Displaying Data in Written Documents*

The Cain Project in Engineering and Professional Communication

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Abstract

This guide explains general rules plus specific advice for creating tables, line graphs, scatterplots, bar graphs, histograms, frequency polygons, and pie charts.

All graphics, from simple tables to complex graphs, function best when they are organized to highlight and make obvious the results that you are reporting. Many readers skim the figures in a document to determine whether the rest of the document is worth reading. Your figure or table therefore needs to be able to stand alone. It also needs to be explained and contextualized in the text. In your discussion of the graphics you show, you assign meaning to the results, helping readers understand why your results matter.

NOTE: More detailed instructions prepared by the Laboratory Coordinators Group are available at the Interdisciplinary Web-based Instructional Materials Web site at http://www.owlnet.rice.edu/∼labgroup/pdf/referenc . There you will find .pdf documents on dimensions and units, fundamentals of graphing, common graphical errors, using software to plot data, error analysis and significant figures, and error representation and curve fitting.

1 General Rules for Graphics in Documents

- Number each graphic and include an informative caption that tells readers what they need to notice. In reports, tables are usually captioned above the table (for example, Table 1. Xxxx.), while figures are captioned below the figure (for example, Figure 5. Xxxxx.).
- Identify graphics correctly. Tables are "tables." Everything else (graph, photo, etc.) is a "figure."
- Place graphics within the text discussing them for easy reference (unless otherwise specified by a journal or other publication).
- Refer to graphics in the text, either in the sentence itself (for example, "Table 2 shows . . .") or within parentheses. For example, you might write, "Apoptosis occurred in 50% of the samples (Figure 2)."
- Introduce figures in the text before the reader sees them and include discussion of figures and tables after the graphics appear.
- Use logical labels or mnemonic abbreviations to aid in comprehension. Most readers can't decipher more than four trendline symbols or other abbreviations to indicate your data. Think logically about labels, legends, and data display.

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[1] http://www.owlnet.rice.edu/∼labgroup/pdf/references.htm

- When necessary information cannot be fit into column headings of tables, use a footnote to guide readers to more information. Footnotes appear in a typeface smaller than that used in the figure caption, and most academic publications order them with the symbols •, †, and §, followed by superscript italic letters (a, b, c). To find unusual symbols in Microsoft Word, go to the "Insert" menu and choose "Symbol." Many publications use footnote numbers or simply add information after the figure title with the word NOTE followed by the additional information in smaller point size. Some publishers use additional symbols not available in the commonly available word processing programs.
- Bigger is better. Be sure that your captions, data points, labels, and so on are easy to read. This is a matter of accessibility.
- Design graphics for black-and-white printers and photocopiers, even if you will ultimately produce the graphic in color.

2 Tables

Best for	**Not so good for**
Organizing verbal and numeric data Reference	Quick overviews Communicating trends

Table 1

Table Sample

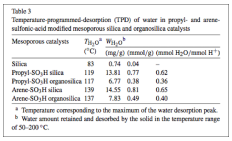

Table 3
Temperature-programmed-desorption (TPD) of water in propyl- and arene-sulfonic-acid modified mesoporous silica and organosilica catalysts

Mesoporous catalysts	T_{H_2O}[a] (°C)	W_{H_2O}[b] (mg/g)	(mmol/g)	(mmol H_2O/mmol H^+)
Silica	83	0.74	0.04	–
Propyl-SO_3H silica	119	13.81	0.77	0.62
Propyl-SO_3H organosilica	117	6.77	0.38	0.36
Arene-SO_3H silica	139	14.55	0.81	0.65
Arene-SO_3H organosilica	137	7.83	0.49	0.40

[a] Temperature corresponding to the maximum of the water desorption peak.
[b] Water amount retained and desorbed by the solid in the temperature range of 50–200 °C.

Figure 1: From Morales, G., Athens, G., Chmelka, B.F., van Grieken, R., and Melero, J.A. (2008) Aqueous-sensitive reaction sites in sulfonic acid-functionalized mesoporous silicas. *Journal of Catalysis 254*:205-217.

2.1 Design tips for creating tables

- Place units in column headings. Don't mix units of measurement.
- Minimize or omit gridlines because the data, not the background, should dominate. For multi-line entries or to aid readability, choose narrow or gray lines to delineate data.
- Add points of space above and below the text or numbers in the table to increase readability. Make sure the extenders" (the lower part of letters such as p, q, and y) don't touch the gridlines.
- Organize data according to reader expectations. Most readers can more easily compare columns than rows. Western readers also expect to find known information on the left and unknown information on the right.
- Color can be a good way to point out contrasts, but if the document will be photocopied, only very strong contrasts will be distinguishable. Try out the photocopy results before you settle on colors. Beware of low-contrast relationships between the background and a colored trend line. Yellow and other pastels on a white background are scarcely visible.

3 Line graphs

Best for	Not so good for
Showing trends or relationships when one variable is dependent on the other	Showing precise data values

Table 2

Line graphc Sample

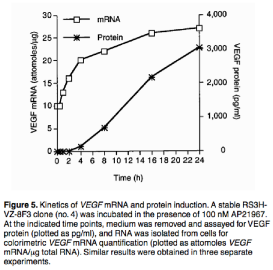

Figure 2: From Pollock, R., Giel, M, Linher, K., and Clackson, T. (2002) Regulation of endogenous gene expression with a small-molecule dimerizer. *Nature Biotechnology 20*:729-33

3.1 Design tips for creating line graphs

- Label all axes with units.
- Use consistent axes and labels for similar data types unless you are specifically calling attention to differing relationships or trends in a data set.
- Consider placing tick marks on the graph lines and using axes on the right and top to assist readers in locating specific data points, such as spectral peaks, if these are important.
- If helpful, label specific data points of interest, within the graph.
- If you have multiple lines plotted in your graph, use a key (also called a legend) to label them. Place the key/legend in or near the graph for ready reference.
- Recall that color can be a good way to point out contrasts, but if the document will be photocopied, only very strong contrasts will be distinguishable. Try out the photocopy results before you settle on colors. Beware of low-contrast relationships between the background and a colored trend line. Yellow and other pastels on a white background are scarcely visible.

4 Scatterplots

Best for	Not so good for
	continued on next page

Showing correlation of two variablesIdentifying non-linear relationshipsIdentifying clusters and outliers (out-of-range points)	Helping readers recognize precise data values

Table 3

Scatterplot Sample

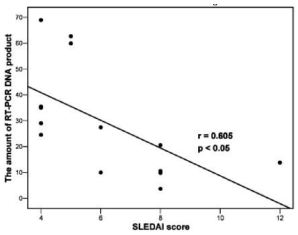

Figure 3: From Kuo, C.-C. and Lin, S.-C. (2007) Altered FOXO1 transcript levels in peripheral blood mononuclear cells of systemic lupus erythematosus and rheumatoid arthritis patients. *Molecular Medicine 13*:561-66.

4.1 Design tips for creating scatterplots

Same as for line graphs, above.

5 Bar graphs

Best for	Not so good for
Representing categorical or non-continuous data (e.g., species, regions, populations) that cannot be plotted on line graphsComparing proportions, amounts, valuesDisplaying data sets that are close together in value (which would overlap in line graphs)	Showing continuous or precise data values

Table 4

Bar Graphic Sample

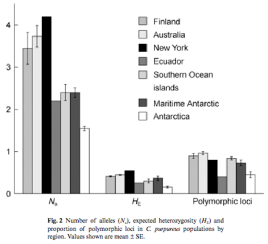

Figure 4: From Clarke, L.J., Ayre, D.J., and Robinson, S.A. (2008) Somatic mutation and the Antarctic ozone hole. *Journal of Ecology 96*:378-385.

5.1 Design tips for creating bar graphs

- Label all axes with units.
- Make spacing between bars half the size of bars to help readers distinguish data from background.
- Avoid 3D effects or shading, which can distort readability.
- If you are reporting on experimental results, choose the bar shading to emphasize the experimental data over the control or base case data. Your experimental values should be the ones that stand out.

6 Histograms

Best for	Not so good for
Assessing the shape of a distributionScreening outliers or checking normality	Showing precise data values (histograms are constructed from frequency tables and often group data into categories)

Table 5

Histogram Sample

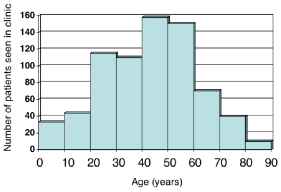

Figure 5

6.1 Design tips for creating histograms

- Place midpoints of intervals on horizontal axis.
- Place frequencies on vertical axis.
- Bars should touch one another (unlike bar graphs).
- Use only with continuous data.

7 Frequency Polygons

Best for	Not so good for
Showing counts/frequency in a visually distinctive wayShowing distribution for two sets of data (less cluttered than a histogram)	Showing precise data values (like histograms, frequency polygons are constructed from frequency tables)

Table 6

Frequency Polygon Sample

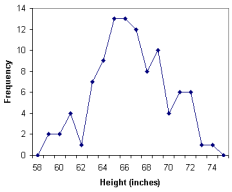

Figure 6

7.1 Design tips for creating frequency polygons

- Follow tips for histograms.
- Use a point (instead of histogram bar) and connect the points with straight lines.
- If desired, shade area underneath the line.

8 Pie Charts

Best for	Not so good for
Representing whole-to-part relationships Showing percentages Distribution of costs	Most scientific displays

Table 7

Pie Chart Sample

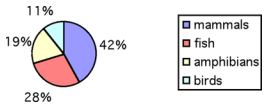

Figure 7

8.1 Design tips for creating pie charts

- Most useful for showing population distributions, budget allocations, and other percentage-related data.
- Avoid 3D effects, which can distort readability.
- If using color to distinguish between sectors (wedges), make sure the colors provide highly legible contrasts, and do not use adjacent colors that are difficult for color-blind readers to tell apart (such as blue and green or green and red).