

Draft

# **Using Graphs and Visuals to Present Financial Information**

**Joseph T. Kelley**

Graphics-based microcomputers have tremendously simplified graph design and production. Affordable laser printers now exist that can produce quickly high quality paper images. Production problems are no longer a valid excuse for not using graphs to explain financial data to management, legislative bodies, and the public. Increasingly sophisticated graphs are available in the daily newspaper, so the standard of comparison used by the average reader is rising steadily.

Because the wealth of possible graphs is so varied, we initially limit our discussion to financial graphs. After considering the basic forms we discuss other types, such as scientific or statistical graphs. As we shall see, within our chosen limitation the possibilities are still vast.

Since studies show that our minds retain only 10 percent of what we hear, but 50 percent of what we see, graphs are a powerful tool for presenting financial information. Because not all graphs are born equal: we must choose the best possible graph for whatever is the message. These materials demonstrate principles and provide copious illustrations of graphs with both strengths and weaknesses. The article points out the good points as well as the bad points, of each graph. The ugly are omitted entirely.

The graphs in these materials were produced by widely available spreadsheet software. Drawing software that is also widely available on major microcomputer platforms was used to improve some graphs. While spreadsheet graphs are generally adequate for in-house displays, presentations to outside groups can benefit from the additional emphasis provided by drawing programs and presentation software.

# Introduction

## Principal Focus

In this chapter we will focus on seven widely-available graphs that are easily produced by most any electronic spreadsheet. They are column graphs, bar graphs, line graphs, area graphs, pie graphs, scatter graphs, and combination graphs. Unfortunately there is no consistency in definitions for basic graphs. One writer's bar graph is another's column graph, etc. For clarity we will define each as we introduce them.

Traditionally we report data in written form, usually by numbers arranged in tables. A properly prepared graph can report data in a visual form. Seeing a picture of data can help managers deal with the problem of too much data and too little information. Whether the need is to inform or to persuade, graphs are an efficient way to communicate because they can

- illustrate trends not obvious in a table
- make conclusions more striking
- insure maximum impact.

Graphs can be a great help not only in the presentation of information but in the analysis of data as well. This article will focus on their use in presentations to the various audiences with which the finance analyst or manager must communicate. We will discuss several related topics as well.

## Use Graphs to Draw Attention to the Most Important Information

Studies show that the human mind can absorb and comprehend a graph more easily than a bland array of figures. If a picture is worth a thousand words, then surely a graph is worth a thousand numbers. But, like numbers, to communicate effectively a graph must present fairly the facts under discussion.

## Fairness of Presentation

No professional would present an audience with a table of data and make a claim that the data meant the opposite of what could be discerned from the table. Similarly, every graph must fairly present the data from which it is constructed. Fairness of presentation exists when a graph is:

- honest
- understandable
- able to attract and hold attention.

In this context, **honesty** can be defined as the faithfulness with which a graph actually represents what you purport it to represent. Without honesty, conclusions drawn from a graph are likely to be flawed or out-and-out false. You will find guidelines for avoiding some of the worst errors later in this article.

**Understandability** means that the intended audience will comprehend the graph. Since the technical sophistication of audiences varies, the complexity of graphs will vary as well. A graph appropriate for a comptroller to study may be unduly complex for a presentation to citizens. Understandability cuts to the core of the reason for using graphs. With it, relationships between data can be more easily understood, without it, you have only pictures clouded by obscurity.

A graph must possess an ability to **attract and hold attention** or the message will not be received by the intended audience. Visual appeal is essential: the eye must be drawn to the most important information with a minimum of superfluous lines: less is more when it comes to graphs. A good graph establishes or expands interest in the data it represents.

Graphs can save time because they can encourage an audience to grasp relationships more quickly than is possible from an arid matrix of numbers. When effectively used, a graph makes the message more explicit to an audience and helps the audience in thinking clearly about the issues at hand.

### **Cardinal Rules**

All graph producers who wish to foster understanding and generate interest should follow the three cardinal rules of graphing:

- explain every graph with words placed physically close to, and preferably on, the graph—without exception!
- refer to every graph in the body of the text. Always!
- polish your graph until it has maximum message and minimum ink.

Probably the greatest single weakness in the use of graphs is the failure to state clearly and concisely the point of the graph. If you do not know what the graph's point is, then the graph is just filler and the principle of "ruthless brevity" applies: if you can do without, do without.

In all forms of presentation, explain the graph for the user. While you might provide the message in accompanying text, graphs sometimes get separated from nearby text. For this and other reasons, every graph should have the message on the graph itself. Since a graph can have more than one possible message, an explicit statement of your message is essential.

Another major failing among graph aficionados is what this author calls a Fibber McGee graph. These graphs contain lines, columns, and text, the way Fibber's closet contained objects: cheek by jowl, tumbling out onto the page in a disorganized mess. You know there is a lot there, but the jumble is so confusing that it is hard to figure out what is important. The point of a graph should be clear: too many lines, columns, or text, in short, too much ink, can easily obscure the message. Focus on maximizing the message, not the ink!

Remember: "Graphs are used to meet the need to condense all the available information into a more usable quantity. The selection process of combining and condensing will inevitably produce a less than complete study and will lead the user in certain directions, producing a potential for misleading."<sup>1</sup> Always take care to see that a graph never misleads an audience.

In the past just inserting a separate page containing a graph into a report would dazzle a reader. Now, hardware and software allow for the effective integration of graphs into a

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<sup>1</sup>Anderson, Anker V. **Graphing Financial Information**. New York, NY: National Association of Accountants, 1983. p 15.

word-processed document. This is the standard to which this article encourages the reader to aspire.

### **Maximum Message, Minimum Ink**

In deciding whether you have achieved the best graph possible, ask yourself: “Does my graph have maximum message and minimum ink?” If there is any way to increase the impact of the graph or to make its message clearer or more direct, you should do it. If there is any way you can remove some ink from the graph without reducing the impact of the message, do so and you will have an improved graph.

A steady application of the principal of maximum message and minimum ink will always result in an improved graph, as we shall see.

## Using Graphs for Analysis (Understanding) and Presentation (Explaining)

Graphs are useful for understanding the meaning of data and for explaining that meaning to others. Graphs used to be so difficult to produce that they were used only for formal presentations, the main application discussed in this article. Fortunately, spreadsheet packages and graphing programs exist that so simplify the process of producing graphs that new uses for graphs have become practical.

### Analyzing Data

A little known use of graphs is for the discovery of data entry errors. Many such errors consist of transposed digits that look similar to the eye, as digits, but visually break a trend in an emphatic way. Perhaps the curve will display a sharp spike or a steady upward trend will inexplicably reverse itself for one year. Research these points: start with asking if the data were keyed correctly, then if the data are correct. You will often discover an error in the source data.

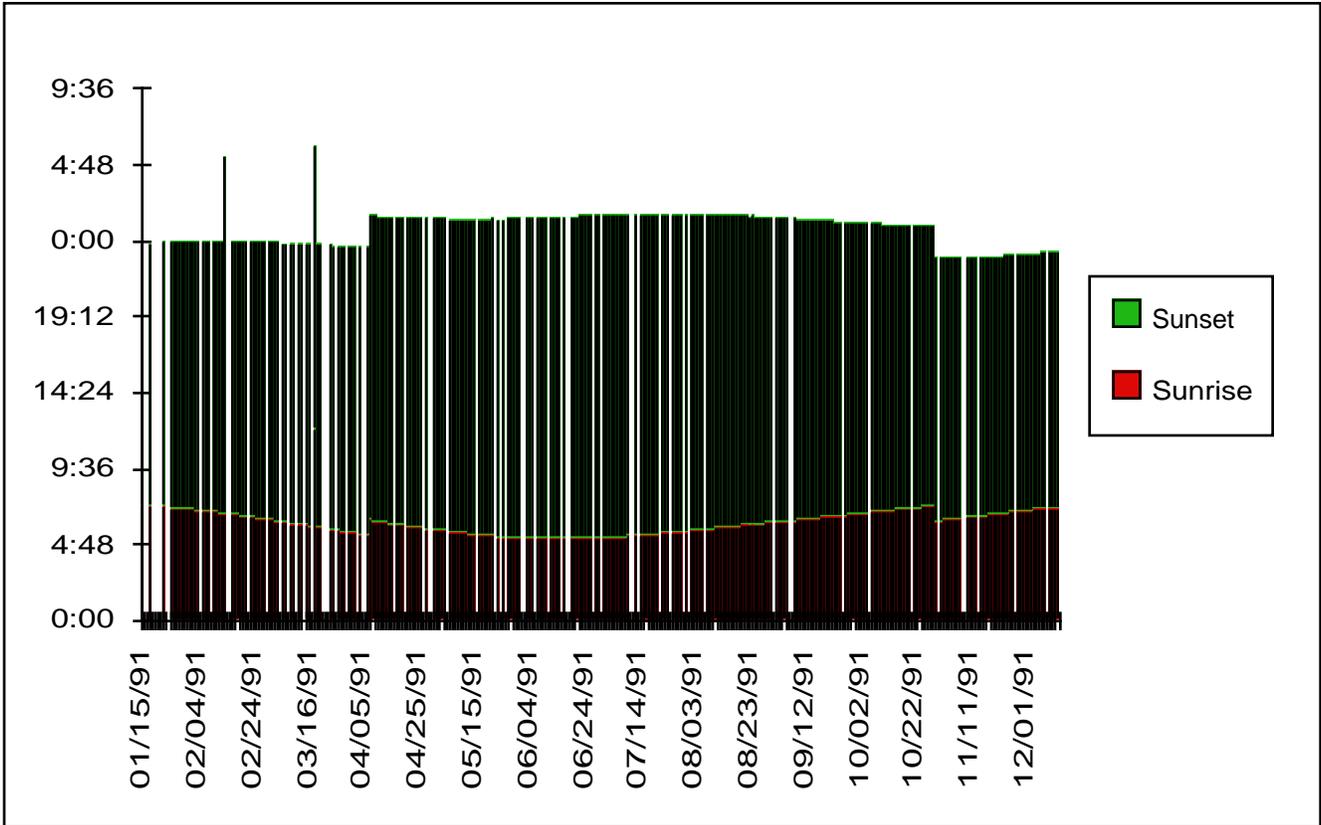
Graphs excel at helping the user in the search for expected relationships that are of use in predicting future costs. For instance, the rate at which the tonnage of trash is increasing has implications about the cost of waste disposal. On the other hand, the absence of an expected trend can either be a major discovery or an indication of errors in the data. In either case, thoughtful graphs display the trend quickly and help the analyst save time and effort. The analytical value of graphs is little discussed but very real.

Because carefully prepared graphs can greatly help the mind in understanding data, the right graphs can tremendously facilitate the process of analyzing the past and predicting the future. Repeatedly re-graph your data in various styles such as lines and columns. Because data can contain more than one message, different graphs might reveal different messages to the data analyst. Trying different graphs is like using different lenses in photography. One moment you are drawn to a detail and the next to the wide picture before you.

### An Application in Practice

The use of graphs to analyze data — to gain an initial understanding of what the data actually say — seems to be much less widely known than the use of graphs to present data. An examination of one case will be useful.

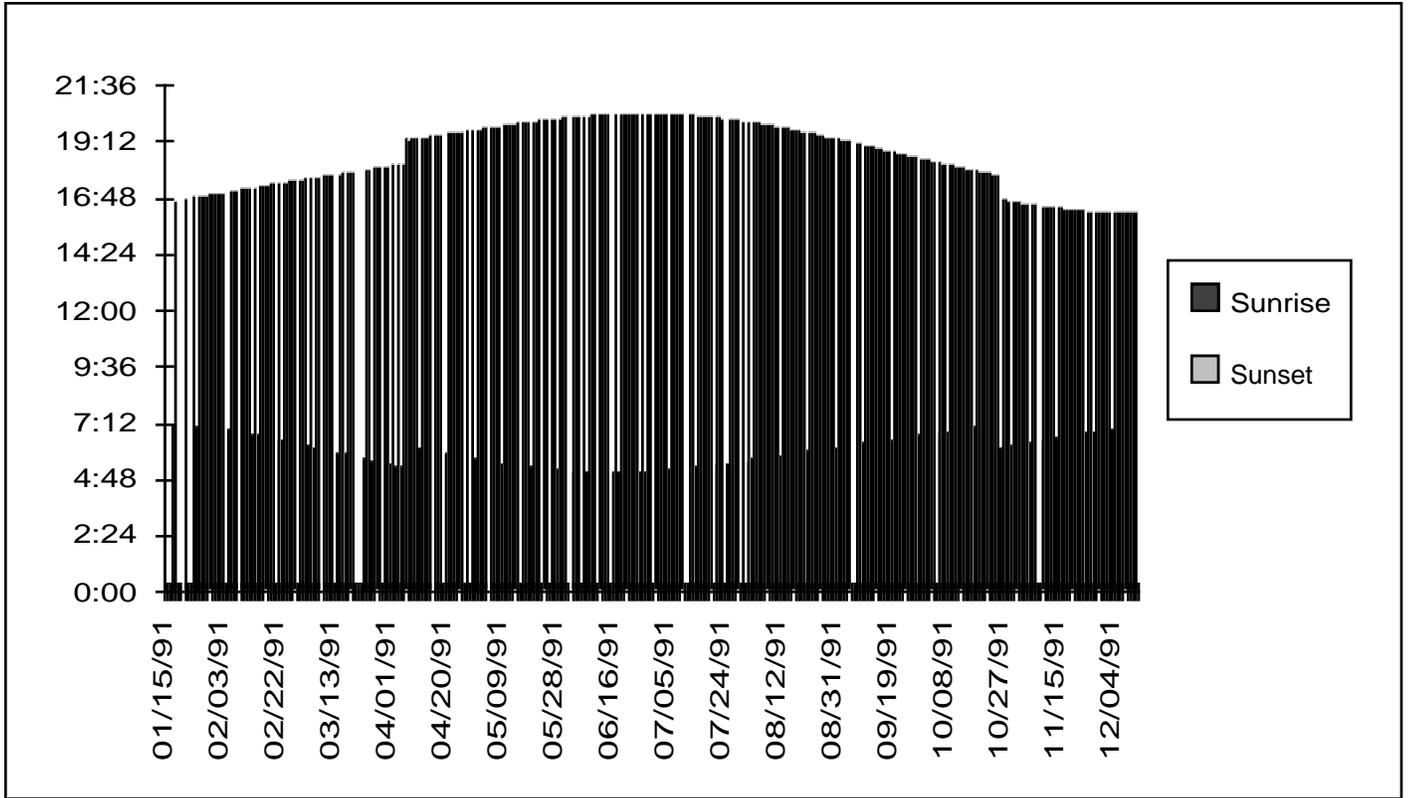
The gathering of the data we are going to look at started with my curiosity about how the length of the day varied during the year in Boston (where I was living at the time). I keyed in sunrise and sunset data from the Boston Globe into a spreadsheet for nearly a year and then decided to graph the data as a column graph. The initial results are shown below:



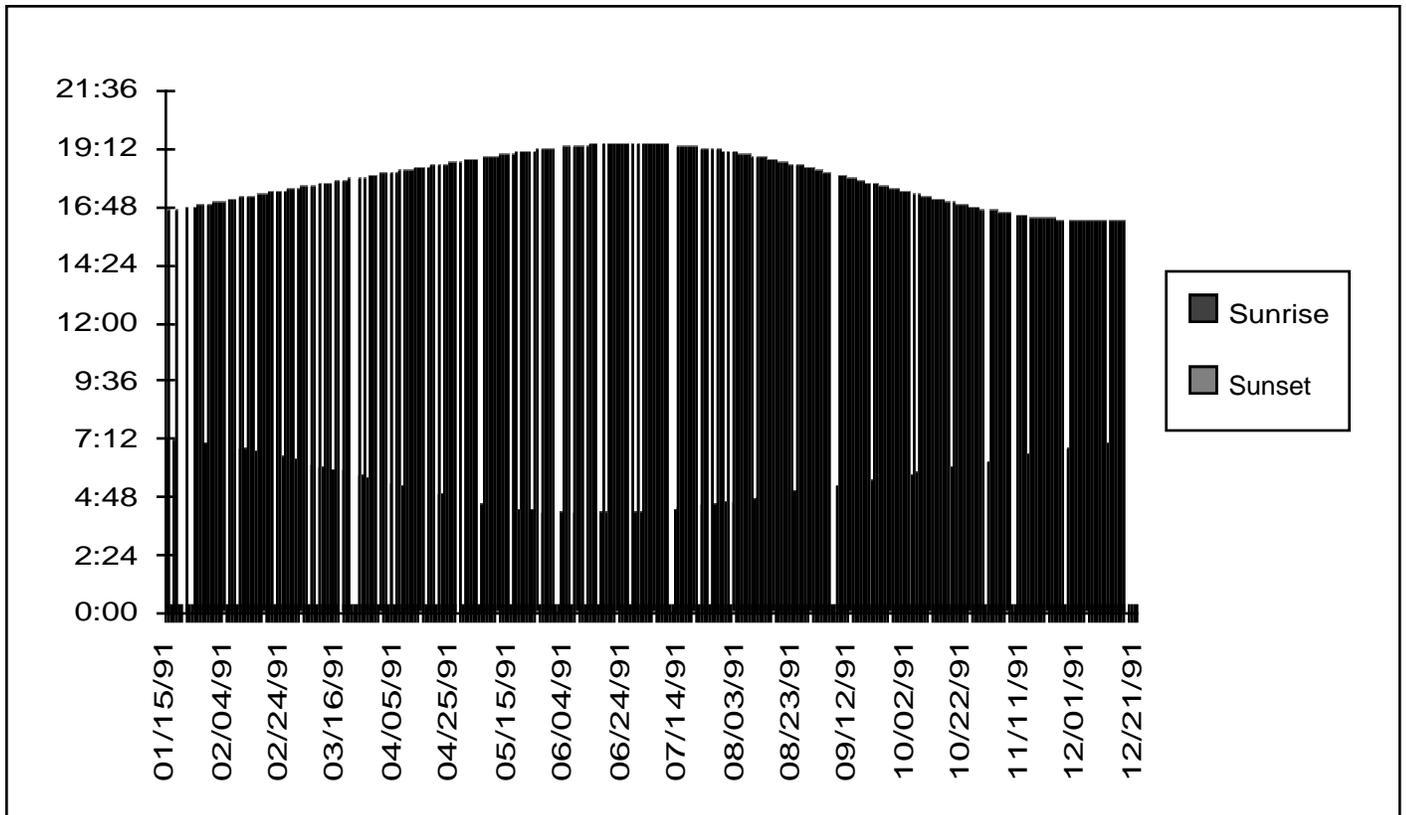
The graph above has a lot of problems but the outstanding ones are the wildly inaccurate data points indicated by the two “spikes” on the left hand side of the graph. Examination of the data showed that the Globe had printed an incorrect value in one case and in the other, I had miskeyed an entry.

POINT: Graphs can be very useful in finding errors in data.

I fixed the discrepant data and graphed the result.



The graph now showed the regularity I had expected but, given that it should be regular, what was the sudden rise in the middle of the graph? Looking at when it started and ended gave the hint. This was the graphical impact of daylight savings time. Daylight savings time is an example of a “change in base” that we will discuss later. For our purposes this means that we should adjust for this change by reversing the effect of daylight savings time by moving sunrise and sunset back one hour from April to October.



The graph now shows the changes in sunrise and sunset with the space between indicating the length of the day.

## Presenting Information<sup>2</sup>

Presentation is the joint process of:

- understanding what you want to say: the message
- saying it.

Graphs, because they are pictures, are particularly appropriate for presentation of financial information.

After using graphs for analysis, decide your message and choose your graph style. Don't decide immediately; look at your data in a variety of graph styles; play with it, think about it. When you have decided clearly what you want the graph to say, start to simplify the graph: are all the components really needed? Is the horizontal, category axis label really needed or is it clearly implied by the data? Could some unattached text eliminate the need for a formal legend? Are all the variables really necessary? Can some ink on the page be omitted?

POINT: Cut, prune, pare, slice, and shape your graph to say loudly and simply only one thing: your message.

<sup>2</sup>The author is grateful to Bob Ardiel, Commissioner of Finance and Administration of Medicine Hat for his pioneering approaches to presentations using graphics.

## Draft

Before making a presentation of a graph, ask yourself “what is the message that I wish to communicate with this graph?” Are you seeking to inform or persuade? Will the presentation be in a small room or a large one? Is the audience technically adept or untrained in the ideas you will discuss? How much time do you have at your disposal? If you feel the need to use many graphs, can you intersperse the presentation with relevant photographs or vary it by asking questions of the audience?

Presenting financial information requires a careful understanding of both “what you want to say” and “who you need to say it to.”

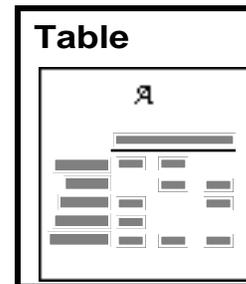
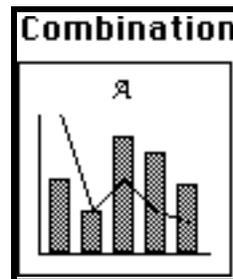
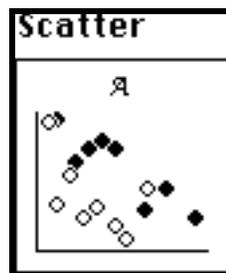
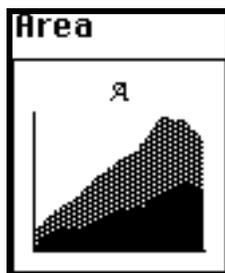
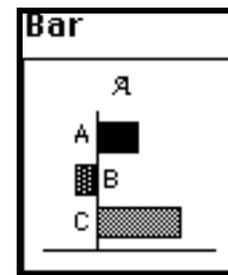
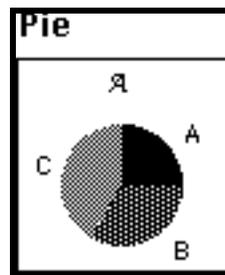
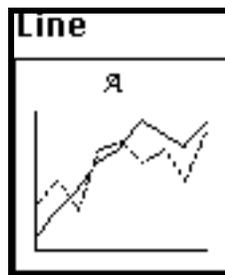
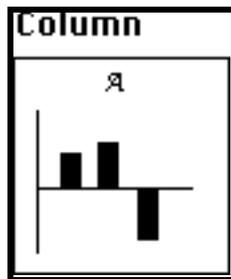
## Graphs Commonly Available for Presentation

The kinds of graphs that are at your disposal will vary somewhat with the software chosen for their production. This article will concentrate on the graphs that can be produced by widely available software products.

The seven basic types of graphs (and tables) discussed are

- column
- bar
- line
- pie
- area
- scatter
- combination, and
- numeric tables

Each will be discussed in turn with various examples given. In addition, tables of data will be discussed as well. The pictures below give a graphical suggestion of the types discussed.



## Column Graphs

### Definition

Column graphs consist of patterned rectangles displayed along a baseline called the x-, category or the horizontal axis. The height of the rectangle represents the amount of data.

The left-to-right bias most people possess, makes column graphs more appropriate for time series data than bar graphs.

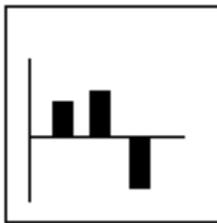
### Purpose

Column graphs best show:

- changes in data over time (short time series)
- comparisons of several items (relationship between two series)

### Usage

#### *Short time series*



Basic Version

Column graphs are an appropriate choice for short time series data because of most readers' left-to-right bias.

However, for more than four time periods, line graphs are usually a better choice; column graphs can put much ink on the page and overwhelm the message. But when a message is a general trend, columns can work as well as lines. Column graphs can also provide variation in a presentation with a number of graphs.

#### *Relationships between two series*

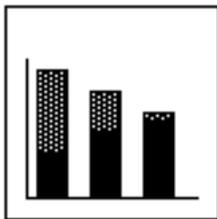


Comparison

Use column graphs to compare several items—a maximum of three.

Comparisons between series have many variations of their own since the columns are frequently overlapped to a greater or lesser degree. Remember when using overlapping that readers generally assign greater psychological significance to the foreground column. Take care that this precedence is appropriate or at least does not mislead.

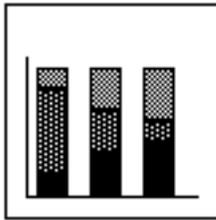
#### *Changes in composition over time—actual numbers*



Stacked Columns  
Actual Numbers

It is often interesting to know the components of some statistic. For instance, seeing the major components of total revenue can sometimes be useful. Stacked column graphs are appropriate in these cases.

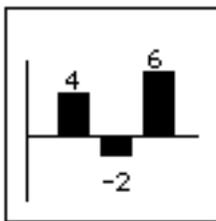
*Changes in composition over time—percent composition*



Stacked Columns  
Percent Composition

If relative change in composition is the message, percent composition is a better choice. In percent composition, the columns are all the same height because they add to 100 percent. Keep the number of sections small, five at maximum.

*Column values as part of the graphs message*



Columns with  
Data Values

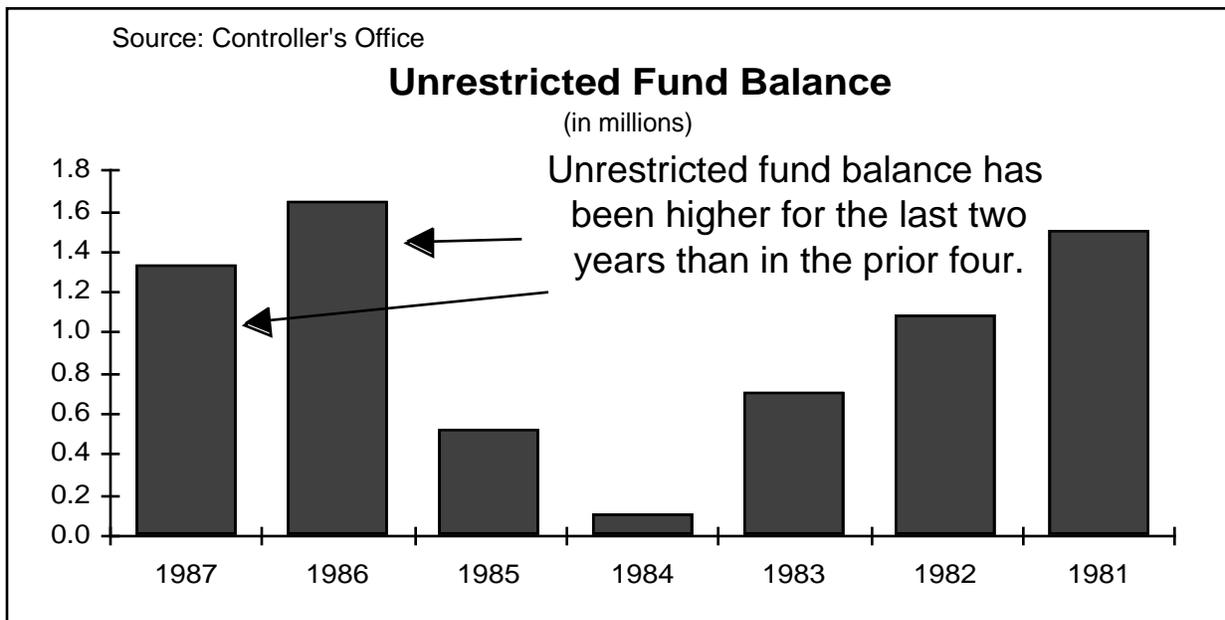
Sometimes the actual values of one or more columns are part of the message. While this variation can often be combined with others, remember that the more ink on the page, the more confusion the message is subject to. If you put the data values on all the (important) points, consider eliminating vertical axis as superfluous.

Data values are also useful when deviation from a norm, standard, or desired situation is the message.

**Sample Column Graphs**

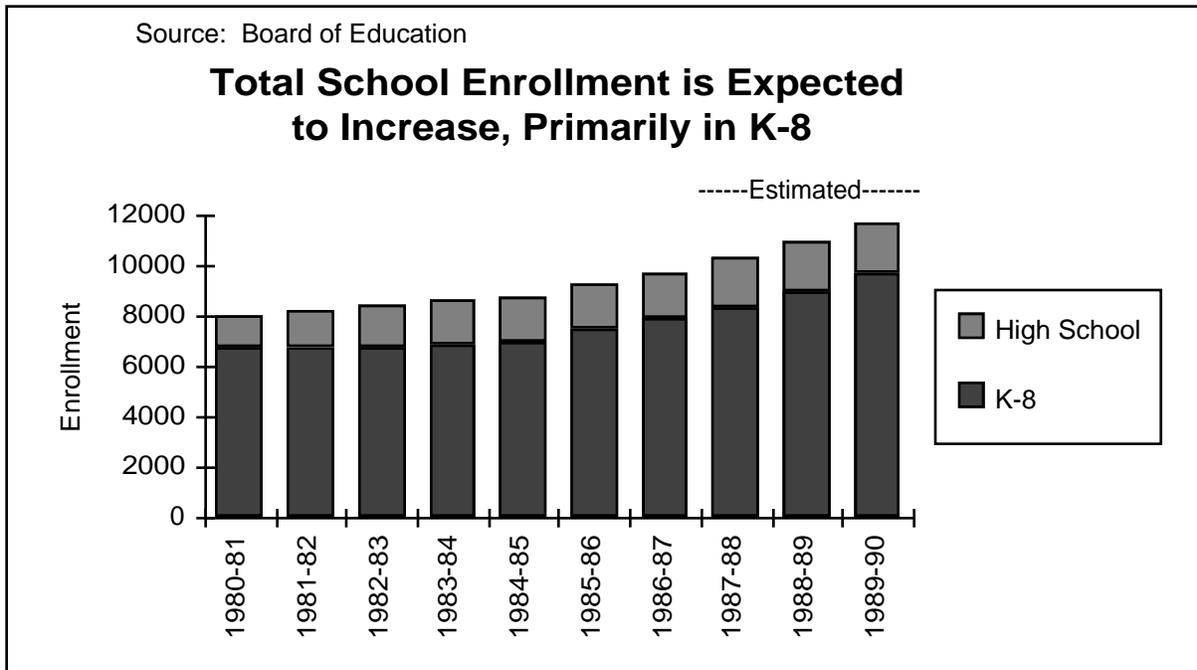
Compare the column graphs that follow.

**Column Graph 1**



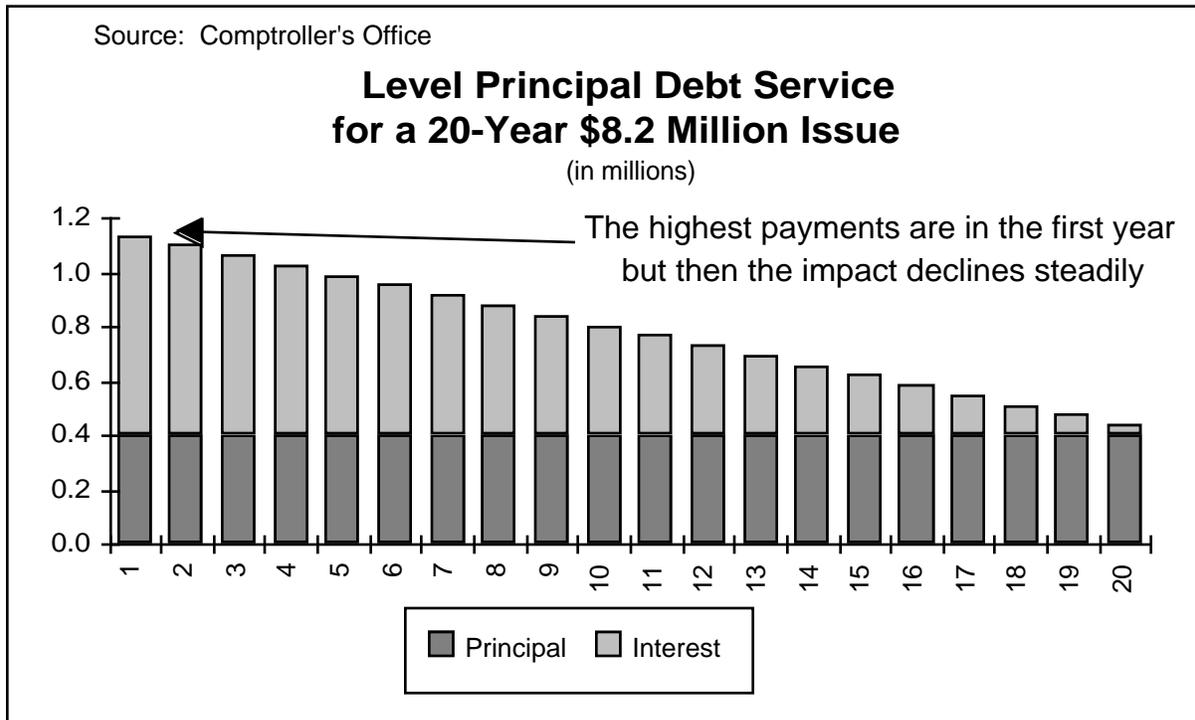
General Description	A column graph show a time series of fund balance results.
Axis Labels & Legends	The y-axis is labeled in the title. Note the non-standard reversal of the usual left to right flow for time. This puts the recent years near the labels on the y-axis.
Other Possibilities	A better presentation of this data would be to put the y-axis on the right hand side and have the data makers increase from the left.

### Column Graph 2



General Description	<p>A stacked column graph that shows total school enrollment as the “sum” of K-8 and High School. Note that the legend takes up valuable space on the side. Placing the legend below the graph would have freed up very useful “real estate.” In general, legends are best placed below data—when you need one at all.</p> <p>The significance of the K-8 trend requires that it be the bottom of the stack for maximum impact.</p>
Other Possibilities	Paired columns might tell the story just as well.

### Column Graph 3



General Description

Stacked columns showing dollar impact of a debt issuance over the 20-year life of the issue.

Axis Labels & Legends

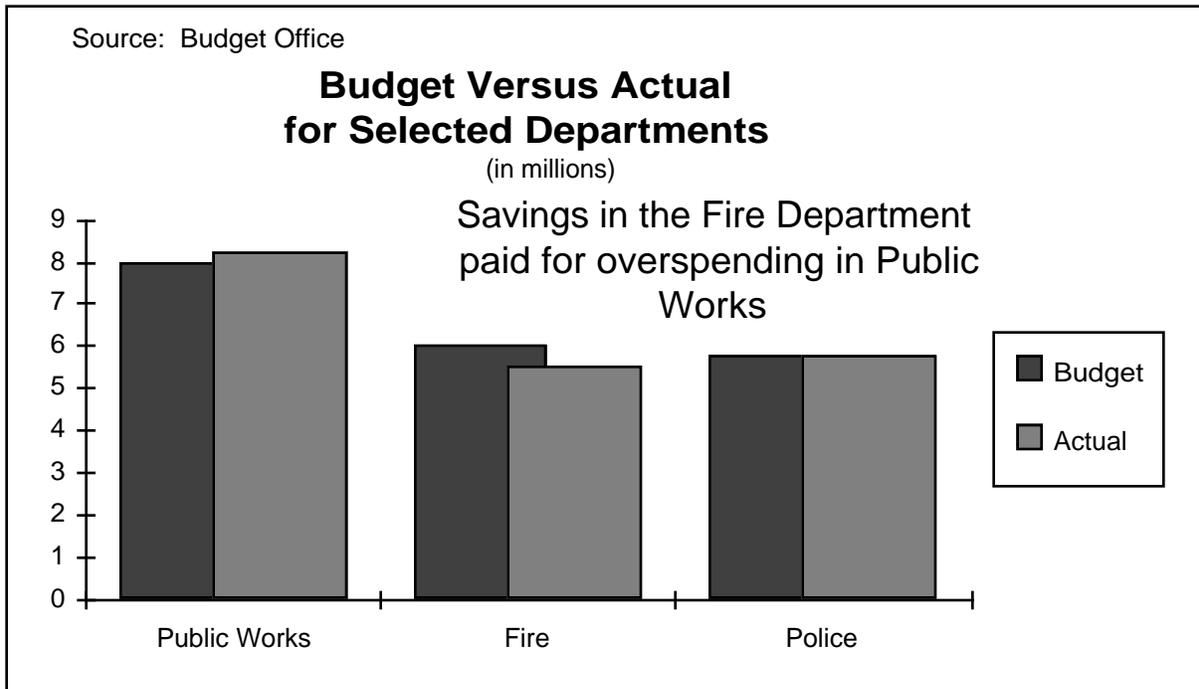
The x- and y-axes are implicitly labeled.

The legend takes up less scarce horizontal space when it is placed below the graph.

Other Possibilities

The legend might be replaced with attached text point at the principal and interest portions of each column.

### Column Graph 4



General Description

Side-by-side columns show budget versus actual figures for the three largest departments.

Axis Labels & Legends

Placement of the legend to the right does no harm in this instance.

Other Possibilities

The values might be placed on the tops of the columns but what is at issue is a principle not the precise amount of overspending.

There is no natural ordering of departments, so a bar graph might have been used.

## Bar Graphs

### Definition

Column graphs in which the rectangles are arranged horizontally. The length of each rectangle represents its value.

### Purpose

Bar graphs best show:

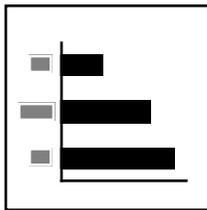
- data series with no natural order.

A bar graph is without the left-to-right bias of a column graph since the presentation is vertical. Thus bar graphs are particularly appropriate whenever time is not the order of the data or when there is no natural order. If the data are a time series, a carefully chosen column graph is generally more appropriate but bar graphs can be used to vary a presentation when many column graphs of time series are used.

Much of the discussion of variations of bar graphs parallels that of column graphs and so will not be repeated here. One modest advantage of bar graphs is that there is greater horizontal space for variable descriptors. For bar graphs, the vertical axis is the category axis.

### Usage

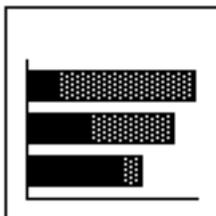
*No natural order of data*



Basic Version

Whenever data have no natural order, bar graphs are the first choice. Generally, you should organize the bars from largest to smallest or vice versa for maximum visual appeal.

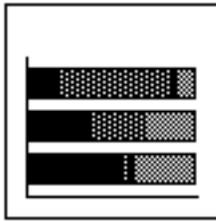
*Change in composition in absolute numbers*



Stacked Bars  
Actual Numbers

Stacked bars are useful to represent change in composition of a whole in terms of actual numbers.

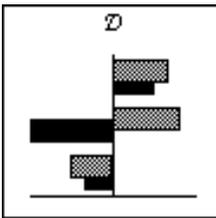
*Change in percent composition*



Stacked Bars  
Percent Composition

Stacked bars can also be used to reflect changes in percent composition. This form can be an effective alternative to two pie charts showing percent composition for two or more time periods.

*Comparison of two or three variables having no natural order*



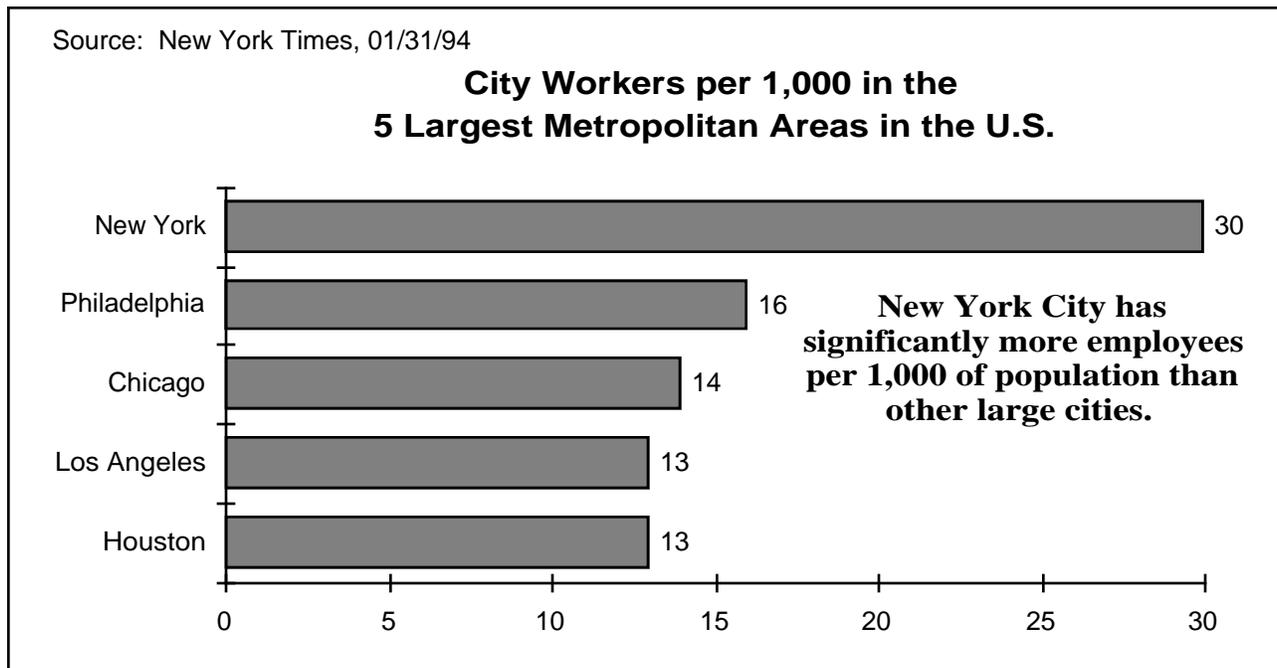
Comparison of  
Two Variables

Stacked bars can be used to compare two or three variables. They are most effective when there is no natural order to the variables.

**Sample Bar Graphs**

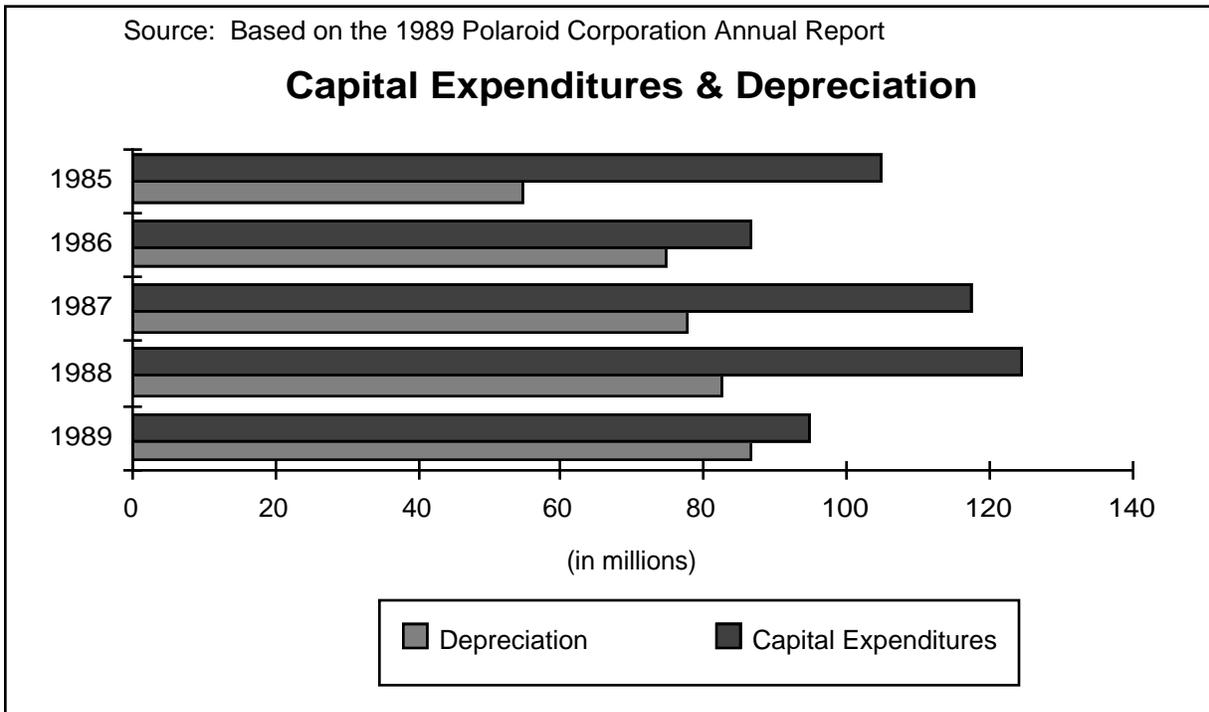
Compare the bar graphs that follow.

**Bar Graph 1**



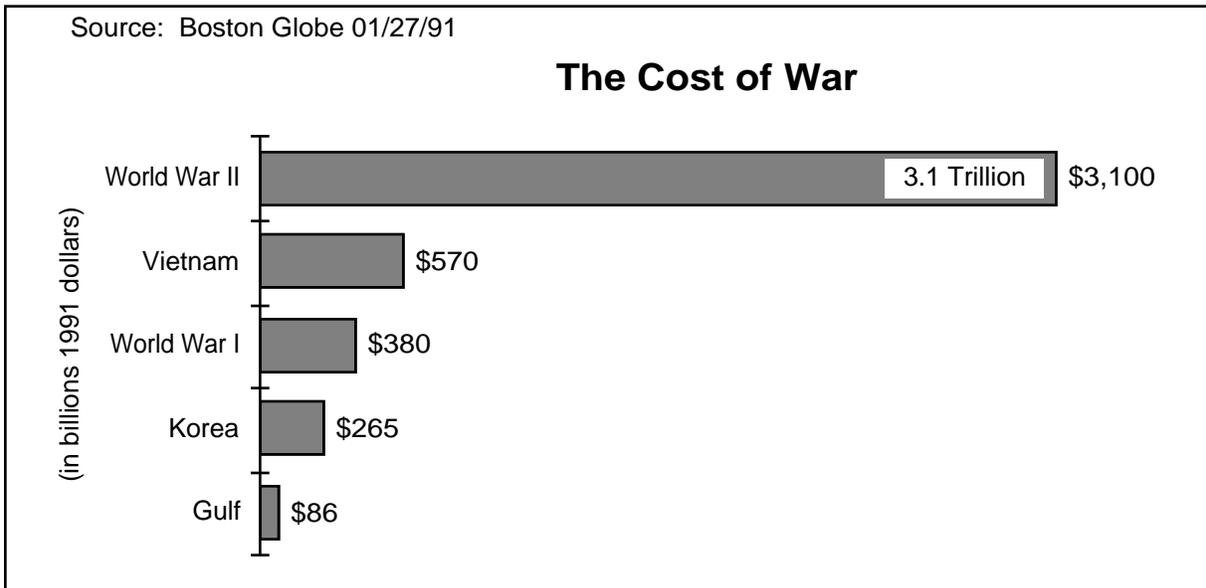
General Description	A bar graph that shows municipal employment per 1,000 population for the five largest metropolitan areas.
Axis Labels & Legends	Note the superfluous axis at the bottom. The horizontal axis should be omitted since each bar is marked with its value.
Other Possibilities	The data could be ordered from smallest to largest but this might weaken the visual impact of the New York City data.

### Bar Graph 2



General Description	An overlapped bar graph comparing depreciation (the wasting of capital assets) and new capital expenditures. Since these ideas relate philosophically, the overlay is appropriate.
Axis Labels & Legends	The horizontal (value) axis is labeled to show the scale.
Other Possibilities	The first choice on this type of data might be a column graph but this bar graph might be providing some variation in a report.
Comments	The annual report from which this came failed to explain the significance of the data. Other sources indicated that creditors might have felt that capital expenditures were too large.

### Bar Graph 3



General Description	A bar graph comparing the cost of the nation's wars in constant dollars.
Axis Labels & Legends	The horizontal (value) axis is labeled to show the scale in billions of 1991 dollars.
Other Possibilities	The data might be sorted so that the largest bar appears at the bottom; however, the largest bar at the top seems to be more striking.
Comments	Since each bar is labeled, a horizontal axis is superfluous.

Other uses of bar graphs might include:

- a display of the percent usage of various schools
- a graph of the average years of training for employees of different departments
- the presentation of the results of a citizen survey on public attitudes about a particular service. Each 100 percent bar might be subdivided by such categories as "very satisfied," "satisfied," and "dissatisfied." The different bars would address such issues as general satisfaction with the service, the quality of the service, and frequency of the service.
- a display of employment by industrial category.

## Line Graphs

### Definition

Line graphs connect data points with lines; different series are given different line markings (for example, dashed or dotted) or different tick marks.

### Purpose

Line graphs are useful when the data points are more important than the transitions between them. They best show:

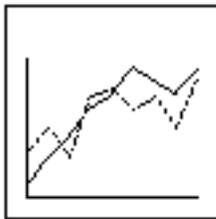
- the comparison of long series
- a general trend is the message.

Four series are the maximum that can be effectively compared. If the lines cross significantly, the graph may not even handle four series. If you have many series, consider more graphs with fewer series on each. Remember that the line marking may, or may not, be very distinctive to the eye. This is a serious consideration in the choice of the right line graph. An alternative is to show data point markers but this can be obnoxious. Yet, especially if the lines cross, the individual time series cannot be distinguished without markers.

Many line graphs do not display well on overhead transparencies because the lines are too thin. The solution is to choose thicker lines when the graph will be projected.

### Usage

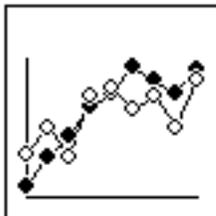
#### *Time series with numerous data points*



Basic Line Graph

Line graphs are the first choice when there are numerous data points. However, if there are multiple series whose lines cross frequently, the ability of the reader to understand the graph may be severely limited. Generally four series is the largest number of series that can be placed on one graph.

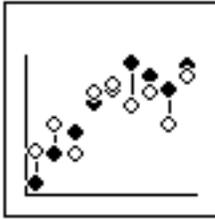
#### *Line graphs with data point markers*



Line Graph with  
Data Point Markers

Data point markers put a lot of ink on the page so they should be avoided, if possible. When the series are close together or frequently crossing they may be a necessary evil.

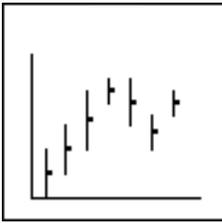
*High-low graphs*



High-Low Graph

High-low graphs show variation in a variable, usually over a fixed time interval (daily, weekly, etc.). Markers, if they are too large, can obscure the variation.

*High-low-close*



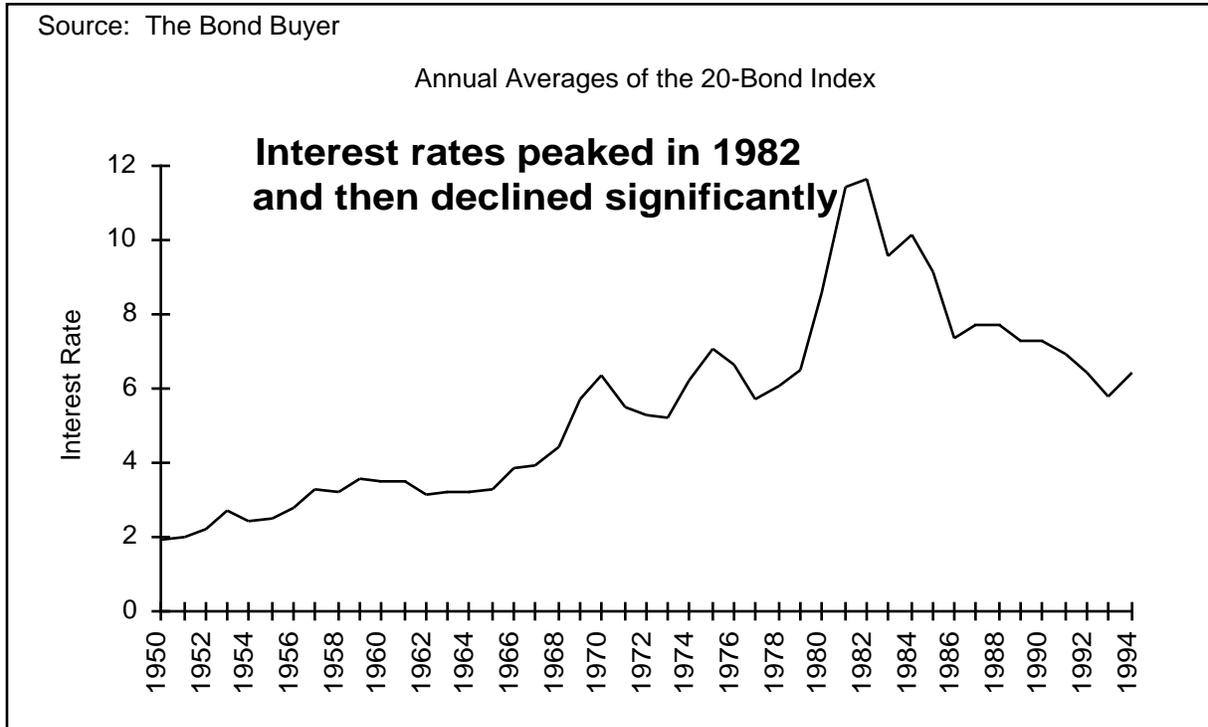
High-Low-Close Graph

High-Low-Close graphs are useful when the value of the variable at the end of the time period is as important as the variation.

**Sample Line Graphs**

Compare the following line graphs.

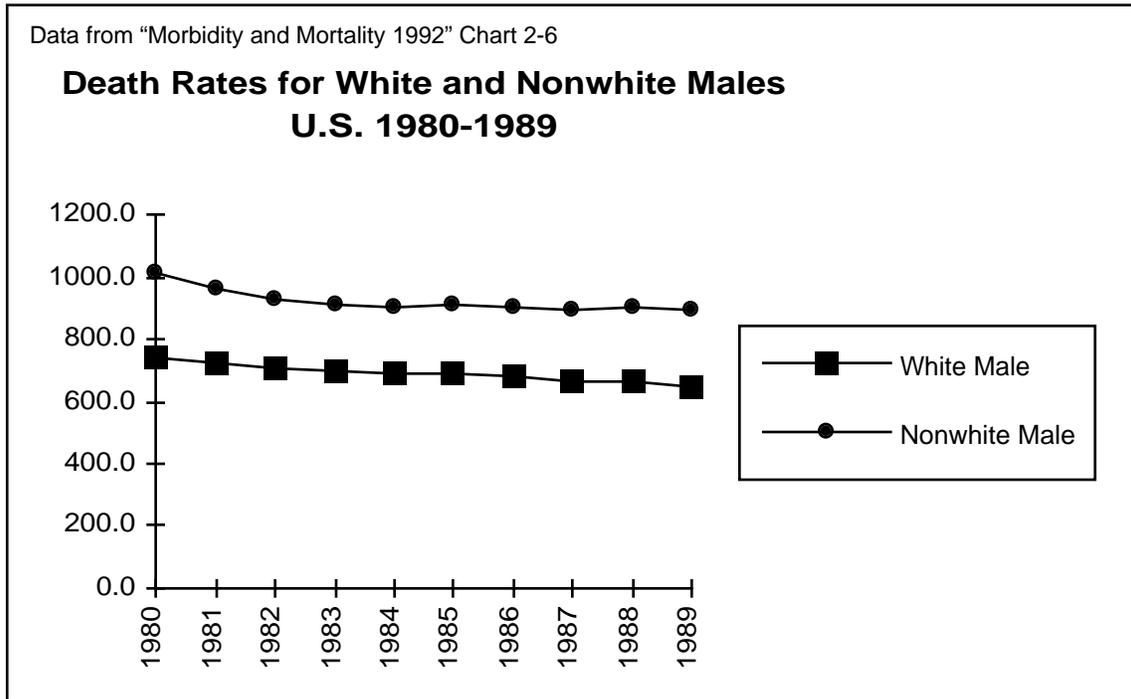
**Line Graph 1**



General Description A line graph showing the rise and fall of interest rates over a 44 year period.

Axis Labels & Legends Implicit labeling on the x-axis with no legend.

### Line Graph 2



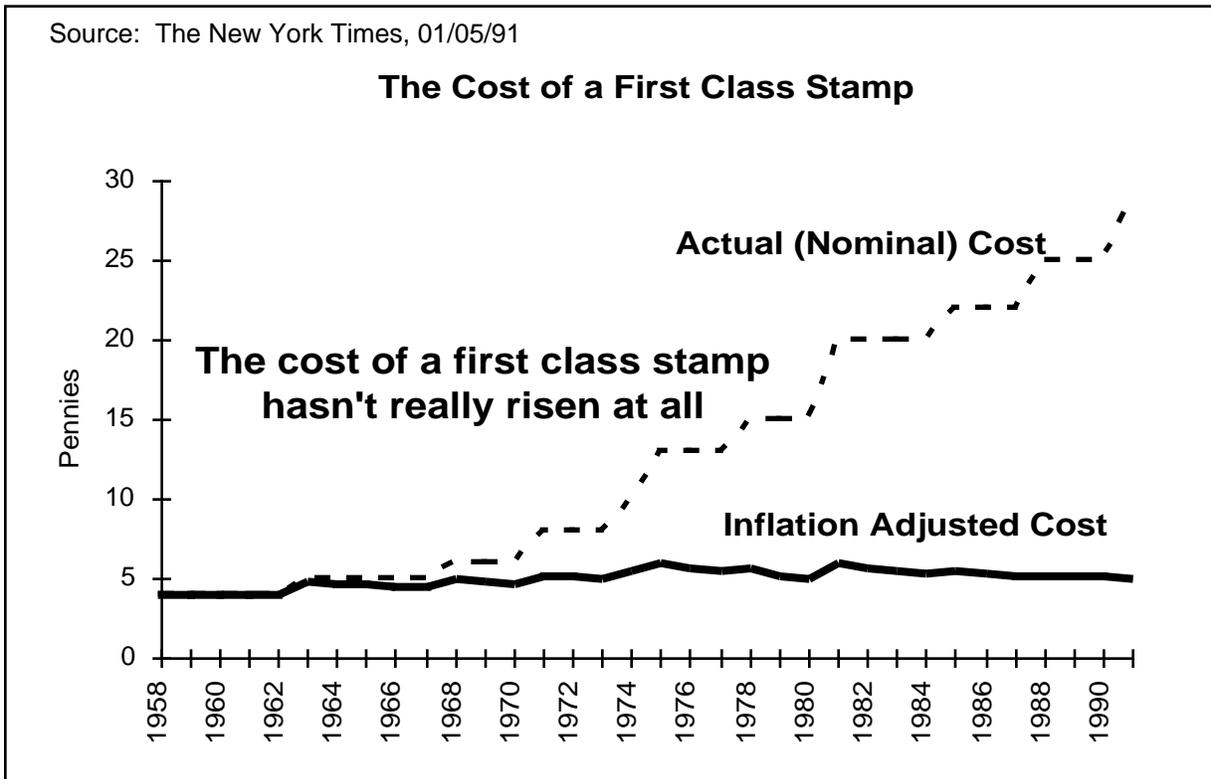
General Description A line graph showing a comparison between white and nonwhite death rates over ten years.

Axis Labels & Legends Implicit labeling on the x- and y-axis and a legend.

Other Possibilities The tick marks are quite "clunky" and detract from the visual appearance of the graph. If the overall trend is the message, using different line types could be more effective.

The legend below the graph would probably improve the presentation.

### Line Graph 3



General Description

A line graph showing a comparison between the nominal (actual) cost of a first class stamp and inflation adjusted cost.

Axis Labels & Legends

The vertical axis is explicitly labeled, the horizontal one only implicitly.

## Pie Charts

### Definition

A pie chart is a circle with radii connecting the center to the edge. The area between two radii is called a slice. Data values are proportionate to the angle between the radii.

### Purpose

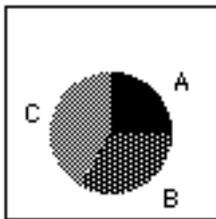
Pie charts best show:

- parts of a whole

Be wary of too many slices since they result in a cluttered graph. Six slices are as many as can be handled on one pie.

### Usage

#### *Parts of a whole*

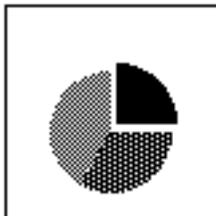


Classic Pie Chart

The classic pie chart is useful for discussions of the composition of a whole. The A, B, and C can be either text or, dollar amounts, or percents. Thus, pie graphs also allow for absolute or percent compositions.

If you have trouble fitting descriptors because the small slices are too close together, alternate fat and thin slices; this will make room for the descriptors.

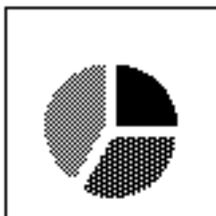
#### *Parts of a whole with emphasis on the 12-O'clock slice*



Slice Separated

Studies show that the 12 o'clock slice is the one to which the viewer's eye is attracted—even in an unexploded pie. The degree of emphasis you wish to give the piece which starts at 12 o'clock determines your choice.

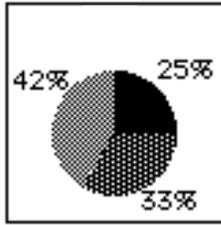
#### *Fully separated pie*



Fully Separated

Occasionally it is useful to separate all the pieces of a pie chart.

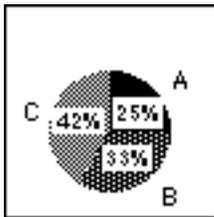
*Parts of a whole with percents*



Percent Composition

Pie charts are such a natural choice for presenting composition of a whole that they are frequently produced with percents applied to each slice. When the underlying numbers that generate each slice are as important as the percents, they should be presented as well. See next example.

*Parts of a whole with percents and labels*



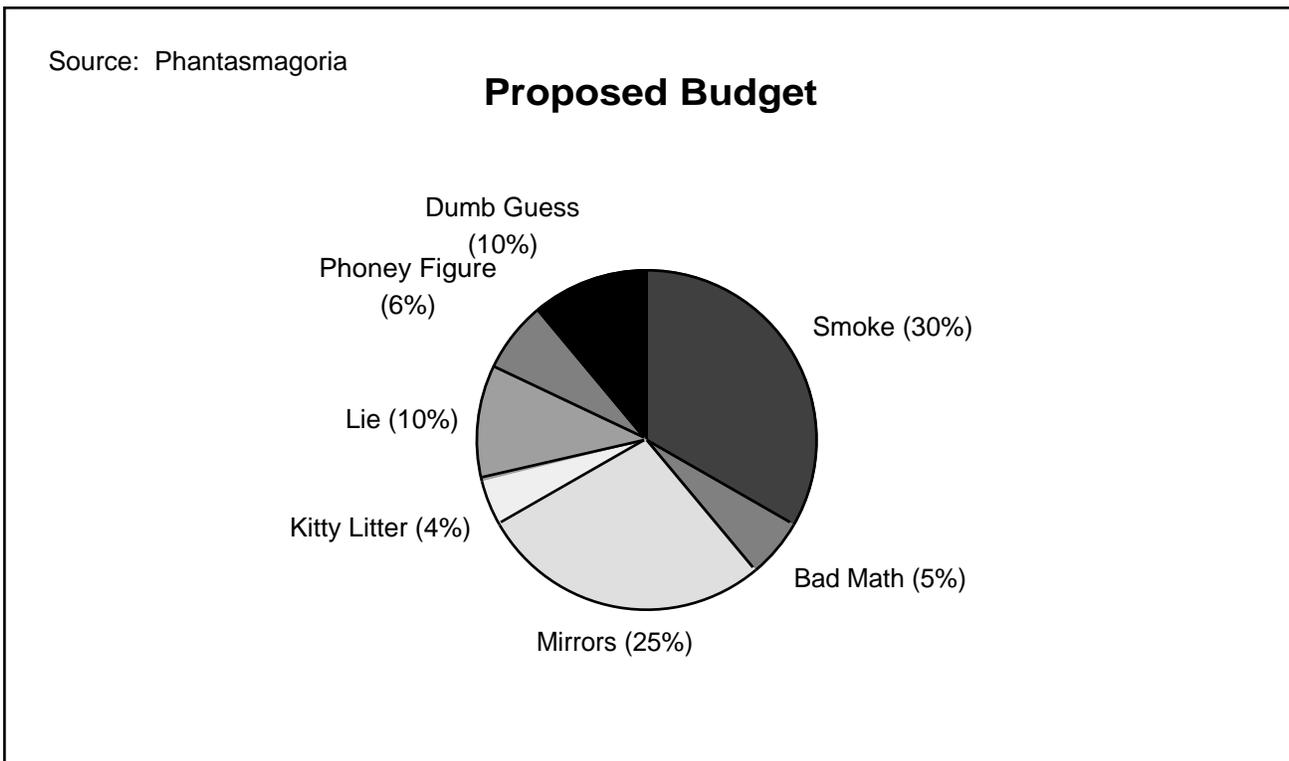
Labels & Percents

As a rule, all pie charts should show the name of the pie slice, its percent of the total and its actual amount unless the data not on the pie are in a table on the same page.

**Sample Pie Charts**

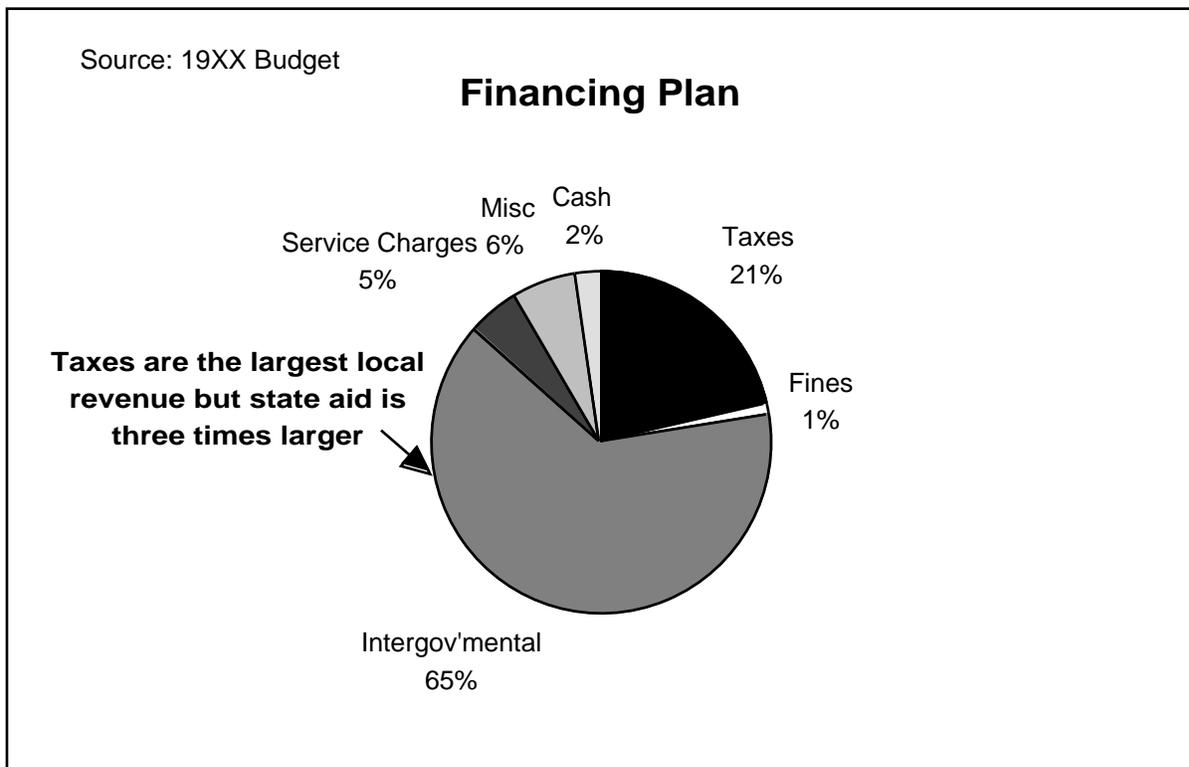
Examine the following pie chart.

**Pie Chart 1**



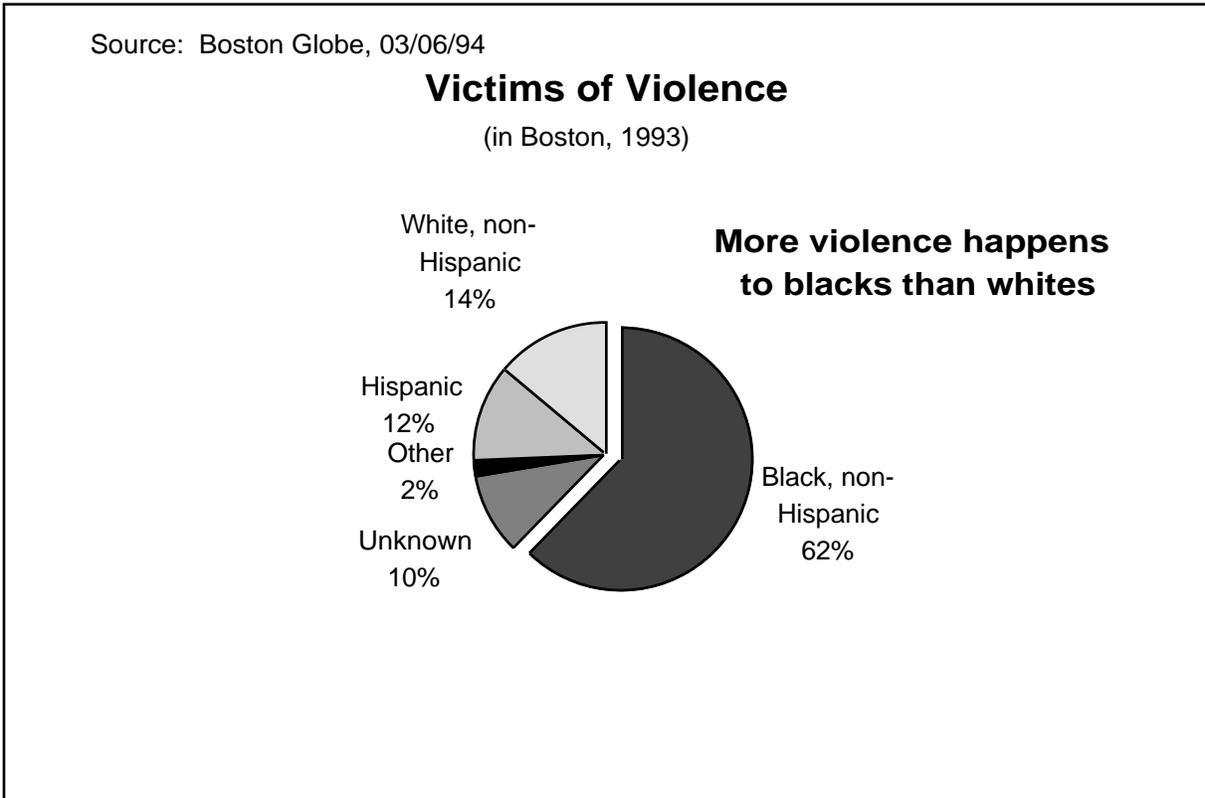
General Description	The pie above shows that graphs can be used to express a sense of humor as well as parts of a whole. Is there anything numerically odd about this graph? (Hint: To what number should the percents of the parts of a whole always add up?)
Legend	No legend needed.
Other Comments	To fit text neatly around the pie, it is often useful to alternate large and small slices by careful preparation of the data table.

### Pie Chart 2



General Description	An example of a classic revenue composition pie chart.
Legend	No legend needed since each slice is labeled.
Variations	A legend might be used with each slice showing only a percent or an amount.

### Pie Chart 3



General Description

A pie chart showing the percent composition of victims of violence in Boston in 1993.

Legend

No formal legend is needed as the slices are individually labeled.

Comments

The 12-o'clock slice is exploded for emphasis.

## Area Graphs

### Definition

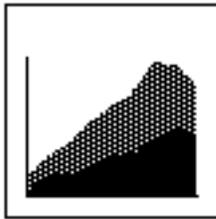
Area graphs are “stacked line graphs” in the sense that values are added to the variables below. Unlike line graphs, the space between lines is filled with shadings.

### Purpose

Area graphs are similar to line graphs with the added drama of shading between lines to emphasize variation between whatever the lines represent. They differ from line graphs in that the shaded areas are “added” one on top of the next. Thus, the scale provides accurate measurements only for the lowest part of the graph. This can cause misinterpretation if not fully understood. If reasonable, consider putting the “flattest” graph on the bottom.

### Usage

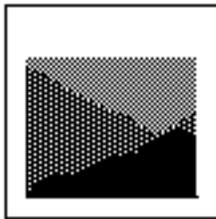
*Change in composition in actual numbers*



Area Graph  
Actual Numbers

Like line graphs, you should use area graphs to display series with many data points. Area graphs can show the change in composition over time in actual numbers.

*Change in percent composition*



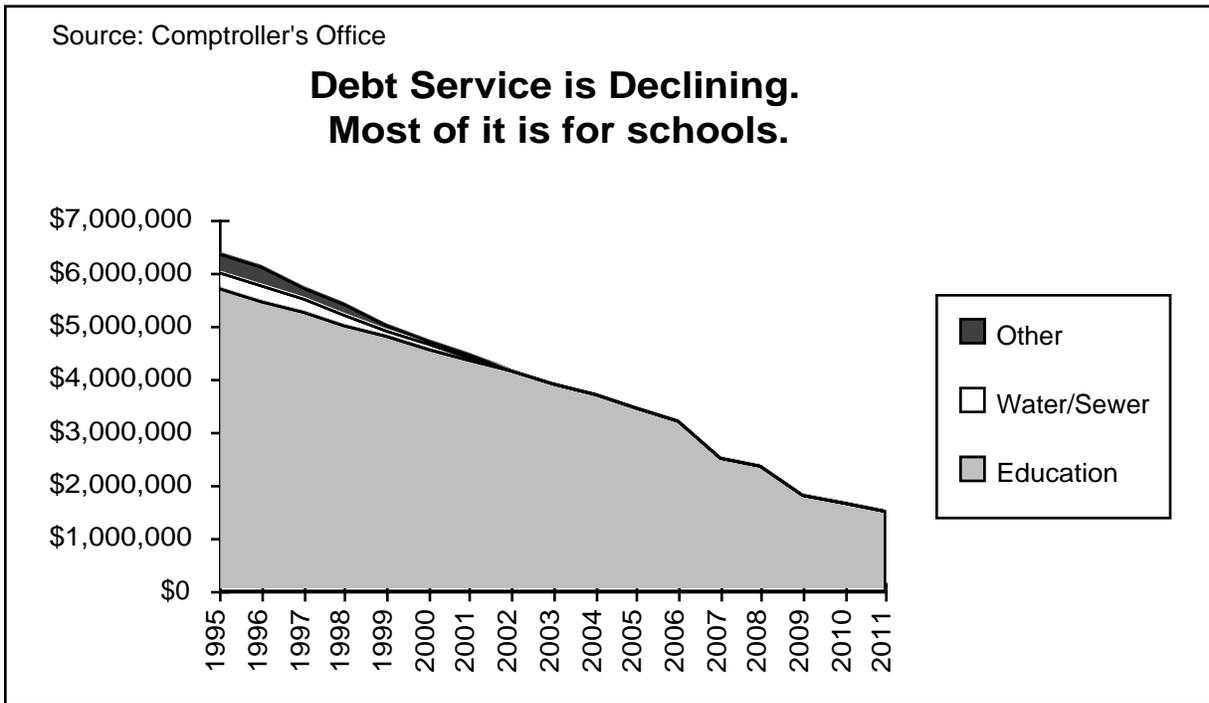
Area Graph  
Percent Composition

Area graphs can show the change in percent composition overtime. The constant height of the graph gives a strong hint that it is a percent composition.

### Sample Area Graphs

Examine the following area graphs:

### Area Graph 1



**General Description**

This area graph shows the decline in debt service associated with the use of level principal payment debt issuance.

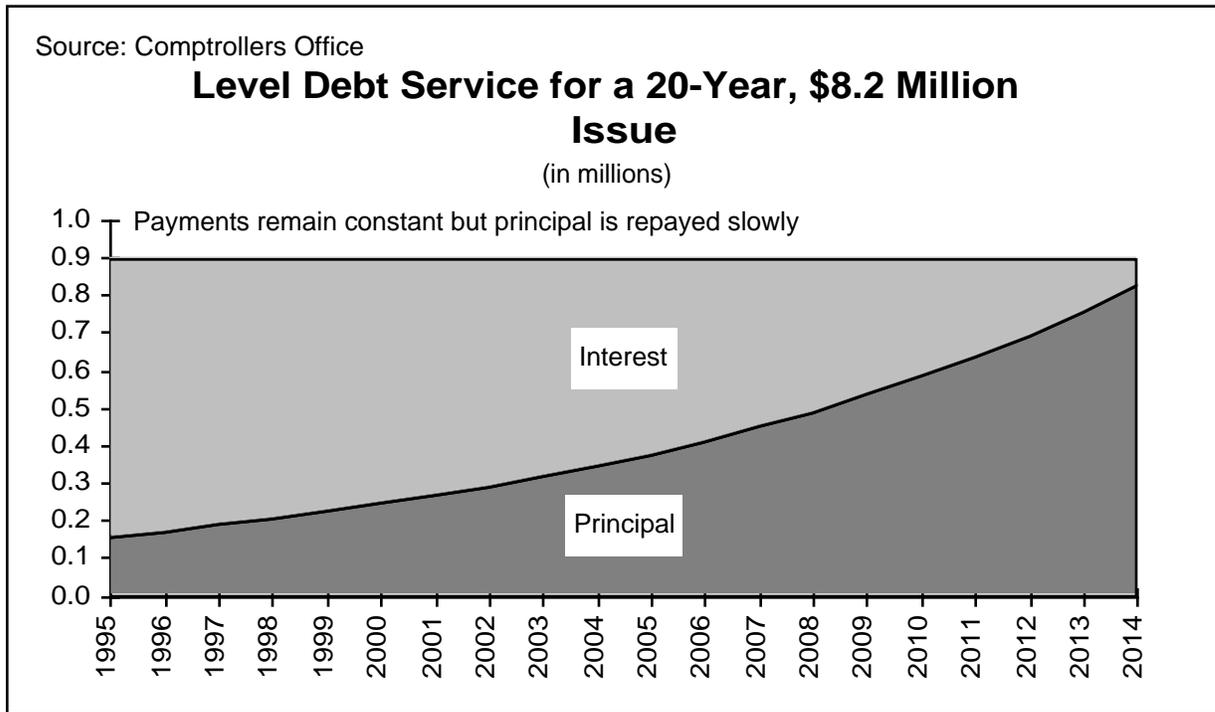
**Axis Labels & Legends**

The vertical axis labels take up a lot of valuable space as does the legend. If the data were scaled to be in millions and the legend placed below the graph, there might be enough room for the years on the horizontal axis to fit more readably.

**Other Considerations**

Only the bottom portion (in this case, education) can be accurately measured against the vertical axis.

## Area Graph 2



General Description

This area graph shows the changing composition of interest and principal in a level debt service debt structure that is similar to a standard home mortgage.

Axis Labels & Legends

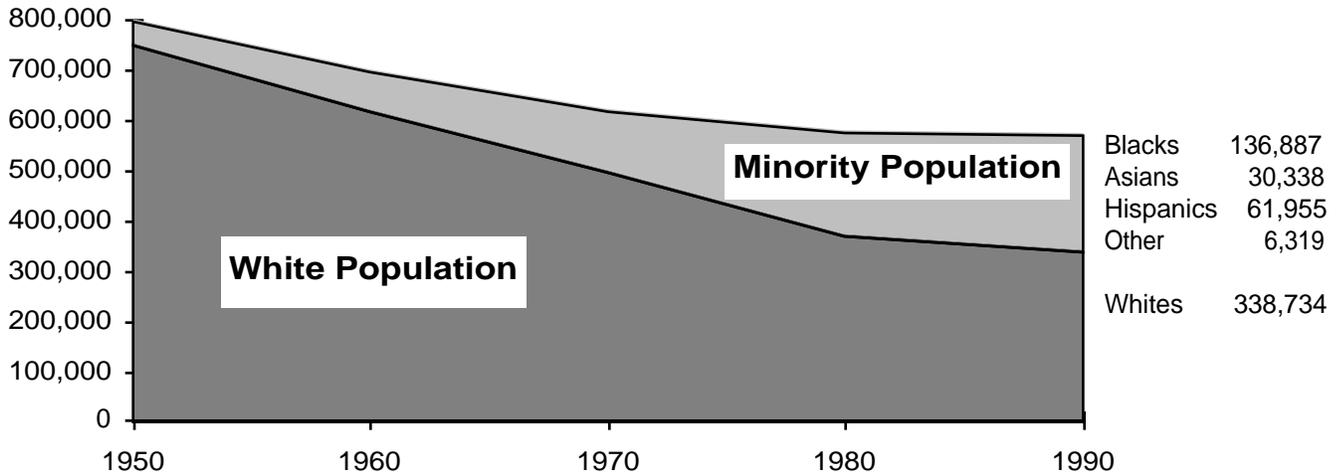
Scaling in millions increases the horizontal space for the graph.

Other Possibilities

### Area Graph 3

Source: Boston Globe 12/12/93

#### Population and Racial Composition of Boston



General Description

This area graph shows the changing composition of .

Axis Labels & Legends

Axes are labeled by implication and the information that would have been placed in a legend is placed on the graph itself.

Other Considerations

No interpretation was given for this graph. Would you care to suggest one?

## Scatter Graphs

### Definition

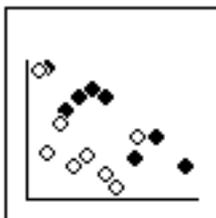
Scatter graphs, sometimes called “dot” graphs or XY graphs, plot the relationship between two variables. The first variable is measured along the x-axis and the second along the y-axis. Because of this, scatter graphs do not have descriptors in the same sense as other graphs.

### Purpose

Scatter graphs best show possible relationships between two variables. The purpose of the graph is to try to decide if some partial or indirect relationship—a correlation—exists.

### Usage

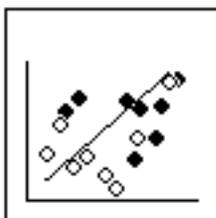
#### *Scatter graph*



Scatter Graph

Scatter graphs are useful to illustrate the degree of relationship between two characteristics of a population, such as age and income. They are useful in developing an insight into situations to which many variables contribute.

#### *Scatter graph with regression line*



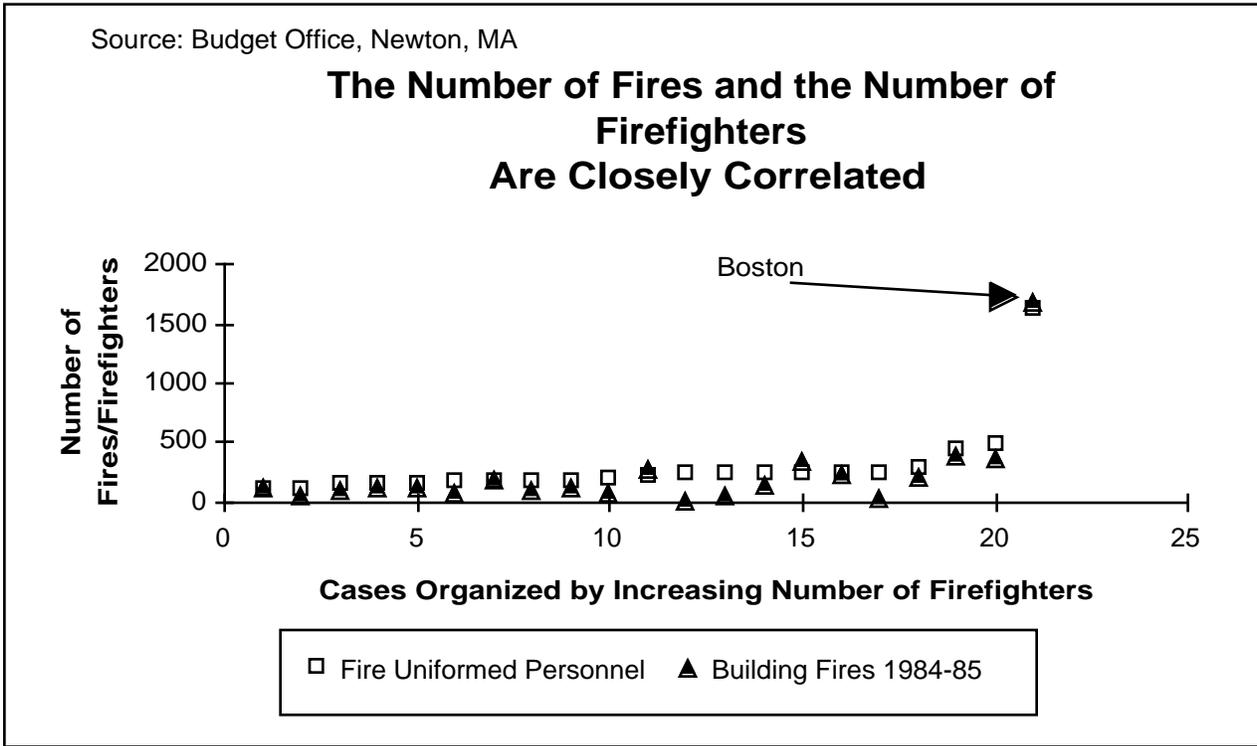
Scatter Graph with  
Regression Line

When a regression line is calculated, plotting it on the graph can assist the untutored reader in perceiving the trend.

## Sample Scatter Graphs

Compare the following scatter graphs.

### Scatter Graph 1



General Description

Organized by increasing number of firefighters, this scatter graph shows a close correlation of the number of fires and the number of firefighters.

Axis Labels & Legends

Both axes labeled and a legend is still needed.

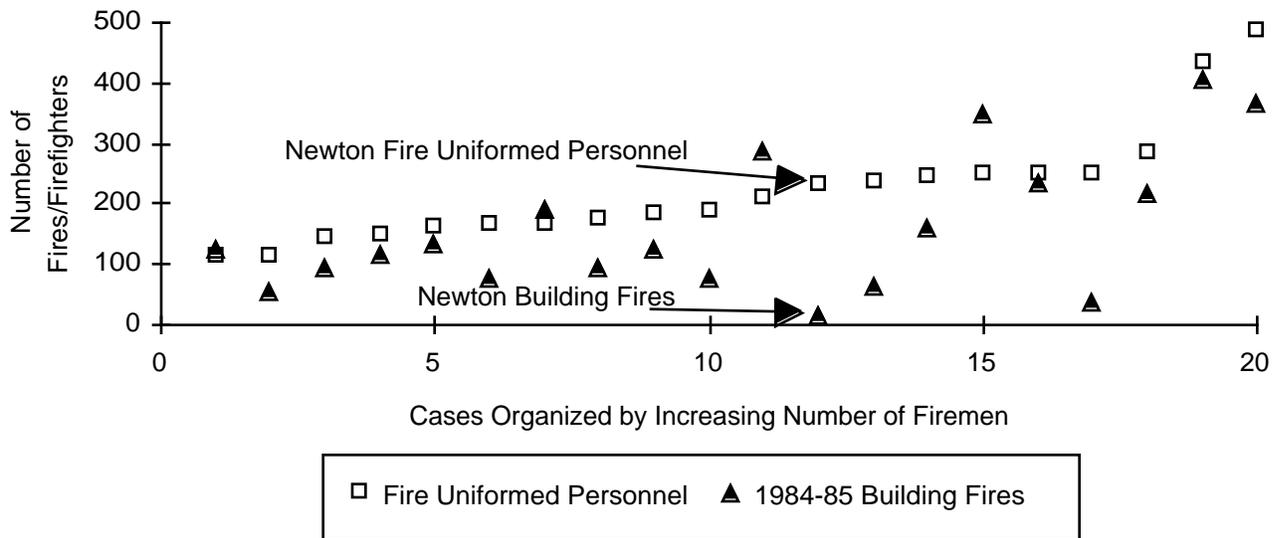
Other Possibilities

The presence of Boston in the sample significantly distorts the graph. Examining graphs without the Boston “outlier” is essential to grasping what the data say.

## Scatter Graph 2

Source: Budget Office, Newton, MA

### The Number of Fires and the Number of Firefighters are Closely Correlated (Excluding Boston)



**General Description**

Organized by increasing number of firefighters, this graph shows a close correlation of the number of fires and the number of firefighters with the distorting impact of the large values for Boston excluded. Note the greater definition of this graph compared with the preceding one.

The discrepancy of the data for the City of Newton is now visually evident.

**Axis Labels & Legends**

Both axes labeled and a legend is still needed.

**Comments**

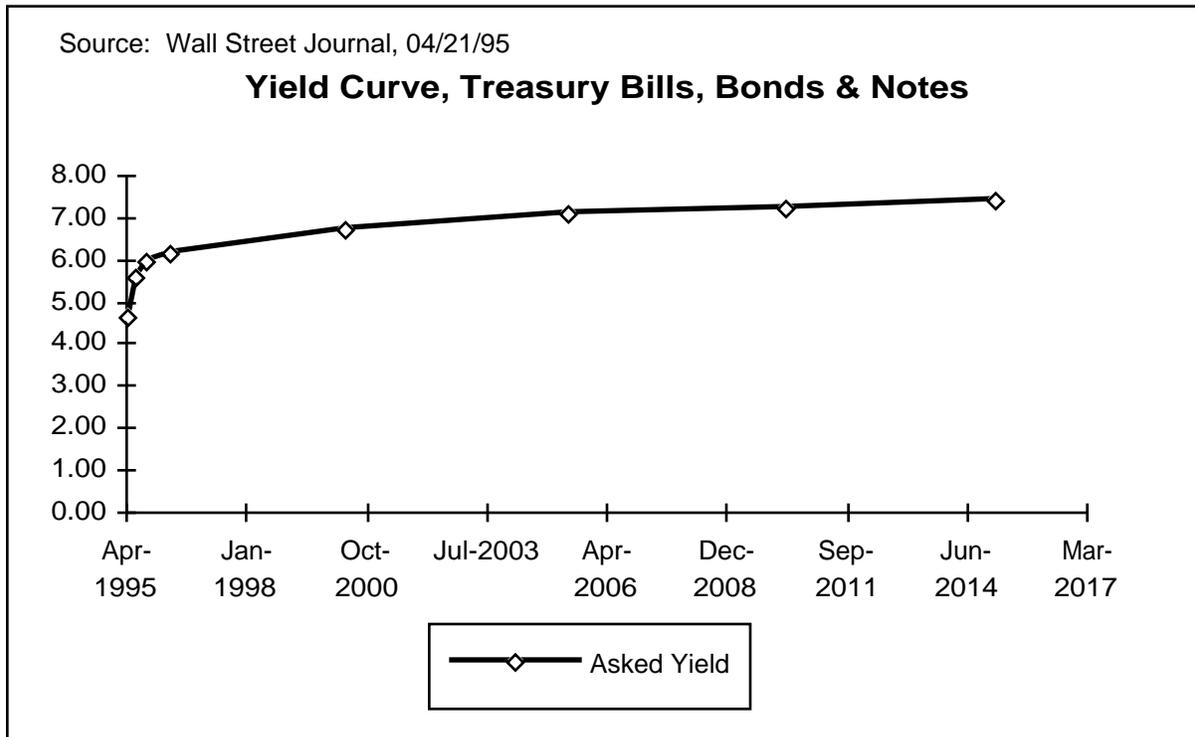
Statistics gives us a means of quantifying the relationship between these two variables.

**Regression Summary**

**Fire Uniformed Personnel vs. 1984-85 Building Fire:**

Count	20
Num. Missing	0
R	.701
R Squared	.491
Adjusted R Squared	.463
RMS Residual	69.459

### Scatter Graph 3



General Description

This scatter graph shows the curve for 30, 90 day, 6 month and 1, 5, 15 and 20 year maturities of U.S. Treasury securities.

Axis Labels & Legends

The axes are implicitly labeled and the legend names the curve.

Other Comments

While this graph seems to be a line graph, the x-axis values are not equally distant, thus requiring a connected XY graph.

Depending on what message is intended for this graph, changing the baseline to increase the visual significance of the relatively flat change in the curve may be appropriate.

## Combination Graphs

### Definition

Combination graphs are presentations of data that use more than one type of graph format in the same graph, such as line and column.

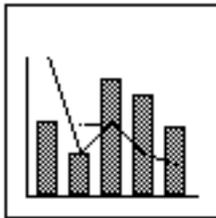
### Purpose

Combination graphs are best used to dramatize the relationship between two variables.

While not fundamentally different from graphs we have discussed already, combination graphs can add a touch of visual flair that might otherwise be absent.

### Usage

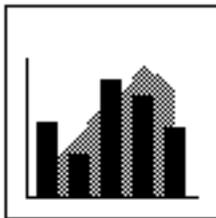
#### *Column graph with line overlay*



Column with Line  
Combination

Because there is a clear visual separation between the line and the columns, this type of data presentation has more emphasis than, say, overlapping columns.

#### *Area graph with column overlay*



Area with Column  
Combination

An area graph can be used to display a variable with numerous data points and still stand out visually behind the column graph of just a few data points.

Since this type of presentation allows for different emphasis to be placed on different data series, take care that the viewer is not misled.

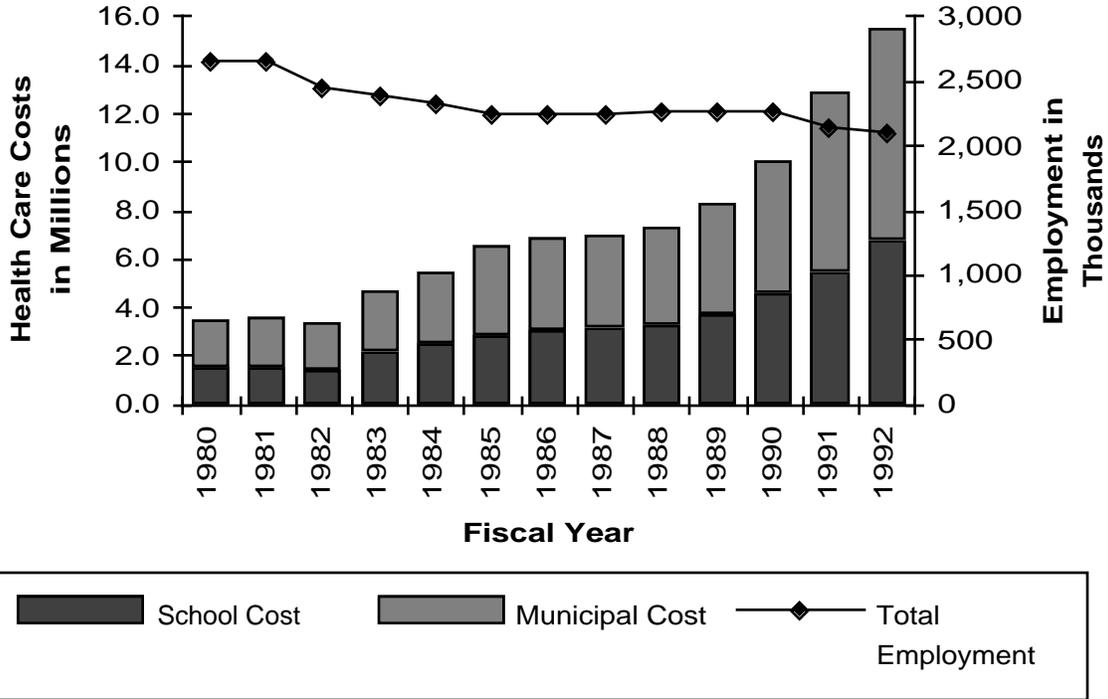
### Sample Combination Graph

Examine the following combination graphs:

### Combination Graph 1

Source: Budget Office, Newton, MA

#### Health Care Costs Escalate Although Total Employment Declines Significantly



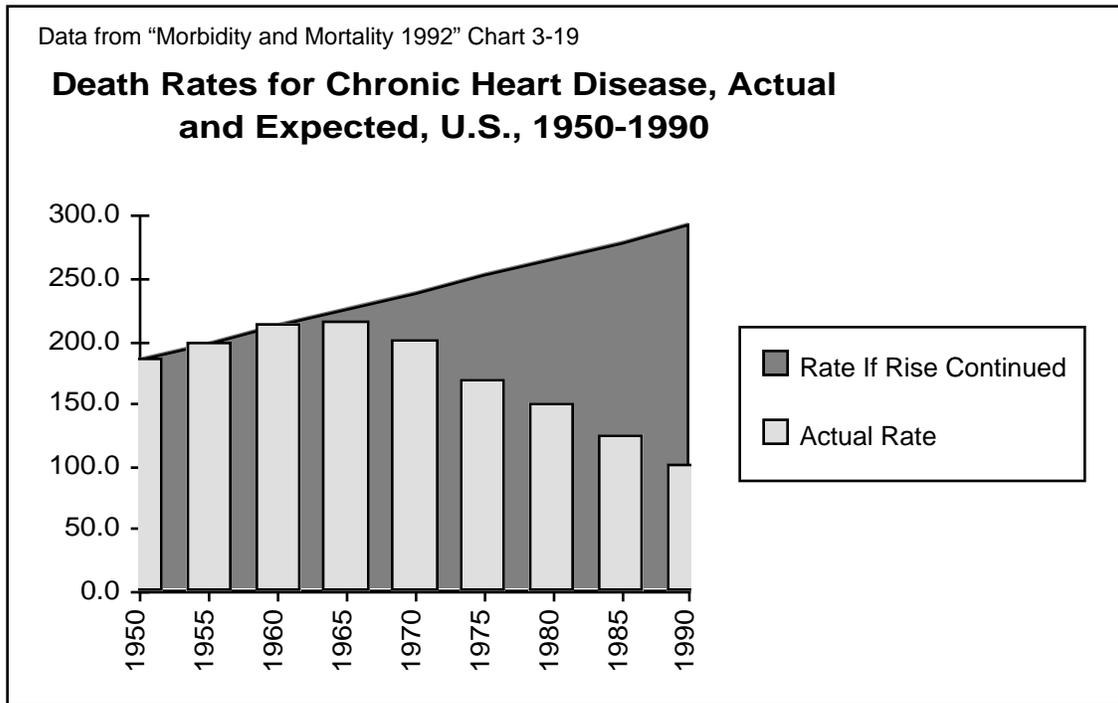
General Description

The graph shows the steadily rising cost of health care and the distribution of that cost between city and schools. The line overlay shows declining total employment which makes the increasing costs more dramatic.

Axis Labels & Legends

Two vertical axes are used and each is labeled as is the x-axis.

### Combination Graph 2



General Description

The graph shows the death rate that would have resulted had the increase not been curbed compared with what really happened. The light descending columns in the foreground contrast effectively with the rising gray area graph in the background.

Axis Labels & Legends

No axis labeling but a legend is used.

Other Possibilities

The legend at the bottom would have left more space for the graph.

## Tables

### Definition

A table is a rectangular array of data with descriptors in the first column and in the column headings.

### Purpose

Tables best show:

- numerous precise data values

While tables are not graphs, their intimate relationship to graphs—as the source of graphs and as a widely used alternative to graphs—require their discussion here. Tables are widely used; unfortunately, readable, well laid out tables are not.

### Usage

#### *Table of data*

Basic Table

Tables should be constructed so that the text describing numbers is as close as possible to the numbers themselves. Formatting should be used to distinguish descriptors from data.

#### *Split table*

Split Table

For display purposes, it is often convenient to split a long table and print multiple sets on the same page. In such situations, it is best to use a visual separator (in this case the vertical bar) to make this clear

As a general rule put effort into seeing that the table fits on a page with the same orientation as the main document; rotated pages discourage the reader unnecessarily. Generally, one digit after the decimal point is adequate. Beware of a failure to add due to rounding and put a simple caveat in a discrete location.

Make your columns only as wide as needed to display the data clearly and center the table on the page.

### Sample Tables

Examine the following tables:

**Table 1**

<b>INCREMENTAL ADDITIONS PROGRAM</b>			
	1992	1993	1994
TOTAL/PERIOD OPEN	\$1,003,037.00	\$1,074,100.00	\$1,280,100.00
ASSET ADDITIONS/N. AMERICA			
NEW ENGLAND	\$11,063.00		
SOUTHEAST	\$23,000.00		
MIDWEST		\$77,000.00	
CANADA		\$60,000.00	
PACIFIC COAST			\$6,667.00
MEXICO			
SUB TOTAL	\$34,063.00	\$137,000.00	\$6,667.00
ASSET ADDITIONS/EUROPE			
GERMANY	\$37,000.00	\$25,000.00	
FRANCE			\$60,000.00
BELGIUM		\$14,000.00	
ENGLAND		\$30,000.00	
ITALY			
SWITZERLAND			
SUB TOTAL/EUROPEAN ADDITIONS	\$37,000.00	\$69,000.00	\$60,000.00
TOTAL ASSETS ADDED	\$71,063.00	\$206,000.00	\$66,667.00
TOTAL ASSETS/PERIOD CLOSE	\$1,074,100.00	\$1,280,100.00	\$1,346,767.00

**General Description**

The table above shows some of the weaknesses of many tables: the text descriptors on the left are frequently far from the numbers they (supposedly) explain; there are dollar signs everywhere—whether they add to comprehension or not; there is no visual subordination in the table although it contains subtotals and totals; and, accuracy is to the penny when this does not appear to be meaningful.

**Other Comments**

The use of a monospaced font has cleverly disguised the output of a powerful computer system as a page from a Selectric typewriter.

The same data as above can be displayed as below:

**Table 2**

<b>Projected Additions to Assets 1992 to 1996</b>					
<b>Europe and North America</b>					
(millions of dollars)					
	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>
Total Assets/Period Open	\$1,003.0	\$1,074.1	\$1,280.1	\$1,346.8	\$1,396.8
Asset Additions/Europe					
Germany	37.0	25.0			
France			60.0	35.0	
Belgium		14.0			
England		30.0			
Italy					20.0
Switzerland					45.5
<i>Subtotal/European Additions</i>	<i>\$37.0</i>	<i>\$69.0</i>	<i>\$60.0</i>	<i>\$35.0</i>	<i>\$65.5</i>
<b>European</b>	<b>\$37.0</b>	<b>\$106.0</b>	<b>\$166.0</b>	<b>\$201.0</b>	<b>\$266.5</b>
Asset Additions/N. America					
New England	11.1				
Southeast	23.0				
Midwest		77.0			
Canada		60.0			
Pacific Coast			6.7		
Mexico				15.0	15.0
<i>Subtotal/N. American Additions</i>	<i>\$34.1</i>	<i>\$137.0</i>	<i>\$6.7</i>	<i>\$15.0</i>	<i>\$15.0</i>
<b>N. American</b>	<b>1,037.1</b>	<b>1,174.1</b>	<b>1,180.8</b>	<b>1,195.8</b>	<b>1,210.8</b>
<i>Total Assets Added</i>	<i>\$71.1</i>	<i>\$206.0</i>	<i>\$66.7</i>	<i>\$50.0</i>	<i>\$80.5</i>
<b>Total Assets</b>	<b>\$1,074.1</b>	<b>\$1,280.1</b>	<b>\$1,346.8</b>	<b>\$1,396.8</b>	<b>\$1,477.3</b>
Note: Columns may not add due to rounding.					
Source: Marketing Department					

## General Description

The new format for the same data allows more information with less clutter. Major changes include: subtotals are distinguished by italics, totals by bold; and, data are appropriately rounded and sourced;

## Other Comments

Right flushing the text descriptors gets them closer to the numbers they are supposed to explain.

**Table 1**  
**Age Adjusted Death Rates for Chronic Heart Disease for New England, 1986**

	Death Rates	Rank
Connecticut	228.8	30
Massachusetts	239.0	23
New Hampshire	240.9	22
Vermont	249.8	17
Maine	257.4	11
Rhode Island	283.5	3

Data from "Morbidity and Mortality 1992" Chart 3-27

#### General Description

The title is both bold and in a larger font size. Column heading are in bold for emphasis. Data source is present but in a reduced font size.

A grouping bar at the top can help pull the columns together visually and text descriptions should be right flushed if they are on the same line as a number. This reduces the distance the eye has to travel from text to number—an important aspect of readability.

#### When working with tables

- **AVOID ALL CAPS.** All capital letters are much harder to read than upper/lower case. (Restrict your use of ALL CAPS to word emphasis within a sentence.)
- avoid underlining (single or double). Underlines usually cut off descenders (the part of g's, y's, etc. below the baseline) and interfere with reading.
- remember that subtotal is one word, not two.
- generally, center column headings but be prepared to right or left flush headings if that makes them appear better on the page.
- go light on gray shadings in tables. Gray shadings from laser printers reduce readability, generally photocopy poorly and fax even worse.

## Decide the Appropriate Graph for Your Data

In choosing the right graph to convey a message, many more choices than we have shown are possible. Most are variations of what we have seen so you can easily deal with them if you know how to make the right basic choice. Since not all graphs are equally appropriate for all messages, the Graphing Advice Matrix, presents some opinionated advice.

In studying the Graphing Advice Matrix, bear in mind that the two basic issues that will guide your choice of a graph are:

- what kind of data will be presented?
- what is to be said about it: what is the message?

Think about these questions as you view the Graphing Advice Matrix. If you are not sure of a particular choice, refer to the section that discusses that type of graph.

## A Graph Is Only as Good as the Underlying Data

Never forget fundamentals: be sure the underlying data are accurate. This is very important whether you are forecasting sales tax collections or estimating tipping fee charges for the remainder of the fiscal year.

While this is not the place for an in-depth discussion of the handling of data series, there are three rules that are relevant to all students of forecasting and estimation. Every data series should be studied carefully for the effects of:

- changes in rate
- changes in base
- anomalous events.

In addition, always use fundamental data series, whenever possible.

When a rate is an integral component of the events resulting in a data series, any changes in the rate will play havoc with the data series. Such changes must be “factored out” by some special effort. When examining a data series of sales tax collections, any change in the sales tax rate will alter collections significantly. If such a series is to be used to forecast future collections, the effects of rate change must be removed. Here, using sales instead of sales tax collections will resolve the problem. Sales are a more fundamental variable than collections.

Similar comments apply to time series of property tax collection, where property values are more fundamental, and to many other series useful in government budget forecasting.

To continue the sales tax collection analogy, a change in base would occur if there had been an annexation resulting in the sudden inclusion of new sales tax paying businesses or if the sales tax were extended to include new items that had previously been excluded. For example, including food as a taxable item (when it had not been so before) would be a change in base. Of any data series, always ask if there has been a change in base it happens more often than is commonly realized.

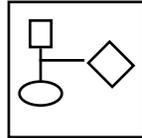
An anomalous event can significantly skew a data series. The Olympic games probably significantly altered sales tax collections for certain southern California communities but including those data in projections would not seem appropriate. Ask about major events concerning whatever data series you are studying and remove their impact from the data series. Floods, currency devaluations, and Papal visits should all be regarded as anomalous events.

As a final piece of advice always try to use fundamental data, sometimes called underlying data, whenever possible. A data series is more fundamental than another data series whenever the first series determines the second. For example, sales tax collections are the product of taxable sales times the tax rate, so taxable sales is more fundamental than sales tax collections. Such an approach can reduce the change in rate problem but will not generally reduce the effects of base changes and anomalous events.

## Some Additional Graphs and Visuals

Many useful graphs and visuals are not produced by widely available spreadsheet products but are available from statistics programs, specialized graphing software, and other readily available sources. We consider some of these below.

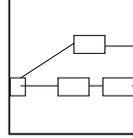
The pictures below give a graphical suggestion of the types discussed.



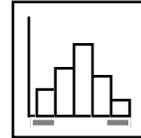
Flow Chart



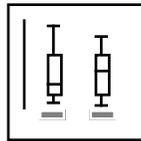
Gantt Chart



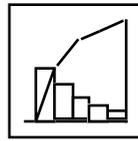
PERT Chart



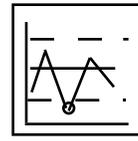
Histogram



Boxplots



Pareto Chart



SPC Chart

## Flow Chart

### Definition

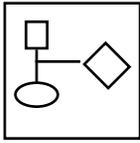
A flow chart is a schematic representation of the steps in a process.

### Purpose

Flow charts are useful to document how a process should work. By noting inputs, outputs, and decision points a flow chart can provide useful visual documentation.

### Usage

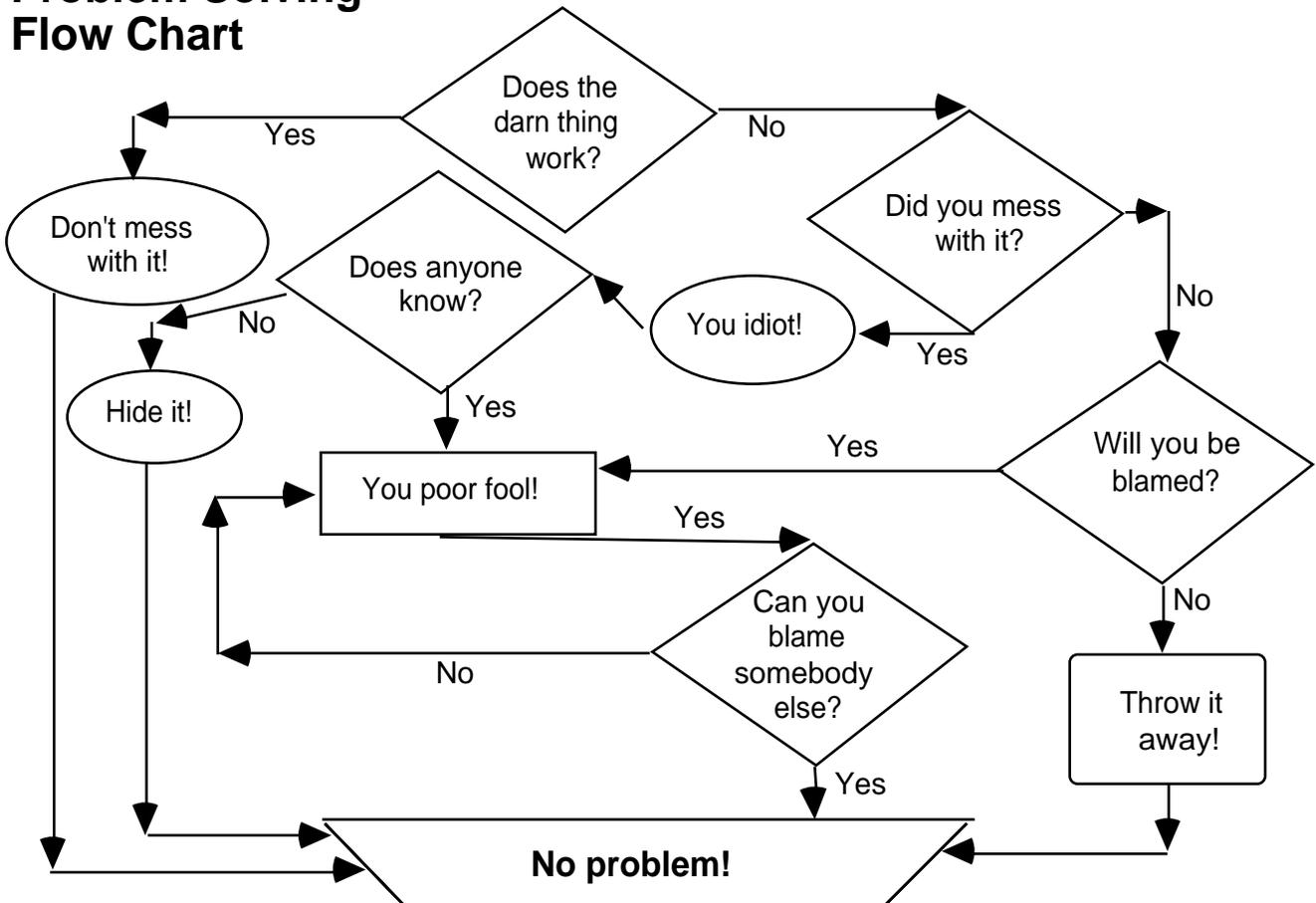
*Describing the steps of a process*



Flow Chart

Flow charts describe how various steps in a process are related to each other and where decisions are made. They can be used to document software, describe the flow of bill payments, plan a new paper flow scheme and to detect possible flaws in existing processes.

## Problem Solving Flow Chart





## PERT Chart

### Definition

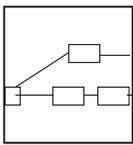
A PERT (Project Evaluation and Review Technique) chart is a schematic representation of the steps in a project, their time needs, and the relationship of each step to the others.

### Purpose

PERT charts are useful to decompose a large project into its constituent steps and to determine the critical path of the project: those steps whose late finish will delay the entire project.

### Usage

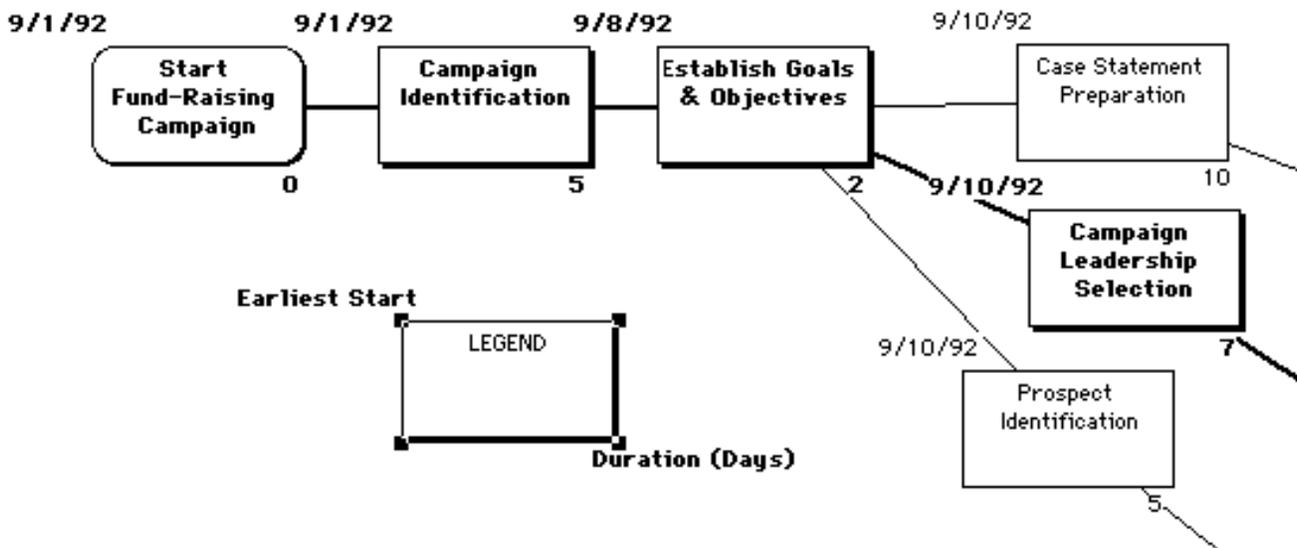
*Describing the steps of a process and determining what really matters*



PERT Chart

PERT charts allow a big and complicated project to be understood as series of steps that must occur in certain sequences without losing the overview of the project. Typically earliest start dates and latest end dates are assigned to each step and the steps linked by time precedence. It is then possible to calculate a critical path which can be used to guide the completion of the project in a timely fashion.

### PERT Chart I



The visual above shows the beginning of a PERT chart. The dark boxes and lines shows the critical path.

## Histogram

### Definition

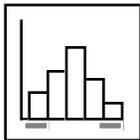
A histogram is a column graph of a frequency distribution into which the variable has been divided (usually adjacent and of equal width) where the heights of the bars are proportional to the number of observations in that interval.

### Purpose

A histograms takes measurement data and displays its distribution.

### Usage

*Visualizing central tendency and spread*

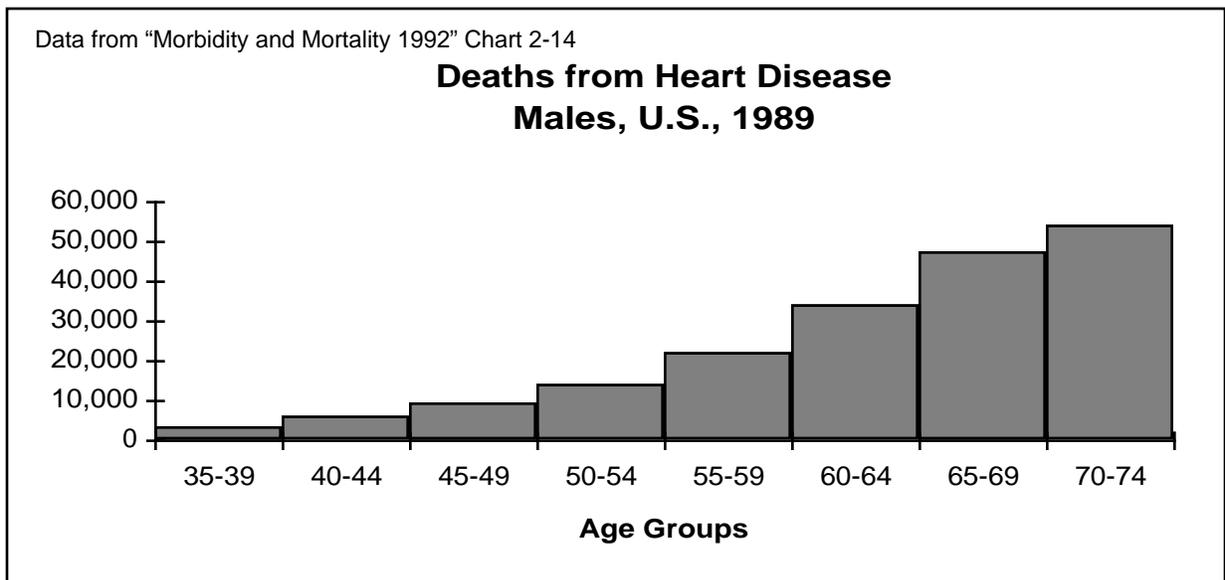


Histogram

Histograms are a classic visual technique for displaying how frequently data occur in equal intervals. The resulting graph shows the degree of “central tendency” (the middle of the data) and “spread” (clustering around the center).

Histograms will quickly tell you whether there is a single peak or multiple peaks (indicative of bi-modal or multi-modal distributions).

## Histogram Graph 1



### General Description

A histogram showing the distribution of deaths from heart disease by age groups. The steadily rising data markers are visually striking.

### Axis Labels & Legends

The y-axis is not formally labeled and is far from the data markers. Putting the y-axis on the right hand side would improve readability but putting the actual values on top of the columns might be better yet—especially if exact values are important.

Draft

Other Possibilities

It would be possible to create this graph with spaces between the columns but since the distribution along the x-axis is continuous, the use of histogram is more appropriate.

Comments

The data show a significant “skew” to the left.

## Box and Whisker Plots

### Definition

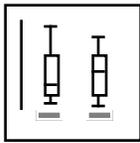
A box and whisker plot displays the 10th, 25th, 50th, 75th, and 90th percentiles of a variable.

### Purpose

Box and whisker plots display variation around the median of a group of data.

### Usage

*Displaying variation around the median*

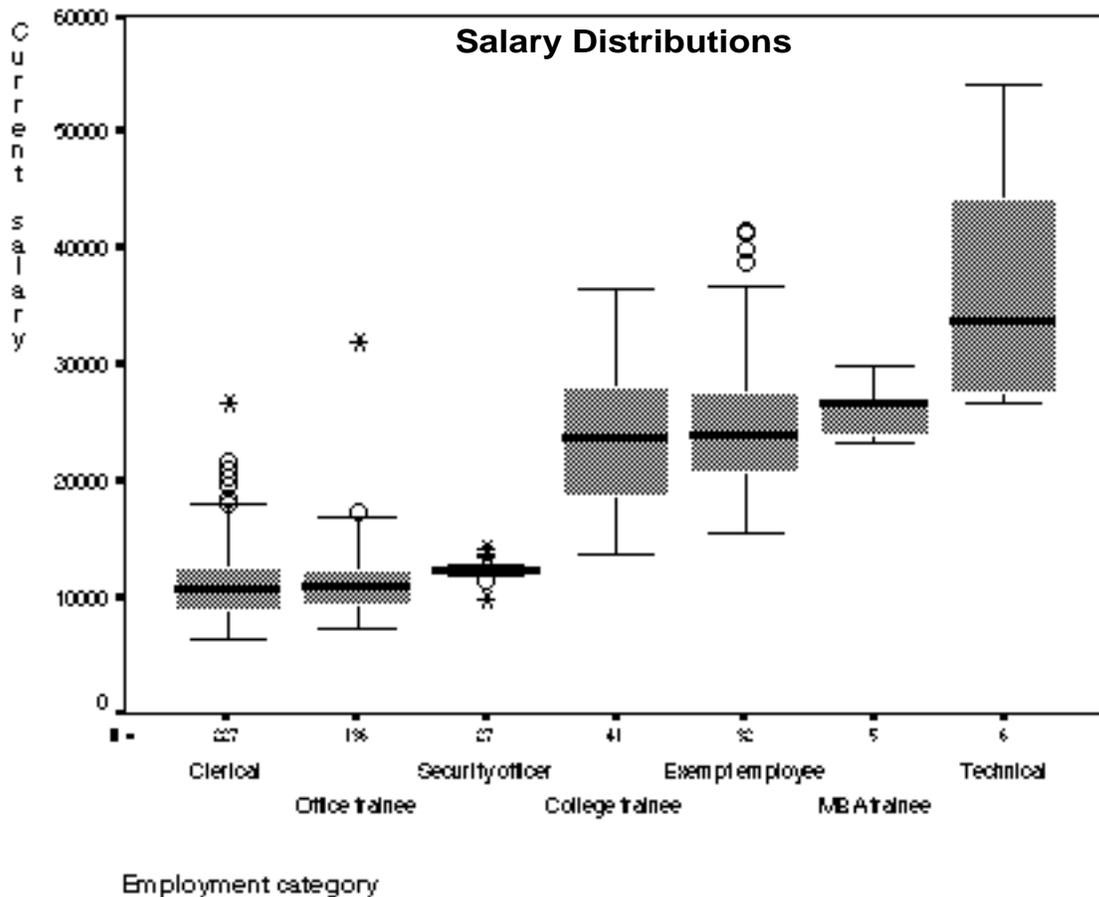


Boxplots

Box plots are similar to histograms in that they display both central tendency and spread in data but they have the advantage that they can display this information for several data sets simultaneously.

The “box” is reserved for the 25th to 75th percentile data, the lines (whiskers) are the largest and smallest data values within 1.5 box lengths, circles designate outliers, asterisks show extreme values.

### Box Plot 1



## Pareto Chart

### Definition

A Pareto chart is a column graph, sorted in descending order; a line may be added to show the cumulative frequency across categories.

### Purpose

Used to display the relative importance of all the problems in a process in order to identify the most significant problems.

### Usage

*Pointing out the most important problems to solve*

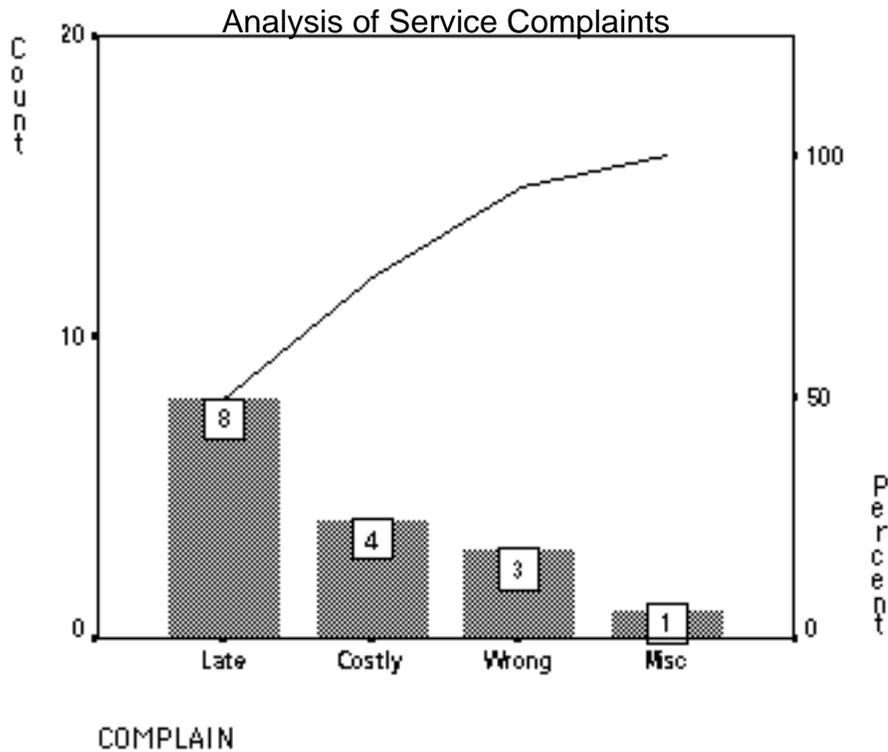


Pareto Chart

Frequently raw data is recorded on the left axis and percentages on the right axis.

The graph below shows an analysis of complaints about a service. The Pareto chart shows that timeliness is the biggest citizen concern.

### Pareto Chart 1



## Control Charts

### Definition

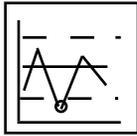
A control chart is a line chart that shows process variation around an expected average. Sometime upper and lower limits on expected variation are also graphed (statistical process control chart).

### Purpose

Control charts are useful in determining whether the long-term average is changing.

### Usage

*Measuring the quality of output statistically*

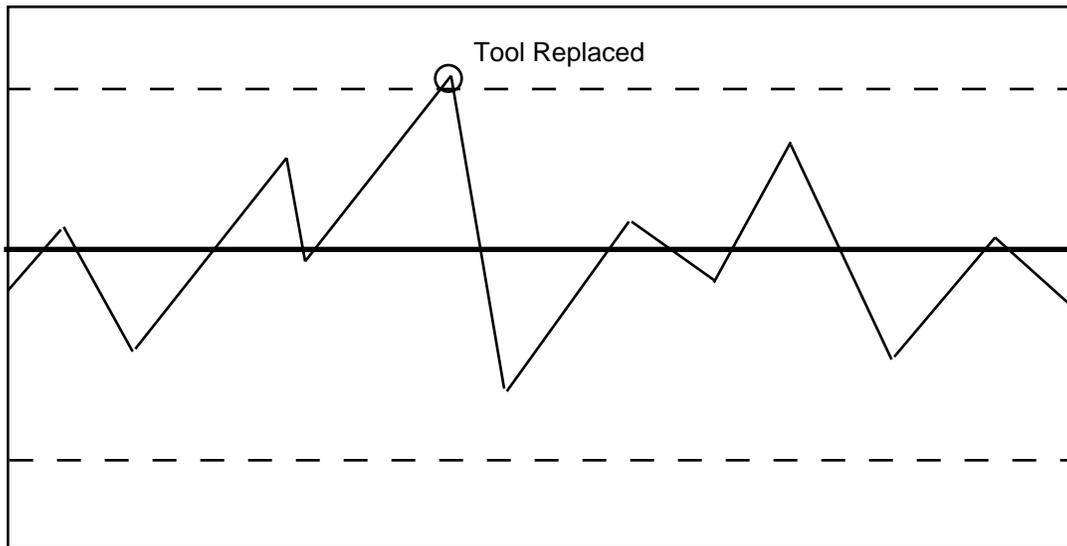


SPC Chart

A control chart uses a line graph to plot the quality of process output samples to help determine if the long run average is changing. When used with mathematically calculated process control limits (usually then called a statistical process control chart or SPC chart), it can identify events that call for active intervention to maintain predetermined standards of quality. Thus, control charts can help distinguish between

normal variation in a process and significant variation.

### Control Chart 1

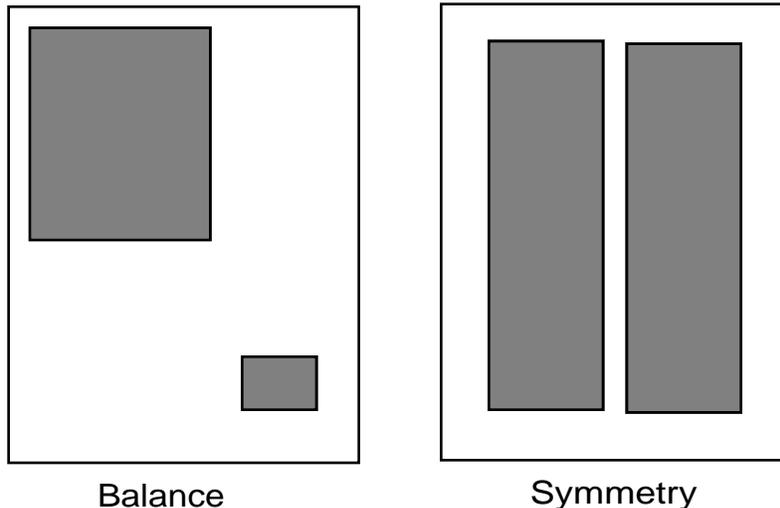


## Design Issues

When putting together the elements that will make up an overhead, a slide, or a full page graphic, there are some classic ideas that should be used.

### Plan Your Page, Transparency or Slide

A reader first perceives a page as a whole, so plan visual harmony among the elements on your page. Emphasize balance but not symmetry. Use small object to balance large ones along an axis of the page. Don't be afraid of white space. Think of white space as a technique to be used to draw attention to the ink on the page. Because the eye finds no natural way to define parts of a perfectly symmetrical page, such layouts are visually boring.



When presenting a graph prepared on clear acetate, consider adding focus and emphasis by using a washable red magic marker to high-light the important trend or hatch the significant slice. This will add a little variation to your presentation as well.

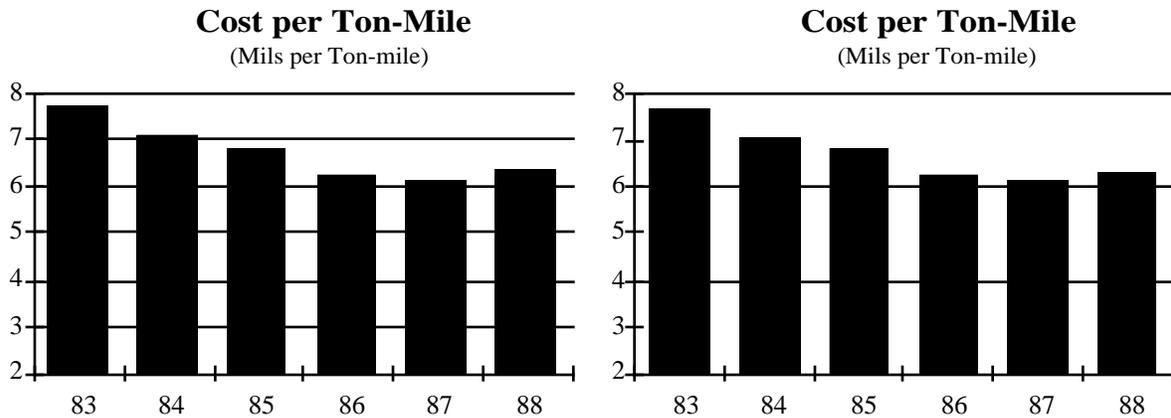
Since ALL graphs should have

- a title
- data series labels (descriptors)
- a source for the data
- an interpretation

there is little discussion below of these important facets of a complete graph.

In the examples that follow we note that although a legend is the “traditional” way to label data series, those graphs with descriptors close to the lines or pie slices, are usually easier to read since the eye requires less backward and forward movement. When possible, you should place descriptors similarly rather than using a legend.

Consider the two graphs below. Note how the graph on the right lacks every other horizontal ruling. If the reader were interested in estimating the amount of the increase in miles per ton-mile, which graph is the better choice? The financial report on which these graphs are based used the graph on the right.



The better microcomputers and software now allow the use of an almost unlimited variety of fonts (such as Times, **Helvetica**, or Courier), styles (such as **bold**, *italic*, or SMALL CAPS) and type sizes. Too many fonts tend to confuse the reader and interfere with communication; three fonts are the maximum.

Take it easy on the styles and sizes also. Remember, moderation in all things.

## Use of Color

Studies show that color is more influential than black and white and that bright colors are more positively received than darker shades. Color monitors are readily available now and affordable high quality color printers are not far in the future. Thus, graphs will have a colorful future.

There can be no denying that color adds a visual flair to anything—the key question is whether it adds anything more than flair. Does color improve communication? Not just capture attention, mind you, but actively help the reader of a graph to do more than stay awake?

Because bright colors can distract the reader and mislead him or her into thinking that a graph has more content than it really possesses, this author urges readers to concentrate on saying it in shades of gray. When you are sure that the graph is the best possible graph in shades of gray, that you have stated its message clearly, then add color to enhance the effect the graph will produce.

There is another reason for setting your monitor to 16 shades of gray **before** you begin graphing. It is the author's observation that every color graph is fated to be reproduced on a black and white copier. The bright colors that most software default to in graphs—the bright red beside the bright blue, etc.—photocopy badly: red and blue photocopy to black thus unintentionally merging pie slices and otherwise distorting your intent and interfering with communication. On the other hand, if you create a graph in shades of gray and then convert it to color, you get a different color scheme, one that will photocopy to shades of gray.

This author offers the following plea for moderation: stick to primary colors and use no more than four of these. The coloring of a graph should complement the message of a graph and never detract from its meaning: beware false impressions.

Color is best used when it *differentiates* portions of a graph, *identifies* important areas or *emphasizes* key points. Save the brightest color for the line or element on which you wish to focus your discussion.

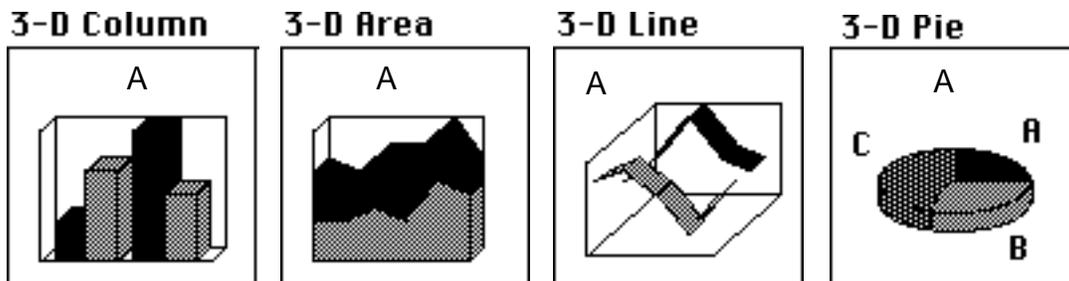
In general, avoid close encounters of the full spectrum kind.

### Three-Dimensional (3-D) Graphs

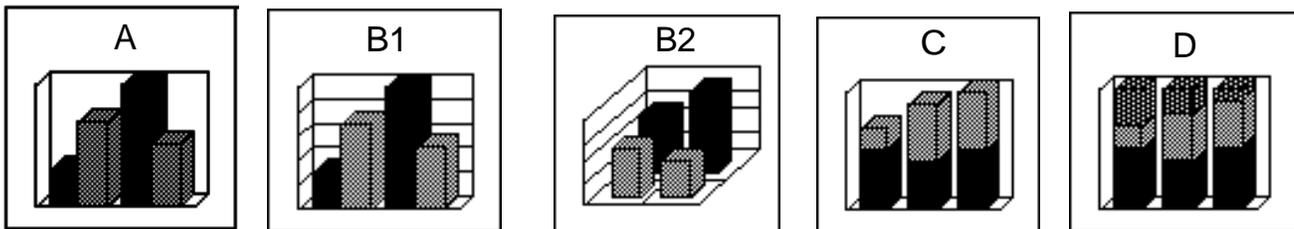
Another issue of this type is the use of three-dimensional effects to heighten the impact of the graph. Like color, three dimensional graphs add visual flair. When the data series is two dimensional (such as population changing over time), a third dimension adds only glitz to the graph but not to the substance. This is acceptable if you do not obscure the meaning.

When the data series is three dimensional (such as a graph of income by educational attainment and age) does anyone who is NOT AN EXPERT at reading graphs really understand it? Just because a graph looks like a schematic of an aerial shot of mid-town Manhattan, does not mean that anyone can really comprehend what you want to communicate. Yet, when the audience has the background to understand a more involved than usual graph—perhaps because the format of the graph has been in use for some time and the same audience views it—complicated formats can contribute to understanding.

Displayed below are 3-D column graphs and some of their variations.



#### 3-D Column

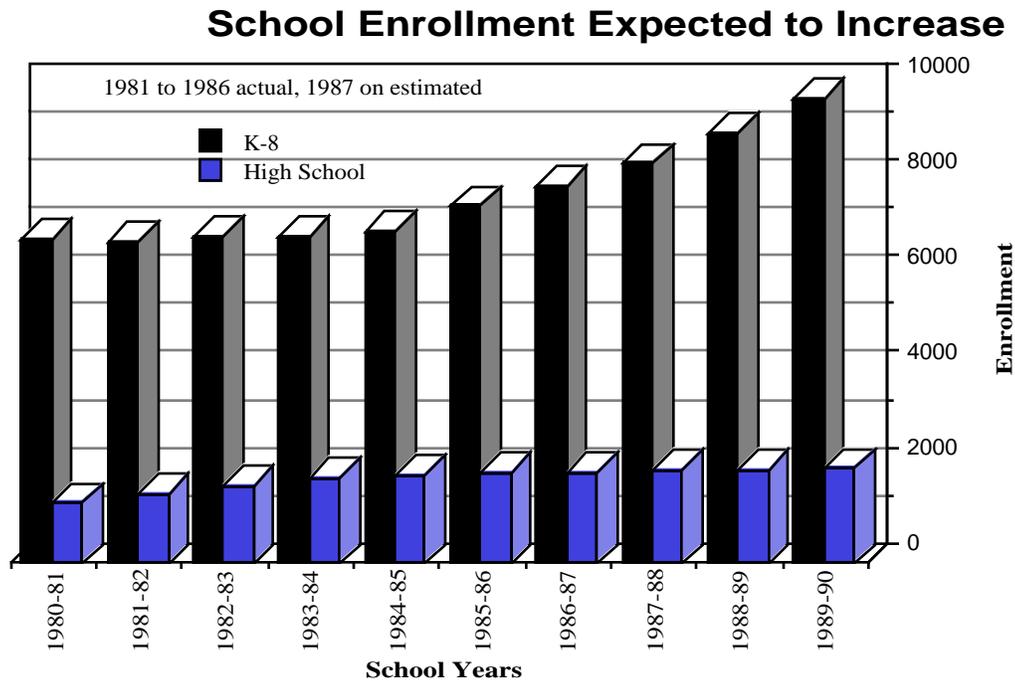


Of the four varieties shown, the only really interesting variation on what we have seen already is B2. Because it uses a two-dimensional perspective grid for each column, it offers the viewer the chance to view the data by individual series or comparatively between series.

The same data as the stacked column graph seen earlier in this article was used to produce the following graph. Note

- the generally increased dramatic effect provided by the dimension of depth;
- the placement of the scale on the right hand side to take advantage of the “depth” of the graph
- the rotated value (vertical) axis label and category (horizontal) axis tick mark labels, and,
- the placement of the legend information in the “under used” upper left hand corner of the graph.

A sharp distinction should be drawn between adding depth to a graph, as shown here, and the use of three-dimensional objects to represent one dimensional data when the height of the object is not proportional to the volume of the object, as happens with pyramids. The use of 3-D objects raises a confusion over whether height or volume is to communicate the value. If height is proportional to volume (true of the rectangular boxes used in the graph below but not true of pyramids<sup>3</sup>), there is no risk of confusion. Remember, moderation in all things.



Graphs with depth, like that above, also have the problem that the reader must decide whether to read the front or the rear of the columns against the grid lines. The placement of the 0 against the rear base of the columns answers the question but this is not immediately obvious to the viewer.

Three-dimensionality adds drama to most graphs but it does not necessarily add clarity. In fact, 3-D graphs generally require grid line to make values visually determinable, even in an approximate way.

POINT: 3-D graphs are more cute than useful.

## Abuse of Graphs

Like all methods of communication, graphs can be abused to misrepresent the underlying reality. Issues of information versus rhetoric and of content versus expression ultimately affect the honesty of presentation. It is the responsibility of the creator of a graph to see

<sup>3</sup>At the request of all of the reviewers of this article, the author has reluctantly suppressed the lengthy proof of this fascinating fact.

that the presentation of the information is honest and fair. At a minimum, there are several practices that should be avoided since they tend to misrepresent data.

Probably the single greatest abuse in the use of graphs is the refusal to interpret the graph: the failure to provide a narrative explanation under the graph. If decoration is the desired effect, use clip art, not graphs. Every graph should have an explanation. If you don't know what the graph says, then eliminate it. Unneeded graphs, like unneeded words, only confuse the issue.

More serious is when a graph misleads the reader by misrepresenting the underlying facts of the situation. Make sure that

- the data agree with its graphical representation
- no relevant data are omitted
- the meaning of data is the same to the preparer and the user.

As a rule, assume users have minimal knowledge of graphs unless you have active information to the contrary.

On the second point, relevant data include clearly displaying which data points are actual, which are estimated and which are projected. Consider a break in space between actual and estimated or use continuous lines for actual data and dashed lines for projected. A viewer who is looking at a data set should be able to estimate visually what fraction of the graph is an estimate.

## **The Baseline: To Move or Not to Move?**

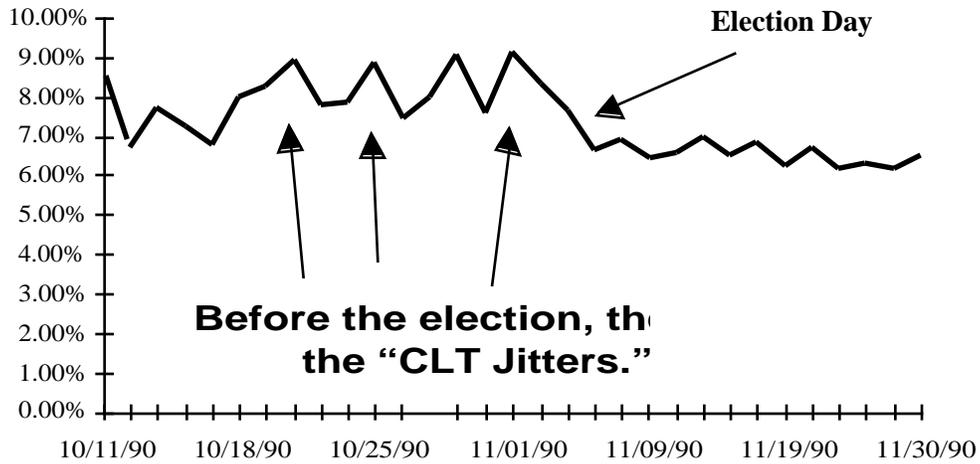
Beware of the disappearing baseline, the situation when the base of the graph is not the x-axis. Software usually allows this but such an approach can unfairly dramatize the changes at the tops of (say) the columns. On the other hand, there are times when a change in the baseline is exactly what you need to do.

The graph below shows market swings of approximately 200 basis points—a highly unusual condition. Moving the baseline is appropriate because borrowers felt the swings in the market more like the second graph than the one just below.

Source: Clark Rowell, Shawmut Bank, NA

Last revised 12/13/91

### Interest Rates Before and After the Election

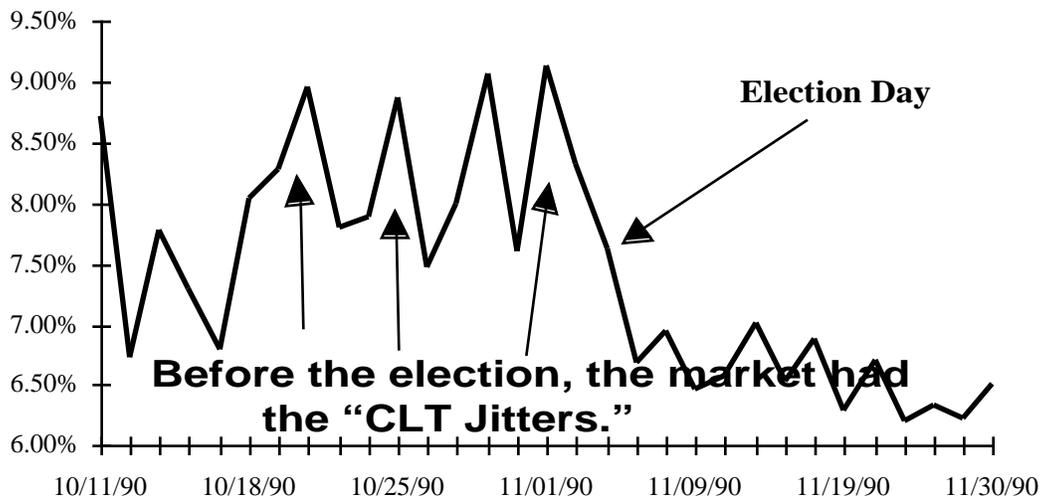


In considering the graph below, remember that the commonly used unit of discussion of interest rates in financial markets is a basis point (one one-hundredth of a percent). Is the amount of fluctuation from before Election Day to after sufficient to justify the change in baseline?

Source: Clark Rowell, Shawmut Bank, NA

Last revised 12/13/90

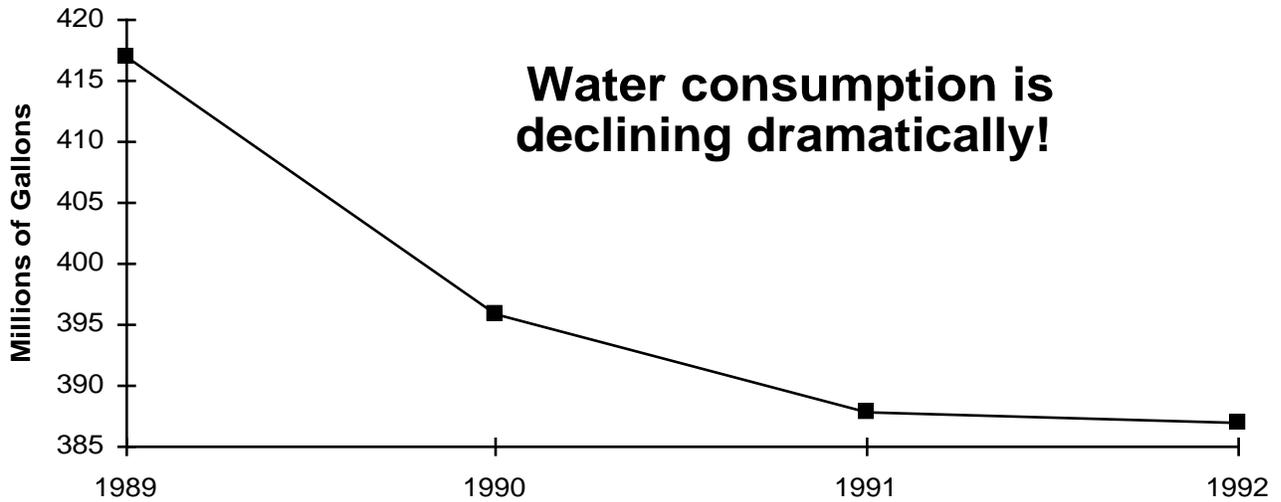
### Interest Rates Before and After the Election



Does the following graph seem persuasive at first glance?

Source: Water Department

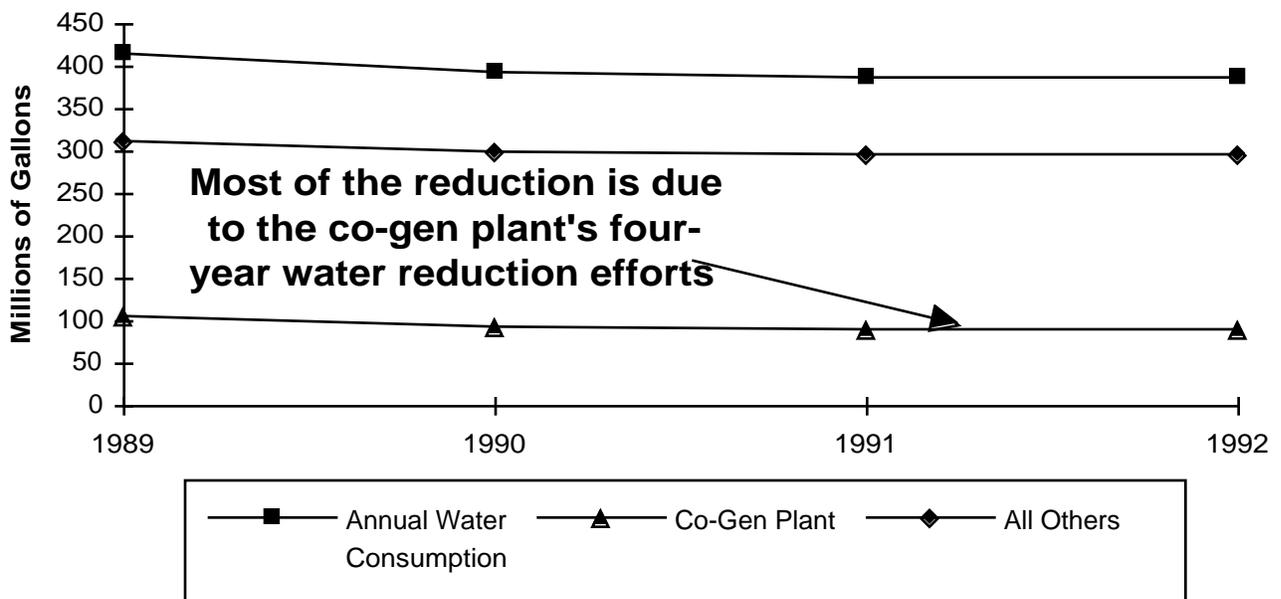
### Annual City Water Consumption



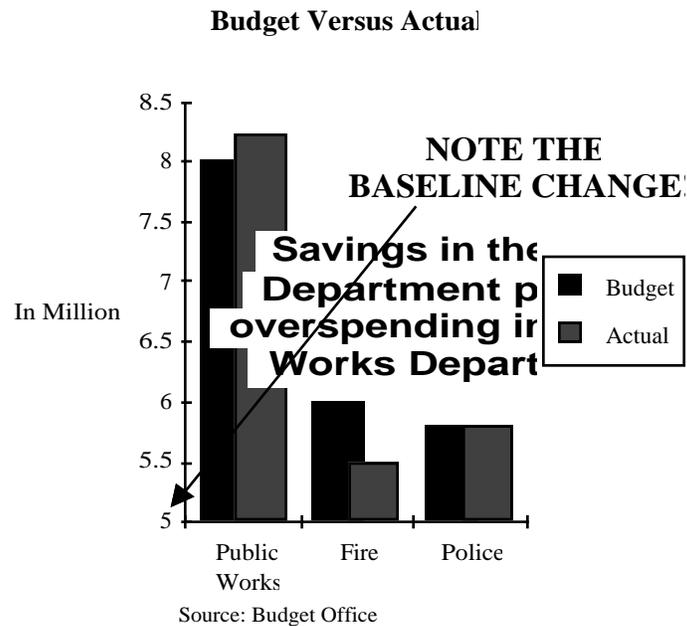
Note the change in baseline. If the baseline were returned to zero and some additional information included, once might be looking at the following graph.

Source: Water Department

### City Water Consumption



Look at the Budget Versus Actual graph below. It is based on the same data that was used to produce the earlier graph. Note how the overspending in Public Works is more visually noticeable—also note the change in the baseline.



Because moving the baseline closer to the data points serves to emphasize differences between the data points (making a somewhat flat line show more variation up or down), it should be used when you regard a small numeric change as significant.

Try to avoid a break in scale when there are no low values. The major exception occurs when all values are large and differ from each other only slightly over the period under consideration (for example, the Dow Jones Average for one month or the market rates shown above). In such a case, without a break in scale, there will appear to be very little change in the series (excepting, perhaps, Octobers 1929 and 1987 for the Dow Jones Industrial Average).

Using *different scales* for different trend lines or using log scales to show rates of change is fine for analysis but untrained audiences do not understand such practices. Don't do it for presentations unless your audience is knowledgeable.

Contracting or expanding vertical or horizontal scales can alter the impression of a graph dramatically. Honesty depends on what you present and how you present it. The effect of scale changes can distort data immensely. Don't, don't, don't.<sup>4</sup>

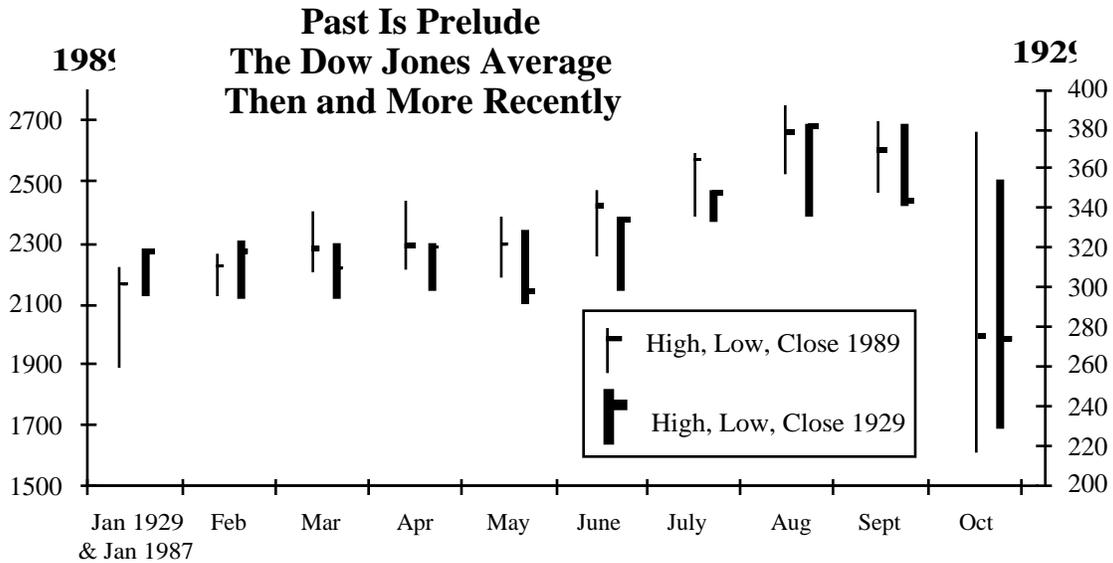
Be wary of using “percentage graphs” (graphs of percentage change in an underlying variable) in presentations. While the jury is out on this practice, this author is doubtful of its value in explaining anything. Percents are already one step removed from reality and changes in percents are thus two steps away from substance.

<sup>4</sup>Every user of graphs should be familiar with Darrell Huff's masterpiece (cited in the Bibliography) **How to Lie with Statistics**.

## Graphic Improvement of Graphs

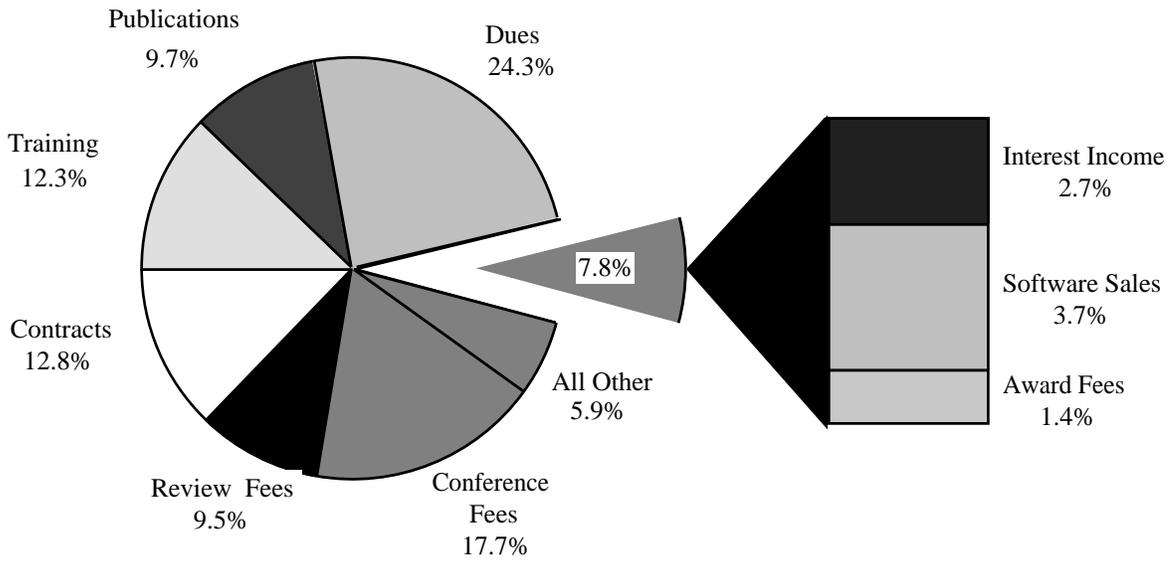
If you compare the widely used graph producing software of today with its peers of 10, 5 and 2 years ago, the most distinguishing change has been the steady movement toward more “punch” per graph with the addition of graphic enhancements. Sometimes (as with the ability to add depth) the enhancements have become features of major graphing programs. At other times (as with the ability to include “clip art” to dress up a graph), the enhancements have required access to additional graphics software.

Generically described as “drawing” software, these programs allow an individual to create expressive graphics by combining graphs produced by spreadsheets. The graph below shows the high-low-close ranges for the Dow Jones Industrial Average for the first ten months of 1929 and 1987. Again, we used a drawing program to combine two “hi-lo-close” graphs because the combination options provided by the software that originally produced the two graphs would not overlay two hi-lo graphs.



The graph below shows a combination of two dissimilar types: and exploded pie with the exploded piece “exploded” into a stacked column. Such graphs can put great emphasis on a particular slice of a pie. Of course, the process could easily be reversed with a piece of a stacked column “exploding” into a pie chart. The source for the graph below contained no commentary on why the particular slice was chosen for conversion to a column.

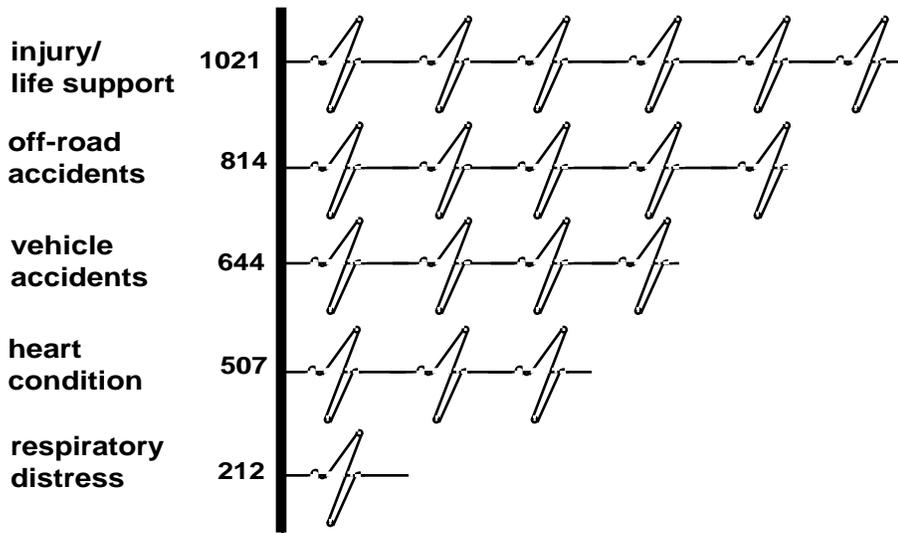
### Planned Revenues



Source: Association Annual Report

Despite the additional effort of production, some nonstandard graphs can be both informative and compelling. The following bar graph was part of the 1981 budget of Southfield, Michigan. It was reproduced in *Effective Budgetary Presentations: The Cutting Edge* (cited in the Bibliography) and was recreated by using Excel to produce a bar graph of the correct proportions that was then touched up in a drawing program (MacDraw) by overlaying the EKG curve on the bars. The graph itself was not directly referenced in the text and is reproduced here as close to the original as this author's limited graphics talent allows.

### Major Types of Medical Emergency Runs in 1980



“Dressing up” of graphs is allowed, but caution that the reader will not be misled, should be the order of the day. Using a silver dollar as a revenue “pie” is unlikely to confuse anyone. Dollar bill “pie charts” also convey the message clearly.

## Information Graphics

An “information graphic” is a closely grouped ensemble of text, clip art and graphs (frequently of different types) that present a summary of the key financial or statistical facets of some larger story. With the increased ease of producing graphs, information graphics have become popular in the print media and can be an effective component of many printed reports.

Information graphs are inappropriate for presentations because they display too much information at one time. Successively displaying the parts of an information graphic (say, bullet charts combined with a sequence of graphs) can be effective.

## Summary: Communicate, Communicate, Communicate!

This article has not attempted to deal with the many other graphics that are of use in a finance office: drawings, maps, digitized photos, organization charts, and schematics. To the extent that the reader’s interest is encouraged without any loss of content or misrepresentation, these approaches should be encouraged.

The human mind is better adapted to understand pictures than it is designed to cope with tables and printouts of numbers. While some of us like numbers, most people are “turned off” by them. A picture (graph) can explain a hundred numbers but it should not require a thousand words to do so. While graph producing software provides a new tool—a tool of sufficient importance that every finance office should be conversant with this technology—it will be of no use unless you understand that only a human being can decide the **message** to present. Ultimately it is all about communication—conveying ideas to others.

Graphs have been in use for about 200 years<sup>5</sup> but only in the last five years have the techniques of production been so dramatically simplified that graphs can now be an integral part of every budget, every financial report and every official statement. An old tool, having acquired great simplicity, can now be used to analyze and explain financial data to the multitude of audiences with whom we must communicate.

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<sup>5</sup>Ironically, one of the first financial graphs ever produced was William Playfair’s area graph of the soaring British national debt in 1786. (See “The Visual Display of Quantitative Information” cited in the Bibliography.)

## A Sometimes Annotated Bibliography

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While not about graphs, per se, this book reproduces many examples of graphical technique not limited to the formats discussed here.
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A radical and fundamental rethinking of how best to present numerical information in a visual fashion. Essential for anyone serious about the presentation of financial information by graphs.
- Zelazny, Gene. "Grappling with Graphics." **Management Review**. October 1975.
- Zelazny, Gene. **Say It With Charts: The Executives Guide to Successful Presentations**. Homewood, IL: Dow Jones-Irwin. 1985.  
Brief, to the point, well organized and filled with examples, this exemplary book covers more material than can be discussed in this brief article.

## **Glossary**

### **Category Axis**

The horizontal or x-axis.

### **Clip Art**

Designs, drawings, and artwork already computerized and just waiting to be pasted into any document of your choice.

### **Chart**

Possibly a map, maybe a graph and sometimes a table. In this article, this word is used only as part of the phrase “pie chart.”

### **Coordinates**

A pair of numbers used to designate the location of a point on a page. Usually measured from a pair of perpendicular lines called the x-axis and the y-axis.

### **Digitize**

To convert an image into a (digital) computer readable format.

### **Drawing**

A portrayal of forms or shapes.

### **Graph**

A pictorial display of numerical relationships between two or more sets of numbers a chart.

### **Graphic**

A diagram, drawing, or other pictorial presentation of information. Also called a visual.

### **Icon**

An image or logo representing a software program or document.

### **Interest Coverage**

### **Legend**

An explanatory caption accompanying a graph.

### **Quick Ratio**

The quotient obtained by dividing the total of “quick” assets (assets such as cash, marketable securities and accounts receivable, that are easily liquefied) by total current liabilities.

### **Table (of data)**

A rectangular array of descriptors and numbers in which the entries in the first column describe the numeric contents of the respective columns and the entries in the top row describe the contents of the respective rows below it.

### **Texture**

Shadings such as hatched lines or dot patterns which separate one section of a graph from another.

### **Time Series**

A pair of data points in which the first coordinate is time and the second data point is some value recorded at the time of the first variable.

### **Value Axis**

The vertical or y-axis.

### **Visual**

Any graph or graphic which conveys information.

## Draft

**x-axis**

A horizontal line which constitutes the base from which vertical measurements are made.

**y-axis**

A vertical line which constitutes the base from which horizontal measurements are made.

**Notes to myself:**

Display a balance sheet as two stacked columns (see if offset columns have anything to offer) or as two pies?

Do a “good grief” versus “good graph” example like Mac Charting Tools?

**File Name**

**Description**

Exhibit I Chart Parts

Exhibit II Graphing Advice Matrix

Cover Sheet

Persuasion ovhds of graphs presentation

Data files

Graph RefMat. 04/25/95

Current master

Draft