Presents Accurate Relative Size of Slices.';
footnote;
pattern1 v=pempty r=6;     /* empty pie slices */
goptions vpos=16 vsize=2.40 IN ymax=2.40 IN ypixels=720;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=DataForSimpleCharts;
pie Name / sumvar=Value
      noheading            /* suppress default pie chart heading */
      coutline=CX000000    /* colour of pie slice outline is Black.
             The default is COUTLINE=SAME, which means "same colour
             as slice fill", presumably controlled by PATTERN statements.
             However, though v=pempty leaves pie slices empty,
             SAS/GRAPH colours the slice outlines using the driver's default
             colour list IF you accept the default COUTLINE=SAME. */
      woutline=2          /* thicken the pie outline */
      slice=none          /* no Name labels */
      value=none          /* no Value labels */
      percent=outside;    /* Percent-of-Whole labels outside the pie */
run; quit;
```

To focus on the 3D problem, SLICE= and VALUE= (used to specify location of the SLICE and VALUE labels) were set to “NONE”. Below is a standard use of the SAS/GRAPH 2D pie chart, displaying slice Name, slice Value, and slice Percent of Whole. You can position this information INSIDE, OUTSIDE, or (with an) ARROW. The ordering of the slices is, by default, alphabetical by slice Name. There is no straightforward way to cure The Overlap Problem. Changing the position of the labels to OUTSIDE does not help. Ordering the slices by DESCENDING slice Value does not help. Consolidating the two smaller slices to end up with fewer slices to label would defeat the objective of maximum communication. And shuffling the slices around to solve the problem has no inherent communication value, is inefficient, and is infeasible for hands-off production applications, which must run with changing input data and no manual intervention.

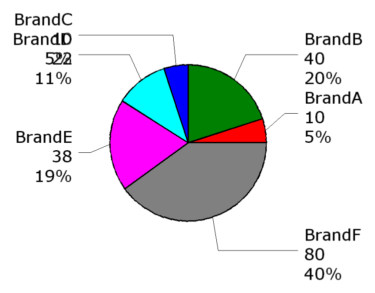


Figure 3: Standard Form of 2D Pie Chart. Susceptible to Label Overlaps.

Market Share by Brand, Sales in Billions of Units

I recommend the usually reliable solution in Figure 4.

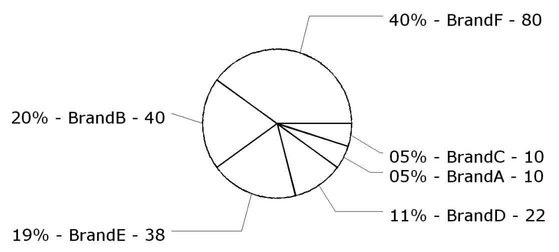


Figure 4: Communication-Effective Pie Chart Without a Legend.

Market Share by Brand, Sales in Billions of Units

There is no communication need to fill the pie slices with colour. The slices are laid down in order of DESCENDING slice Value. “Show them what’s important.” Here is the code used to create Figure 4:

```
proc means data=DataForSimpleCharts noprint sum;
var Value;
output out=PieTotal sum=TotalValue;  run;

data SliceNameWithPercentAndValue;
length NameWithPercentAndValue $ 17;
set DataForSimpleCharts;
if _N_ eq 1 then set PieTotal;
Percent = (Value / TotalValue) * 100;
NameWithPercentAndValue =
trim(left(put(Percent,Z2.)))  || '%' || ' - ' ||
trim(left(Name)) || ' - ' || trim(left(put(Value,2.)));
run;

title2 h=1.00 f='Georgia' j=L
'  Figure 4: Communication-Effective Pie Chart Without a Legend.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Market Share by Brand, Sales in Billions of Units';
footnote;
pattern1 v=pempty r=6;
```

```
goptions vpos=21 vsize=3.15 IN ymax=3.15 IN ypixels=945;
goptions hpos=50 hsize=4.79 IN xmax=4.79 IN xpixels=1437;
proc gchart data=SliceNameWithPercentAndValue;
pie NameWithPercentAndValue / value=none percent=none
    sumvar=Value noheading coutline=CX000000 woutline=2
    descending   /* order pie slices from large to small          */
    slice=arrow; /* connect label outside pie to slice with arrow */
run; quit;
```

Colour-coding the pie slices, and using a legend to provide all the text, eliminates any overlap possibility. SAS/GRAPH can provide a pie legend, but limits what you can put in it. A better legend solution, Figure 19, is postponed till later in the tutorial, due to its complexity.

Horizontal bar chart labels cannot suffer the overlap problems of pie charts, and cannot suffer the common problem of vertical bar charts, which is bar labels that are too wide to fit under the bars. But, in Figure 5, the third dimension adds no communication value.

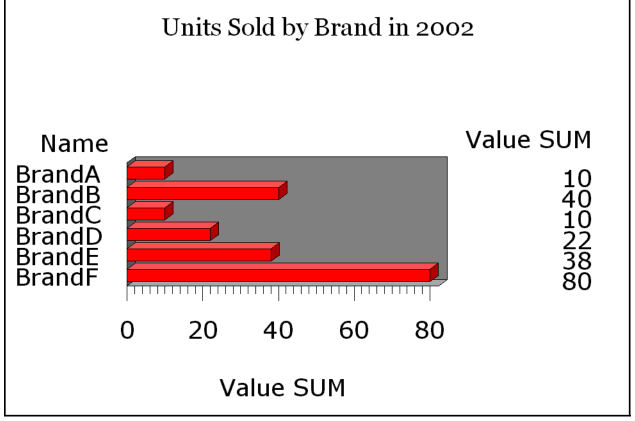


Figure 5: Default 3D Bar Chart. Needless Complexity.

I recommend the obviously better 2D horizontal bar chart in Figure 6.

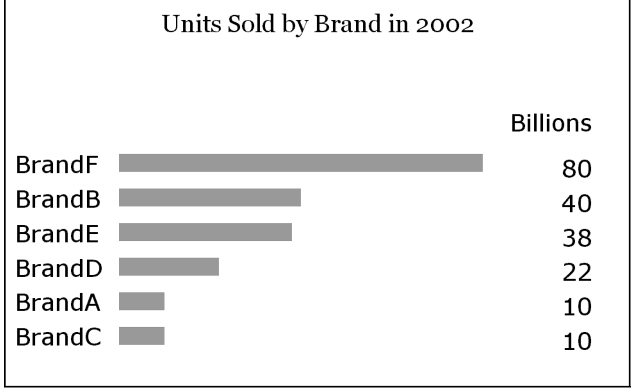


Figure 6: Communication-Effective Horizontal Bar Chart.

Here are the strengths of Figure 6. The bars are ranked from highest to lowest. “Show them what’s important.” There is nothing in the image that is dispensable. The bars are lightly shaded. A colour would add nothing. Using BLACK as the area fill, especially when there are numerous bars, would cause the image to be unnecessarily dominated by the area fill. Using an EMPTY area fill (hollow rectangles) can cause visual confusion, especially when there are numerous bars, between what are the bars and what are the spaces.

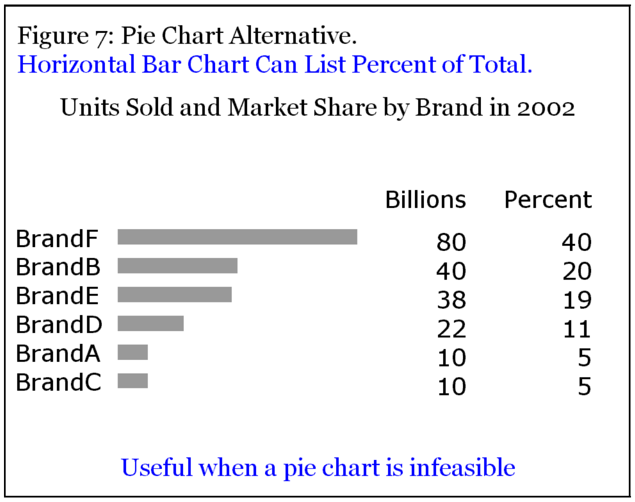
Sometimes, in a horizontal bar chart with numerous entries, rather than ordering bars by size to support quick identification of the largest or smallest, it may be more important to support quick information look-up with bars ordered by name.

Here is the code to create Figure 6:

```
title2 h=0.94 f='Georgia' j=L
'  Figure 6: Communication-Effective Horizontal Bar Chart.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
```

```
'Units Sold by Brand in 2002';
footnote;
pattern1 v=solid c=CX999999 r=6; /* use light browser-safe gray */
axis1 label=none major=none minor=none style=0;
axis2 label=none major=none minor=none style=0 value=none;
goptions vpos=15 vsize=2.25 IN ymax=2.25 IN ypixels=675;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=DataForSimpleCharts;
hbar Name /
     sumvar=Value
     sumlabel='Billions' /* label for column of Values          */
     width=0.6       /* adjust width of bars                    */
     space=0.6       /* adjust spacing between bars             */
     maxis=axis1     /* axis1 statement defines the Names axis  */
     raxis=axis2     /* axis2 statement defines the Values axis */
     descending;
run; quit;
```

With a minor enhancement to Figure 6 we can achieve the considerable benefit provided by Figure 7 below. Namely, by specifying five parameters in the HBAR statement, we get what can be used in lieu of a pie chart in situations where no pie chart is feasible. The alternative of combining multiple small slices into OTHER is anti-communicative, and just invites two questions, "What is in OTHER? How big are the pieces?" As a communication tool, your graph should answer questions, not create them.



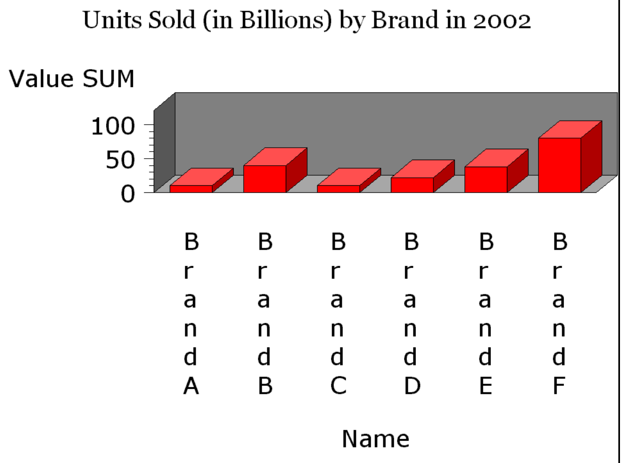
Replacing use of SUMVAR= and SUMLABEL= with the code in red, here is what is used to create Figure 7:

```
title2 h=1.00 f='Georgia' j=L
'  Figure 7: Pie Chart Alternative.' j=L c=CX0000FF
'  Horizontal Bar Chart Can List Percent of Total.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Units Sold and Market Share by Brand in 2002';
footnote1 h=1.00 f='Georgia' j=C c=CX0000FF
'Useful when a pie chart is infeasible';
footnote2 h=0.50 f=none ' ';
pattern1 v=solid c=CX999999 r=6; /* use light browser-safe gray */
axis1 label=none major=none minor=none style=0;
axis2 label=none major=none minor=none style=0 value=none;
goptions vpos=17 vsize=2.55 IN ymax=2.55 IN ypixels=765;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=DataForSimpleCharts;
hbar Name /
     freq=Value freq freqlabel='Billions'
     percent percentlabel='Percent'
     width=0.5 space=0.5 maxis=axis1 raxis=axis2 descending;
run; quit;
```

The use of FREQ= rather than SUMVAR= above is counterintuitive, but is necessary to get the result shown.

Figure 8 shows you a default 3D vertical bar chart.

Figure 8: Default 3D Bar Chart. Difficult to Use.

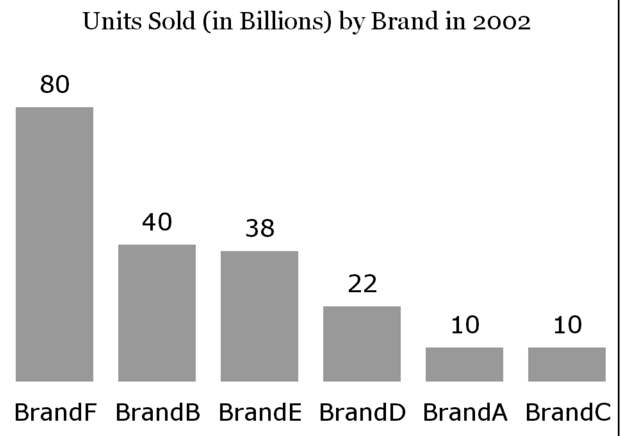


Here, too, the third dimension adds no value. Though the bar labels are short, they cannot fit horizontally.

(As stated in the Introduction, these Figures were created for a two-column format of the paper. The width was not deliberately chosen to force the x-axis values in the figure above to be printed in vertical stacks. Various ways of distorting the presentation of x-axis value text in vertical bar charts, also used in Excel, are all impediments to communication, and can be avoided by use of horizontal bar charts when needed. In countries where text is printed horizontally, presentation of text in graphs does not deserve to be an exception to the norm.)

A preferred result is shown in Figure 9. This is, in effect, a rotation of Figure 6 through 90 degrees. All the design principles are the same.

Figure 9: Communication-Effective Vertical Bar Chart.

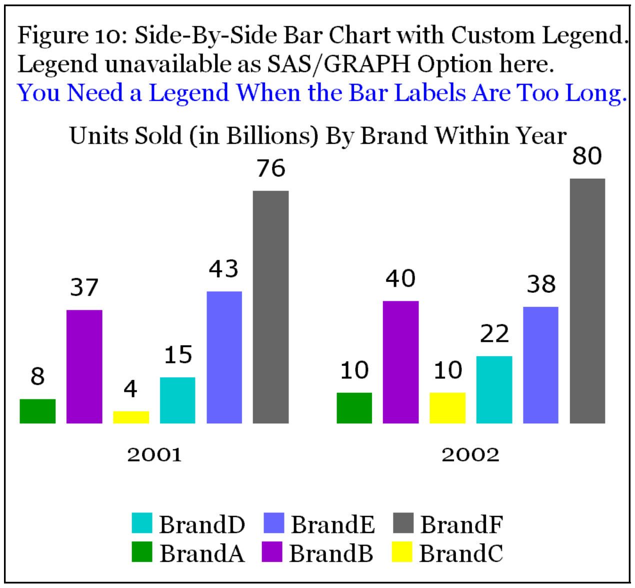


Here is the code used to create Figure 9:

```
title2 h=1.00 f='Georgia' j=L
'  Figure 9: Communication-Effective Vertical Bar Chart.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Units Sold (in Billions) by Brand in 2002';
footnote;
pattern1 v=solid c=CX999999;  /* use light browser-safe gray */
axis1 label=none major=none minor=none style=0;
axis2 label=none major=none minor=none style=0 value=none;
goptions vpos=17 vsize=2.55 IN ymax=2.55 IN ypixels=765;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=DataForSimpleCharts;
vbar Name /
     sumvar=Value
```

```
      sum
      descending
      maxis=axis1 raxis=axis2;
run; quit;
```

When the data requires two-level classification, the vertical bar chart solution is the side-by-side chart in Figure 10.



The legend has to be "faked" by building it with footnotes because PROC GCHART does not support a legend for this situation. With some key comments highlighted in red, here is the code used to create Figure 10:

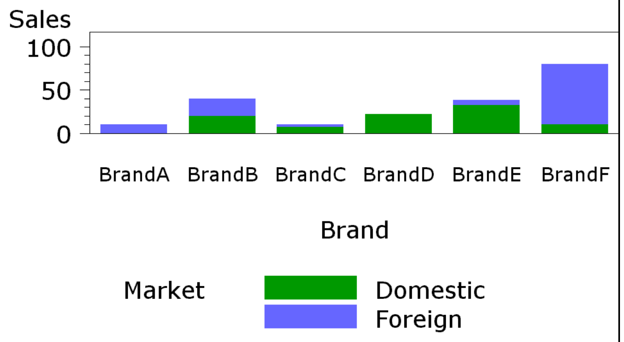
```
title2 h=1.00 f='Georgia' j=L
'  Figure 10: Side-By-Side Bar Chart with Custom Legend.' j=L
'  Legend unavailable as SAS/GRAPH Option here.' j=L c=CX0000FF
'  You Need a Legend When the Bar Labels Are Too Long.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Units Sold (in Billions) By Brand Within Year';
footnote1 /* create the legend */   h=1.00   j=C
f='Monotype Sorts' c=CX009900 '6E'X        /* '6E'X is the square  */
f='Georgia' c=CX000000 ' BrandA   '
f='Monotype Sorts' c=CX9900CC '6E'X
f='Georgia' c=CX000000 ' BrandB   '
f='Monotype Sorts' c=CXFFFF00 '6E'X
f='Georgia' c=CX000000 ' BrandC'    j=C    /* now start a new line */
f='Monotype Sorts' c=CX00CCCC '6E'X
f='Georgia' c=CX000000 ' BrandD   '
f='Monotype Sorts' c=CX6666FF '6E'X
f='Georgia' c=CX000000 ' BrandE   '
f='Monotype Sorts' c=CX666666 '6E'X
f='Georgia' c=CX000000 ' BrandF';
footnote2 h=0.50 f=none ' ';
pattern1 v=solid c=CX009900;     /* 2 steps darker than RGB green */
pattern2 v=solid c=CX9900CC;     /* purple                        */
pattern3 v=solid c=CXFFFF00;     /* yellow                        */
pattern4 v=solid c=CX00CCCC;     /* 1 step darker than RGB cyan   */
pattern5 v=solid c=CX6666FF;     /* 2 steps lighter than RGB blue */
pattern6 v=solid c=CX666666;     /* medium dark gray              */
axis1 label=none major=none minor=none style=0 value=none;
axis2 label=none major=none minor=none style=0 value=none offset=(0.5,0);
axis3 label=none value=(f='Georgia') nobrackets;
goptions vpos=20 vsize=3.00 IN ymax=3.00 IN ypixels=900;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=UnitsSoldByBrandAndYear;
vbar Brand / sumvar=Value sum maxis=axis1 raxis=axis2
```

```
     group=Year      /* group the midpoints (Brands) by Year       */
     gaxis=axis3     /* axis3 statement defines Group (Year) axis */
     patternid=midpoint;   /* vary pattern (colour) by Brand      */
run; quit;
```

Regrettably popular is use of the Stacked Bar Chart. How can you estimate the measurement for the upper bars in Figure 11? Even with a larger vertical scale the problem persists. Graph viewers should not be forced to perform "visual subtraction" to estimate the data values.

Figure 11: Stacked Bar Chart. NOT an effective tool.*

Units Sold (in Billions) By Market Within Brand in 2002

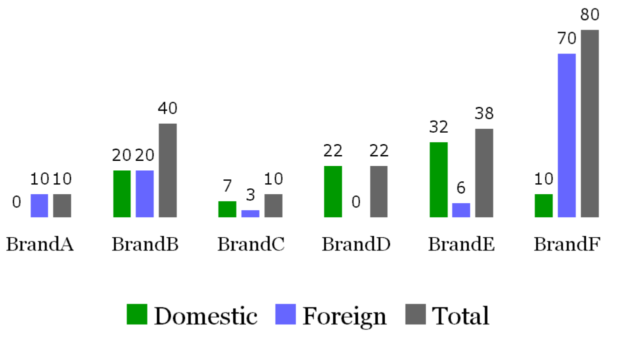


*How easily and reliably estimate value for Upper Bar?

Figure 12 is the better solution when you want to graph multiple components and their total. As in Figure 10, it is necessary to "fake" the legend because PROC GCHART does not support a legend for this situation.

Figure 12: Effective Bar Chart for Parts with Totals.

Units Sold (in Billions) By Market Within Brand in 2002



The code to create Figure 12 is the same as that used for Figure 10, except that it includes some preprocessing of the input, and shortens the graph. Since the bar values are directly presented, rather than being estimated by reference to a vertical axis and tick marks, and since the colour of the smallest bar is clear, no communication value would be added by increasing the height of the display area. Here is the code:

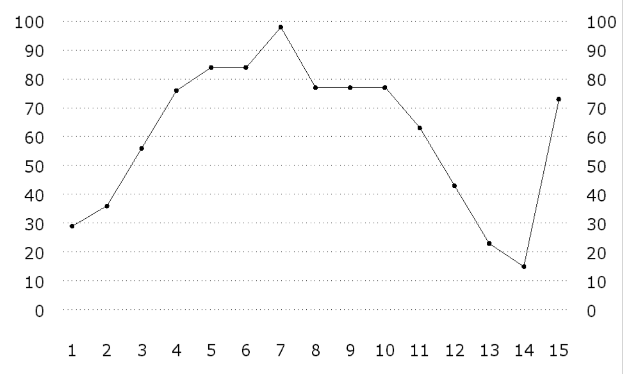
```
proc sort data=UnitsSoldByBrandAndMarket; by Brand Market; run;

data UnitsSoldWithTotals;
length Market $ 3;
retain Total 0;
set UnitsSoldByBrandAndMarket;
by Brand;
Total = Total + Value;
output;
if last.Brand;
Market = 'Total';
Value = Total;
```

```
output;
Total = 0;
run;

title2 h=1.00 f='Georgia' j=L
'  Figure 12: Effective Bar Chart for Parts with Totals.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Units Sold (in Billions) By Market Within Brand in 2002';
footnote1 h=1.00 j=C
f='Monotype Sorts' c=CX009900 '6E'X
f='Georgia' c=CX000000 ' Domestic   '
f='Monotype Sorts' c=CX6666FF '6E'X
f='Georgia' c=CX000000 ' Foreign   '
f='Monotype Sorts' c=CX666666 '6E'X
f='Georgia' c=CX000000 ' Total';
footnote2 h=0.50 f=none ' ';
pattern1 v=solid c=CX009900;
pattern2 v=solid c=CX6666FF;
pattern3 v=solid c=CX666666;
axis1 label=none major=none minor=none style=0 value=none;
axis2 label=none major=none minor=none style=0 value=none offset=(0.5,0);
axis3 label=none value=(f='Georgia' h=0.80);
goptions htext=0.70; /* size of bar-end value labels */
goptions vpos=15 vsize=2.25 IN ymax=2.25 IN ypixels=675;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=UnitsSoldWithTotals;
vbar Market / group=Brand
     sumvar=Value sum maxis=axis1 raxis=axis2
     gaxis=axis3 patternid=midpoint;
run; quit;
```

A vertical bar chart is sometimes used to track a trend, but the plot line is commoner. Here is a custom example:

Figure 13: Fine lines to facilitate estimation of y-values.

Sales (in 1000's of $) by Day During April 2003



Unless the trend line is rather smooth, automated annotation of each plot point is difficult, as we shall see. So what can we do? Figure 13 makes it easy to achieve a reasonable estimate of the y-values, by using reference lines and reduced size dots. Note that the y-axis starts at 0, even though no y-value comes below the $10,000 reference line. This choice of starting range is deliberate.

Tip: Usually start the vertical axis at zero. This smoothes out, somewhat, changes in the y-value. Allocating all the plot space only to the range of y-values present would amplify the size of changes, and cause needless cheer or fear about the magnitude of a change. Assessing the significance of a change has to be more sophisticated than reacting to the visual effect of choice and use of axis size on a graph. In some cases, the numeric value of, not the visual size of, of the percent change is the best indicator of change significance.

Here is the code used to create Figure 13:

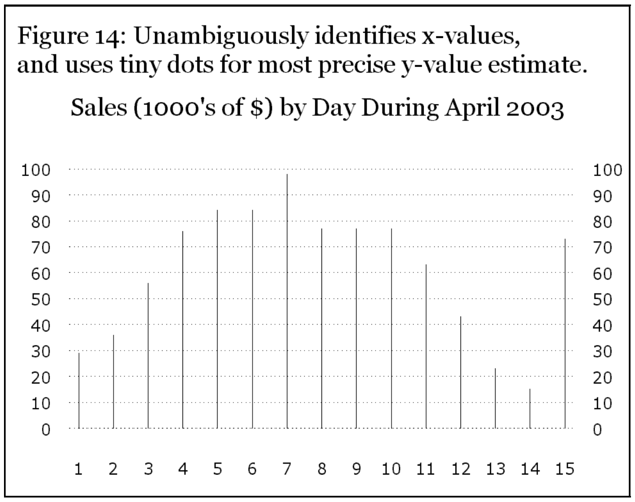
```
title2 h=1.00 f='Georgia' j=L
'  Figure 13: Fine lines to facilitate estimation of y-values.';
```

```
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Sales (in 1000''s of $) by Day During April 2003';
footnote;
axis1 label=none major=none minor=none style=0 value=(h=0.70);
axis2 label=none major=(c=CXFFFFFF) minor=none style=0 value=(h=0.70);
axis3 label=none major=(c=CXFFFFFF) minor=none style=0 value=(h=0.70 j=L); /* left justify
                                                        tick mark values for this axis */
symbol1 v=dot h=0.25 i=join;
goptions vpos=17 vsize=2.55 IN ymax=2.55 IN ypixels=765;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gplot data=DataForTrendPlot(where=(YearMonth='200304'));
plot Sales*DayOfMonth /
     haxis=axis1    /* axis1 statement defines the horizontal axis */
     vaxis=axis2    /* axis2 statement defines the vertical axis   */
     vzero          /* start vertical axis at zero                 */
     autovref       /* reference lines at y-axis major tick marks  */
     lvref=33;      /* line type 33 for reference lines            */
plot2 Sales*DayOfMonth=1 /
                    /* PLOT2 produces the right-hand vertical axis */
     vaxis=axis3    /* axis3 statement defines right-hand axis     */
     vzero;         /* start vertical axis at zero                 */
run; quit;
```

When a trend line is very dense along the x-axis (i.e., has many dates to plot), the correct x-value to associate with a trend plot point can be hard to determine. Figure 14, though not really so dense as to need it, shows the ultimate support for visual estimation of x-values.

Our scope here is static images—ones that can be printed, can be photocopied, etc. For a web-enabled trend display, one would have some other options. You could use pop-up text for each plot point, or hyperlinks to tabular data. (For such solutions, see Reference 3.) Of course, the static image solution for the most accurate, precise, easy data value determination is a graph with a companion table on the same page.

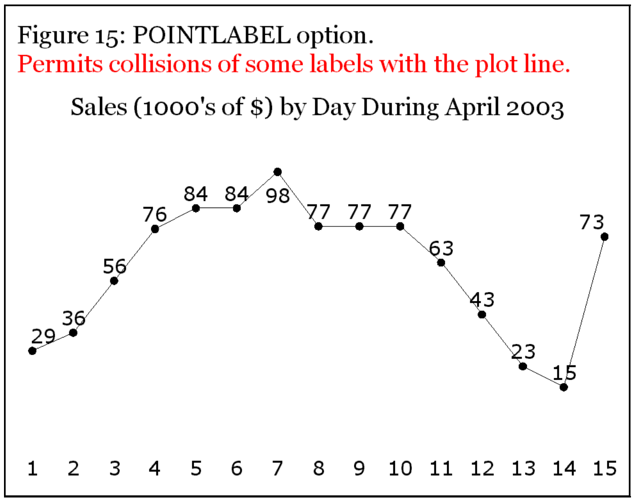
This is the thinnest possible vertical bar chart, not a trend line:



To create Figure 14, use these replacements in the code for Figure 13:

```
symbol1 v=point i=needle;
title2 h=1.00 f='Georgia' j=L
'  Figure 14: Unambiguously identifies x-values,' j=L
'  and uses tiny dots for most precise y-value estimate.';
```

SAS/GRAPH does provide an option to perform automatic annotation of the y-values (and x-values, if also desired) of all the points on any plot. It is the POINTLABEL option of the SYMBOL statement. Though it makes an effort to succeed, POINTLABEL is not always reliable, as can be seen in Figure 15. Since the y-values are annotated, there is no need for a y-axis. This data is designed to exercise all 13 possible three-point / two-segment changes in line slope—not to deliberately frustrate the POINTLABEL option, but to fully test it.

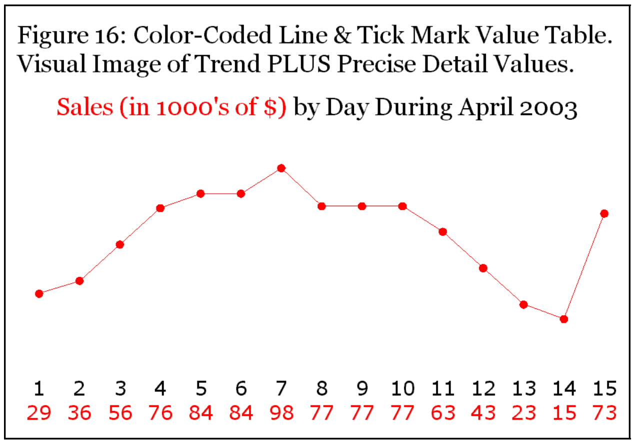


Here is the code used to create Figure 15:

```
title2 h=1.00 f='Georgia' j=L
'  Figure 15: POINTLABEL option.' j=L  c=CXFF0000
'  Permits collisions of some labels with the plot line.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Sales (1000''s of $) by Day During April 2003';
footnote;
axis1 label=none major=none minor=none style=0 value=(h=0.85);
axis2 label=none major=none minor=none style=0 value=none;
symbol1 v=dot h=0.50 i=join pointlabel=(h=0.85);
goptions vpos=17 vsize=2.55 IN ymax=2.55 IN ypixels=765;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gplot data=DataForTrendPlot(where=(YearMonth='200304'));
plot Sales*DayOfMonth /
     haxis=axis1 vaxis=axis2 vzero;
run; quit;
```

The problem in Figure 15 has been solved. The solution is outside the scope of this introductory tutorial, and uses a custom macro. If you are interested in the macro, please send me an email. If you wish to build your own macro, see Reference 3.

Figure 16, using colour-coding, provides the visual guidance of a trend line for quick assessment, complemented with the precision of an on-graph table. A graph is a visual aid to accelerate decision-making and inferences. A table of precise values (or annotation of them on the graph) is a necessity for reliable decision-making and inferences. Since all y-values are in the table, there is no need for a y-axis.



Here is the code used to create Figure 16:

```
%macro maketks;
%do i = 1 %to &ValCount;
```

```
tick=&i "&&x_value&i" j=C c=CXFF0000 "&&y_value&i"
%end;
%mend  maketks;

data _null_;
set DataForTrendPlot(where=(YearMonth='200304')) end=lastobs;
call symput('y_value'||trim(left(_N_)),trim(left(Sales)));
call symput('x_value'||trim(left(_N_)),trim(left(DayOfMonth)));
if lastobs;
call symput('ValCount',_N_);
run;

title2 h=1.00 f='Georgia' j=L
'  Figure 16: Color-Coded Line & Tick Mark Value Table.' j=L
'  Visual Image of Trend PLUS Precise Detail Values.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
c=CXFF0000 'Sales (in 1000''s of $) '
c=CX000000 'by Day During April 2003';
footnote;
axis1 label=none major=none minor=none style=0
          value=(h=0.85 %maketks);
axis2 label=none major=none minor=none style=0 value=none;
symbol1 v=dot h=0.50 i=join c=CXFF0000;
goptions vpos=15 vsize=2.25 IN ymax=2.25 IN ypixels=675;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gplot data=DataForTrendPlot(where=(YearMonth='200304'));
plot Sales*DayOfMonth /
     haxis=axis1 vaxis=axis2 vzero;
run; quit;
```

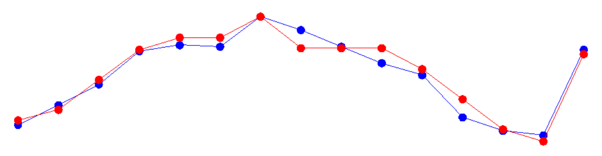
The keys to this solution are: (a) the preprocessing to load Sales and DayOfMonth values as macro variables into the global symbol table; (b) the retrieval of those values as tick-mark values in the AXIS1 statement with the %MAKETKS macro; and (c) colour-coding the title, the plot dots and plot line, and the tick-mark table entries. If you use OPTIONS MPRINT, and inspect the SAS log, you will find that the effect of the %MAKETKS macro is to produce, at run time, the following AXIS1 statement:

```
axis1 label=none major=none minor=none style=0 value=(h=0.50
             tick=1   "1" j=C c=CXFF0000 "29"
             tick=2   "2" j=C c=CXFF0000 "36"
             . . .
             tick=15 "15" j=C c=CXFF0000 "73");
```

Figure 17 takes the concept and method one step further.

Figure 17: Color-Coded Trends & Tick Mark Value Table.
Multi-Line Multi-Class Plot.

Sales (in 1000's of $) by Day During April 2003
and Tabular Comparison with Previous Month



```
 1   2   3   4   5   6   7   8   9  10  11  12  13  14  15
--- --- --- --- --- --- --- --- --- --- --- --- --- --- ---
29  36  56  76  84  84  98  77  77  77  63  43  23  15  73
26  39  53  75  79  78  98  89  78  67  59  31  22  19  76
```

Day of Month
Sales During Report Month
Sales During Previous Month

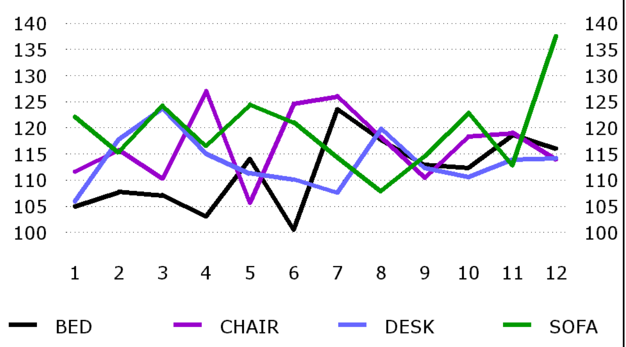
Here is the code used to create Figure 17:

```
%macro maketks2;
%do i = 1 %to &ValCount;
tick=&I c=CX000000 "&&x_value&i" j=C '---' j=C c=CXFF0000 "&&y_value&i" j=C c=CX0000FF
"&&y_prev&i"
%end;
%mend  maketks2;

data _null_;
set DataForTrendPlot(where=(YearMonth eq '200304')) end=lastobs;
call symput('y_value'||trim(left(_N_)),trim(left(Sales)));
call symput('x_value'||trim(left(_N_)),trim(left(DayOfMonth)));
if lastobs;
call symput('ValCount',_N_);
run;

data _null_;
set DataForTrendPlot(where=(YearMonth eq '200303'));
call symput('y_prev'||trim(left(_N_)),trim(left(Sales)));
run;

title2 h=1.00 f='Georgia' j=L
'  Figure 17: Color-Coded Trends & Tick Mark Value Table.' j=L
'  Multi-Line Multi-Class Plot.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Sales (in 1000''s of $) by Day During April 2003' j=C
'and Tabular Comparison with Previous Month';
footnote;
axis1 label=(h=0.80
             j=L c=CX000000 'Day of Month'
             j=L c=CXFF0000 'Sales During Report Month'
             j=L c=CX0000FF 'Sales During Previous Month')
                 major=none minor=none style=0 value=(h=0.85 %maketks2);
axis2 label=none major=none minor=none style=0 value=none;
symbol1 v=dot h=0.50 i=join c=CX0000FF;
symbol2 v=dot h=0.50 i=join c=CXFF0000;
goptions vpos=20 vsize=3.00 IN ymax=3.00 IN ypixels=900;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gplot data=DataForTrendPlot;
plot Sales*DayOfMonth=YearMonth / haxis=axis1 vaxis=axis2 vzero
     nolegend;   /* suppress the automatic default legend */
run; quit;
```

With too many lines in a multi-line trend plot, a legend and reference lines must replace the table of tick-mark values. (Four plot lines are actually not too many.) For easy y-value estimation in a complex graph, the y-axis range fills the display area, rather than starting at zero.

Figure 18: Multi-Line Multi-Class Plot With Legend.
Too many lines for tick mark value table to be feasible.

Sales by Product Category by Month During 1998



Here is the code used to create Figure 18:

```
title2 h=1.00 f='Georgia' j=L
'  Figure 18: Multi-Line Multi-Class Plot With Legend. ' j=L
'  Too many lines for tick mark value table to be feasible.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Sales by Product Category by Month During 1998';
footnote;
axis1 label=none major=none minor=none style=0 value=(h=0.75);
axis2 label=none major=(c=CXFFFFFF) /* make major ticks invisible */
minor=none style=0 value=(h=0.75) order=100 to 140 by 5 ;
axis3 label=none major=(c=CXFFFFFF) /* make major ticks invisible */
minor=none style=0 value=(h=0.75 j=L) order=100 to 140 by 5 ;
symbol1 v=none i=join w=6 c=CX000000;  /* w=6 thickens the lines */
symbol2 v=none i=join w=6 c=CX9900CC;
symbol3 v=none i=join w=6 c=CX6666FF;
symbol4 v=none i=join w=6 c=CX009900;
symbol5 v=none i=none r=4; /* no symbols/lines for PLOT2 */
legend1 label=none value=(h=0.75) shape=line(1.5);
goptions vpos=17 vsize=2.55 IN ymax=2.55 IN ypixels=765;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gplot data=DataForFourLineTrendPlot;
plot Sales*Month=Product /
     haxis=axis1 vaxis=axis2
     legend=legend1 /* legend1 statement defines the legend */
     autovref lvref=33;
plot2 Sales*Month=Product /
     vaxis=axis3
     nolegend;
run; quit;
```

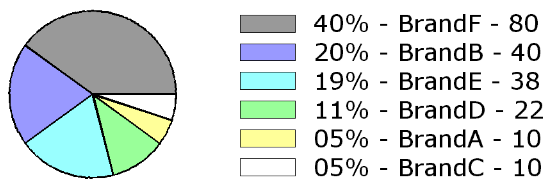
The SYMBOL5 statement prevents drawing visible lines for the PLOT2 statement, for which the only function is production of the right-hand-side vertical axis. The other SYMBOL statements define the line colours. Because it can be difficult to distinguish colours of thinly drawn lines, they are thickened by use of W=6 in the SYMBOL statements. SYMBOL statements are always applied in ascending sort sequence order of the values of the CLASS variable, i.e., the values of Z in code PLOT Y*X=Z. Here, Z is Product.

It is also possible to create an overlay plot of two different y variables, with different y-axes. However, code for the design that I recommend is too lengthy to print here. During the presentation, I show the result. To request the code, please send me an email.

Figure 19 is the most problem-resistant pie chart you can build with SAS/GRAPH—if you wisely insist on code that can merely be pointed at the data, and that no post-processing or special manipulation or circumvention should ever be required.

Figure 19: Pie Chart With Legend Always Effective.

Market Share, Brand, and Sales in Billions of Units



This legend is custom-built. The Software-Intelligent code dynamically orders the legend entries and the pie slices from largest to smallest. “Show them what’s important.” The colour list is designed to go from darkest to lightest, so that the smaller pie slices are more conspicuous. The legend normally obtainable from SAS/GRAPH only includes the pie slice name labels, not PERCENT and VALUE.

If you permit SAS/GRAPH to place the PERCENT and VALUE around the pie perimeter, there is no guarantee that overlaps will be avoided. The only way that the solution in Figure 19 can “fail” is if you have pie slices that are too small to be distinguishable. However, even in that situation, you have the legend, which is an all-inclusive ranked table that supplies name, percent, and value for every pie slice, including the invisible slices—though the visual image is lost, the quantitative information is still delivered.

This solution is more complicated than I like to present in an introductory tutorial, but it is too important and too widely applicable to omit. Those pie label overlap problems occur too often, and have no better solution.

Here is the code used to create Figure 19:

```
%macro dopattrn;
%do I = 1 %to 6;
pattern&i v=psolid c=&&SliceColor&i r=1;
%end;
%mend  dopattrn;

%macro getlegnd;
%do I = 1 %to 6;
  "&&legentry&i"
%end;
%mend  getlegnd;

data ColorList;
pctseq = 1; color='CX999999'; output;
pctseq = 2; color='CX9999FF'; output;
pctseq = 3; color='CX99FFFF'; output;
pctseq = 4; color='CX99FF99'; output;
pctseq = 5; color='CXFFFF99'; output;
pctseq = 6; color='CXFFFFFF'; output;
run;

proc sort data=SliceNameWithPercentAndValue;
by descending Percent;
run;

data ToSort;
set SliceNameWithPercentAndValue;
pctseq = _N_;
call symput('legentry'||trim(left(_N_)),
                     trim(left(NameWithPercentAndValue)));
run;

proc sort data=ToSort; by pctseq; run;

data SliceWithColor(drop=pctseq);
merge ToSort ColorList;
by pctseq;
run;

proc sort data=SliceWithColor; by NameWithPercentAndValue; run;

data _null_;
set SliceWithColor;
call symput('SliceColor'||trim(left(_N_)),trim(left(color)));
run;

title2 h=1.00 f='Georgia' j=L
'  Figure 19: Pie Chart With Legend Always Effective.';
title3 h=0.50 f=none ' ';
title4 h=1.00 f='Georgia' j=C
'Market Share, Brand, and Sales in Billions of Units';
footnote a=+90 h=0.10 IN ' ';
%dopattrn;
legend1 order=(%getlegnd)
        label=none shape=bar(3,0.6) across=1 position=(middle right outside);
goptions vpos=15 vsize=2.25 IN ymax=2.25 IN ypixels=675;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
proc gchart data=SliceNameWithPercentAndValue;
```

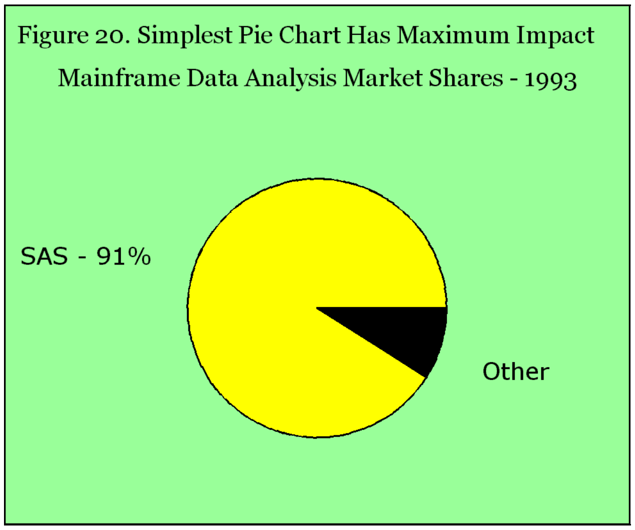
```
pie NameWithPercentAndValue /
    sumvar=Value noheading descending
    coutline=CX000000 woutline=2
    legend=legend1
    slice=none value=none percent=none;   /* turn off all pie labels */
run; quit;
```

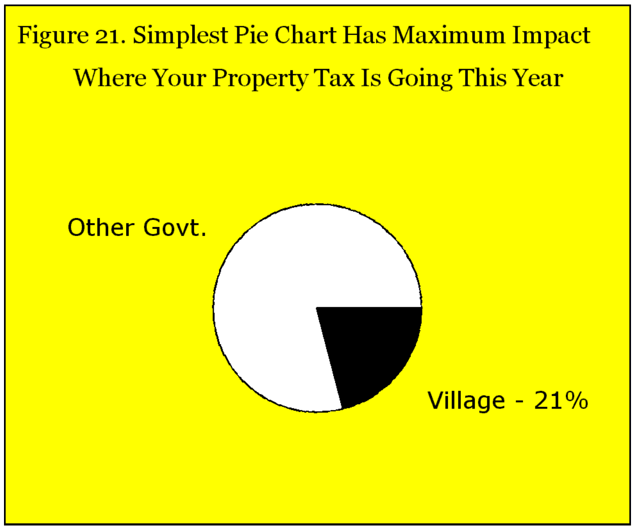
The same data set, SliceNameWithPercentAndValue, which was prepared for Figure 4, is used here. The FOOTNOTE statement with the strange parameter A=+90 (90 degrees counterclockwise) forces extra blank space at the right-hand margin, pushing the legend to the left.

The Irrefutable Power of Simplicity

Developed prior to the dominance of desktop computing, and Windows and Unix servers, and using market data for mainframe computing software, very dear to me among my designs is what I like to call “The Pac-Man Pie Chart”. (“Pac-Man” was an early computer game. It used an icon like the pie chart in Figure 20.) Figure 20 is a case where what’s in “Other” just does not matter. The other software alternatives have market shares that are insignificant.

Conversely, you can also apply this design when you want to emphasize smallness of a share of the whole. I.e., you can lump everything else on the chart into one huge slice of “Other”. In that case, you can satisfy any interest in the content of “Other” with a companion table. If web-deploying that graph, you can provide the table as pop-up text for, and/or an optional hyperlink from, its big slice. See Figure 21.





Here is the code used to create Figure 20:

```
data ForSimplestPie; infile CARDS;
input @1 software $9. @18 PctShare 4.1;
CARDS;
SAS - 91%        91
Other             9
; run;
title2 h=1 f='Georgia'
j=L '  Figure 20. '  c=CX0000FF 'Simplest Pie Chart Has Maximum Impact';
title3 H=0.5 F=none ' ';
title4 h=1 f='Georgia'
j=C 'Mainframe Data Analysis Market Shares - 1993';
goptions vpos=18 vsize=2.70 IN ymax=2.70 IN ypixels=810;
goptions hpos=34 hsize=3.25 IN xmax=3.25 IN xpixels=975;
goptions cback=CX99FF99;      /* light green background */
pattern1 v=psolid c=CXFFFF00; /* full strength yellow   */
pattern2 v=psolid c=CX000000; /* black                  */
proc gchart data=ForSimplestPie;
pie software / sumvar=PctShare noheading slice=outside value=none
               coutline=CX000000 woutline=2 midpoints='SAS - 91%' 'Other    ';
run; quit;
```

The blue title text on the green background would be easier to read if rendered in black. This was a choice by me in favor of emphasis, regrettably at the expense of some diminution of readability. (In more extreme cases, and too commonly, an unacceptable design error.)

How to Create the Input Data (values for observations not listed can be read off the graphs created with them)

```
data DataForSimpleCharts;
infile cards;
input @1 Name $6. @8 Value 2.;
cards;
BrandA 10
. . .
; run;

data UnitsSoldByBrandAndYear;
infile cards;
input @1 Year $4. @6 Brand $6. @13 Value 2.;
cards;
2001 BrandF 76
. . .
; run;

data UnitsSoldByBrandAndMarket;
infile cards;
input @1 Brand $6. @8 Market $8. @17 Value 2.;
cards;
BrandF Domestic 10
. . .
; run;

data DataForTrendPlot;
infile cards;
input @1 DayOfMonth 2. @5 Sales 2. @8 YearMonth $6.;
cards;
1   29 200304
. . .
; run;

data DataForFourLineTrendPlot(drop=Date Year Actual);
set sashelp.prdsal3
    (where=(Year=1998) keep=Year Product Actual Date);
Sales = Actual / 1000;
Month = month(Date); run;
proc summary nway data=DataForFourLineTrendPlot;
class Product Month;
var Sales;
output out=DataForFourLineTrendPlot(drop=_type_ _freq_) sum=Sales; run;
```

Common Preliminary Code for All the Graphs

```
proc catalog c=work.gseg kill; run; quit;   /* to permit reuse of a name= in reruns */

goptions reset=all;   /* it is best to do this reset before every graph */

goptions cback=CXFFFFFF;   /* background colour is RGB white, EXCEPT for Figure 20 */

goptions htext=1.00 ftext='Verdana';   /* height and font used for parts of graph for which
you do not make an explicit assignment, or for which no direct controls are available in
SAS/GRAPH. With the exception of the last-mentioned situation, you can override htext= and
ftext= in various graphic PROC Step statements with h= and f=. */

goptions border;   /* Put the graph in a box, to separate it from text when being published
in, e.g., Microsoft Word. Alternatively, you can apply a border to the inserted graph using
Microsoft Word itself. For this paper, both were borders were applied. */

title1 h=0.50 f=none ' ';   /* empty space between border and TITLE2 */
```

Using and Customizing Graphic Device Drivers

```
goptions device=PNG (or GIF);     /* specifies the device driver                 */

goptions gsfname=YourFileRef;     /* specifies FILEREF for output .png or .gif file */

filename YourFileRef 'c:\YourFileName.ext';  /* .ext is .png or .gif              */

goptions HPOS=      number of columns in the graphic area.
goptions VPOS=      number of rows in the graphic area.
goptions HSIZE=     horizontal size of the graphic area.
goptions VSIZE=     vertical size of the graphic area.
goptions XMAX=      maximum value for HSIZE.
goptions YMAX=      maximum value for VSIZE.
goptions XPIXELS=   maximum number of pixels in the XMAX space.
goptions YPIXELS=   maximum number of pixels in the YMAX space.

PNG driver defaults are:
    hpos: 76     xmax: 6.474 IN     hsize: 6.474 IN     xpixels: 615
    vpos: 43     ymax: 3.631 IN     vsize: 3.631 IN     ypixels: 345
GIF driver defaults are:
    hpos: 88     xmax: 8.420 IN     hsize: 8.420 IN     xpixels: 800
    vpos: 43     ymax: 6.310 IN     vsize: 6.310 IN     ypixels: 600
```

The above default values are overridden for the graphs created here, changing HSIZE & HPOS (and/or VSIZE & VPOS) proportionately to maintain default cell size and shape.

PNG image files are bigger than GIF image files for the same graph, but can produce smoother contours and better text. For graphs to be imbedded in a document, you can, e.g., set the pixel counts to 300 (or more) times the size in inches—as was done in all the examples in this paper. However, for web publishing, you may prefer the GIF driver, since quicker downloads (web page displays) result from smaller file sizes. Note that web pages are unlikely to be displayed at resolutions more than 100 pixels per inch, and often much less.

These drivers have default colour lists. I have only used Browser-Safe RGB colours with codes of the form CXrrggbb, where rr, gg, and bb are from the list 00, 33, 66, 99, CC, FF. Browser-Safe colours are a set of 216 colours recommended for web use. For more information about colour, please see Reference 2.

Glossary of SAS/GRAPH Statements and Options Used in This Paper

TITLE and FOOTNOTE statements.
You can use up to 10 of each per graph, but you can get more than 10 title lines or footnote lines by use of J= between quoted text strings to force a line break. There is no apparent limit on the number of line breaks within a TITLE or FOOTNOTE.
F= means FONT=. 'Georgia' and 'Verdana' are enclosed in single quotes because they are Windows fonts, rather than SAS/GRAPH fonts.
H= means HEIGHT=. With nothing after the numeric assignment, the default unit is CELLS. It could instead be CM (centimeters), PT (points), PCT (percent of graphic display area), or IN (inches). The entire graph composition area is divided into cells, whose size is determined from default or custom-specified GOPTIONS parameters (see discussion above).
J= means JUSTIFICATION=. Possible values are C (center), L (left), and R (right).
Text must be enclosed in quotes. If the text contains any macro variables, it must be enclosed in double quotes. The text may be specified in multiple quoted strings, which will be concatenated in the display. However, if you insert a J= assignment between two strings, the second string is displayed on a new line. This same thing can be done for the text strings in LABEL= assignments and in tick mark values.
The statement "FOOTNOTE;" is used to turn off any FOOTNOTE statements that may have been defined for a prior graph during the same SAS session.

AXIS statements.
LABEL= ('some text', with optional use of F=, H=, J=) is used to label the axis. For some examples, LABEL=NONE.
MAJOR=NONE suppresses printing of major tick marks.
MINOR=NONE suppresses printing of minor tick marks.
STYLE=0 suppresses printing of the axis line.
VALUE=('tickmark1 text' 'tickmark2 text' . . ., with optional use of F=, H=, J=) is used to customize the labels of the major tick marks (even if the tick marks themselves are not displayed—i.e., MAJOR=NONE does not prevent assignment of tick-mark values).
For examples where vertical axis tick mark values are superfluous (e.g., on a bar chart with bar ends labeled with the exact values of the y variable), VALUE=NONE is used here.
In some examples, the tick mark text is specified in parts, with J= separating them, to create stacked tick mark labels. In other examples, the values automatically supplied by SAS/GRAPH are controlled only as to height.
ORDER=starting value to ending value by increment value, specifies the range bounds for the axis, and the value difference between intermediate major tick marks.

OFFSET= can be used to put some space between where the axis would naturally begin and where it actually begins. It is useful, e.g., to offset the y-axis if you have plot points closer to the x-axis than you prefer.

SYMBOL statements.
V= specifies the plot symbol placed at each data point. The examples here use either DOT or NONE.
I= specifies interpolation between plot points; here we usually use JOIN or NONE. For I=NEEDLE, see the effect in Figure 14.
H= specifies the size of the plot symbol.
C= specifies the colour of the plot symbol and, if I=JOIN, the colour of the plot line.
W= specifies the width of the plot line.

PATTERN statements.
V= specifies the type of area fill. The examples use either PEMPTY (for empty pie slices) or SOLID (for solid bars).
C= specifies the colour of the area fill.
R= specifies for how many areas the assigned V= and C= should be repeated.

LEGEND statements.
LABEL= (‘some text’, with optional use of F=, H=, J=) is used to label the legend. For some examples, LABEL=NONE.
SHAPE=BAR(x,y) or =LINE(x) specifies the length and height of the rectangular area fill samples or the length of the plot line samples.
ORDER= specifies the order of the legend entries.
ACROSS= specifies the number of columns into which the legend entries are arranged. (Use DOWN= to specify number of rows instead.)
POSITION= specifies the location of the legend in the graph display area.
VALUE= (‘text1’ ‘text2’ . . . , with optional use of F=, H=, J=) is used to customize the text of the legend entries.

PLOT statements and options.
PLOT Y*X specifies that the vertical axis variable is Y and horizontal axis variable is X.
PLOT Y*X=Z specifies that there is to be a separate plot drawn for every value of classification variable Z.
HAXIS=AXISp and VAXIS=AXISq specify that statements AXISp and AXISq define the horizontal and vertical axis characteristics.
VZERO specifies that the vertical axis must start with 0.
AUTOVREF specifies that a horizontal reference line be drawn at the major tick marks on the vertical axis, even if tick marks not drawn.
LVREF specifies the line type used to draw the VREFs.
LEGEND=LEGEND1 specifies that statement LEGEND1 is to be used for the multi-line plot.
NOLEGEND specifies that no LEGEND be created.
PLOT2 Y*X=k specifies that a vertical axis must be drawn at the right-hand side, and that statement AXISk defines the axis characteristics.

Options Common to HBAR and VBAR Statements.
HBAR/VBAR Name specifies that the variable Name contains the values to label the bars.
SUMVAR=Value specifies that all values of Value for the same value of Name should be summed to determine the measurement (the so-called “response”) for that value of Name (the so-called “midpoint”). This also can be used when each Name value occurs only once.
WIDTH= specifies the non-default width of the bars.
SPACE= specifies the non-default space between the bars.
MAXIS=AXISp specifies that the AXISp statement defines the characteristics of the axis for the Name values (the so-called “midpoints”).
RAXIS=AXISq specifies that the AXISq statement defines the characteristics of the axis for the Value values (the so-called “responses”).
DESCENDING specifies that the bars be arranged in descending order of length (HBAR) or height (VBAR).

Option used here with VBAR Statements. (This is NOT used with HBAR.)
SUM specifies that the value of SUMVAR appears at the top of each bar.

Options used here with HBAR Statements.
SUMLABEL= specifies the heading for the column of SUMVAR values that always appear at the right margin of the bar chart.
FREQ=Value specifies that all values of Value for the same value of Name should be summed to determine the charted measurement for that value of Name. FREQ can be used when each Name value occurs only once. This sum is regarded as a “frequency of response”, but it can be the response variable itself, like SUMVAR=. This is the artifice used to create Figure 7.
FREQ specifies that a column of FREQ values be listed at the right margin of the bar chart.
FREQLABEL= specifies the heading for that column of FREQ values.
PERCENT specifies that a column of Percents of the Whole be listed at the right margin of the bar chart.
PERCENT LABEL= specifies the heading for that column of PERCENT values.

Options used here with VBAR Statements. (These CAN also be used with HBAR.)
GROUP= specifies that this third variable (besides what is assigned as Name and Value) will group sets of midpoint values (i.e., sets of what I call the Name variable).
GAXIS=AXISk specifies that the AXISk statement defines the characteristics of the “axis” for the GROUP variable. This “axis” is below (or to left of) the midpoint axis for VBAR (or HBAR).
AXIS3 . . . NOBRACKETS removes unneeded brackets that by default would span each group of bars.
PATTERNID=MIDPOINT specifies that the PATTERN statements are to used to distinguish bars *within* a group.

PIE statements and options.
PIE Name specifies that the variable Name contains the strings to label the slices.
SUMVAR=Value specifies that all values of Value for the same value of Name should be summed to determine the measurement (or "response") for that value of Name. This also can be used when each Name value occurs only once.
NOHEADING specifies that the default pie chart heading be omitted (it's neither elegant, nor necessary—every chart deserves a TITLE).
COUTLINE=CX000000 specifies that pie slices be outlined in Black.
WOUTLINE= specifies the width of pie slice outlines.
PERCENT=OUTSIDE specifies that each SAS/GRAPH-supplied Percent of Whole be displayed outside of its respective slice.
VALUE=NONE specifies that the values of Value not be displayed.
SLICE=ARROW specifies that each value of Name be displayed outside its respective slice, with an "arrow" connecting it to the slice.

Web-Publishing Your Graphs

To put your graph in a web page, use the GIF (or, if download time is not a concern, the PNG) driver, and wrap your graph code as follows:

```
ods html path='c:\YourFolderName' (url=none) body='YourWebPageName.html'
         gtitle gfootnote
         style=styles.YourWellDesignedStyle
        gpath='c:\YourFolderName';
 /* YOUR GRAPH CODE GOES HERE */
ods html close;
```

In this case, you omit the gsfname goption, and the filename for the GIF or PNG file. To control the name of the GIF or PNG file that is stored in the GPATH= folder, put NAME='XXXXXXXX' after the / in the PIE, HBAR, VBAR, or PLOT statement (or CHORO statement, in the case of a map), where XXXXXXXX is a unique 8-character name.

For web design and construction methods, see References 1-5.

For a compendium of well-designed web-enabled graphs, maps, and tables built with ODS, SAS, and SAS/GRAPH, see Reference 5.

If contemplating using an ODS Table of Contents, code for a well-designed TOC can be found in Reference 4.

Related Work by the Author

1. "The Power of Pictures and Paint: Using Image Files and Color with ODS, SAS, and SAS/GRAPH", *Proceedings of the Twenty-Eighth Annual SAS Users Group International Conference*, SAS Institute (Cary, NC), 2003.

2. "Effective Communication with Colour", *elsewhere in these Proceedings*.

3. With Francesca Pierri, "%TREND: A Macro to Produce Maximally Informative Trend Charts with SAS/GRAPH, SAS, and ODS for the Web or Hardcopy", *Proceedings of the Twenty-Seventh Annual SAS Users Group International Conference*, SAS Institute (Cary, NC), 2002.

4. "Web Communication Effectiveness: Design and Methods to Get the Best Out of ODS, SAS, and SAS/GRAPH", *Proceedings of the Twenty-Eighth Annual SAS Users Group International Conference*, SAS Institute (Cary, NC), 2003.

5. With Francesca Pierri, "Your Graphs and Tables at Their Best on the Web with ODS", *VIEWS 2001 Proceedings*, United Kingdom SAS Users Group (London, UK), 2001.

Notices

Author Information

Questions, comments, suggestions, and other solutions are welcome.

LeRoy Bessler PhD
Email: bessler@execpc.com
Phone: 1 414 351 6748 (evenings and weekends—time is six hours earlier than GMT)

Dr. LeRoy Bessler has special interests in: Software-Intelligent application development, which yields SAS solutions that are reliable, reusable, maintainable, and extendable; and communication-effective design and construction of reports, tables, graphs, maps, spreadsheets, and web pages.