➤ ➤ ➤ ➤ ➤ CHAPTER 15

Figures

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This chapter discusses methods of preparing and submitting the figures and other illustrations that accompany a scientific paper for publication. The past 10 years have seen a radical technological shift in the way figures are created by authors and handled by publishers. Whereas authors previously submitted figures that were *camera-ready*—that is, ready for the printer's camera to photograph before making printing plates— today many authors create figures using computer software, and most publishers encourage electronic versions of figures. This chapter presents guidelines for working with figures using the computer tools currently in widespread use; it also includes recommendations regarding the use of color, fonts, and scanners, as well as good style for citing and captioning figures.

Technical requirements and certain style points differ from publisher to publisher and from journal to journal, so bear in mind that this chapter presents general guidelines. ACS journals have some specific requirements that may differ from the general guidelines presented here, and these are noted throughout the chapter. As always, before you finalize figures for your manuscript, you should consult your publisher's guidelines for submitting artwork. For ACS journals, consult recent issues as well as the Guide, Notes, or Instructions for Authors that appear in each journal's first issue of the year or at https://paragon.acs.org/paragon/index.jsp (see "Author Information"). For ACS books, consult the brochure "How To Prepare Your Manuscript for the ACS Symposium Series" or see "Info for Authors" at https://pubs.acs.org/books.

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Box 15-1. Do I Need a Figure or a Table?

Do I want the basic point to be communicated at a glance?
Use a figure.

Do I want the reader to see trends and relationships?
Use a figure.

Do I want the reader to see exact numbers?
Use a table.

Do I want to communicate a lot of information with words?
Use a table.

When To Use Figures

A *figure* is an illustration used in scientific or scholarly publishing. Figures can be graphs of data, photographs, sketches, flow charts, and so on. Figures can play a major role in highlighting, clarifying, and summarizing data and results and can substantially increase the readers' comprehension of the text by communicating visually. For example, line graphs show trends. Bar graphs compare magnitudes. Pie charts show relative portions of a whole. Photographs can provide absolute proof of findings. In general, figures should be used when the picture really is worth a thousand (or so) words.

However, figures can decrease a reader's comprehension, and they can cause outright confusion if they are poorly rendered or cluttered, if they do little more than repeat data already presented in text, or, worse, if they present information at odds with the text. An excessive number of figures can dilute the value of any individual figure: when presented with too many figures, a reader may look carefully at none of them. Figures should not be used to present data that would be better presented in a table. See Box 15-1 and Chapter 16, "Tables."

The cost of publishing figures has decreased substantially over the past two decades, partly because authors are able to prepare better quality figures (so the publisher does not have to) and partly because of the shift to electronic methods of Web and print publishing that are less cumbersome than earlier technologies, which required a high-quality, pristine paper original of all art. The cost of publishing color figures has also decreased substantially because most color photographs can now be provided in electronic form and no longer require expensive color separations before being put on a printing press. The cost of using color in Web publications is inconsequential (although color should still be used carefully to enhance your meaning, not just to grab attention). See Box 15-2.

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Box 15-2. Do I Need To Use Color?

Do I need color to make the picture comprehensible to the reader?

Color should be used only when it is essential to understand the chemical nature of the material in the picture. Otherwise the picture should be prepared in black and white.

Do I need color in my line graph, bar graph, or pie chart?

Color is rarely required in these figures. Lines with varying dash styles in line graphs and distinct grayscale shades in bar graphs or pie charts work as well.

Do I need color to catch the reader's eye?

No.

Do I need color to organize related information for the reader?

No. Judicious use of fonts and careful placement of words and objects usually does just as well.

How To Cite Figures

All figures must be "called out", that is, mentioned or discussed by name and number in the text. (If you cannot find a graceful, logical place to put the callout, then you might consider deleting the figure.) Follow these guidelines in citing figures.

➤ Capitalize the word "Figure" when it is followed by the figure number.

➤ Number figures sequentially with arabic numerals in order of discussion in the text (Figure 1, Figure 2, etc.).

➤ Designate parts of a figure by using a combination of the arabic numeral and a sequence of consistent labels, usually (but not always) letters: Figure 1a, Figure 1b; Figure 1A, Figure 1B; Figure 1-I, Figure 1-II. Do not cite, for example, Figure 4 and Figure 4A.

EXAMPLES OF FIGURE CALLOUTS IN TEXT

The block copolymers may contain a small but detectable fraction of impurities, as shown in Figures 1 and 2.

Figures 3–5 show the production of acid-reactive substances in three different oils.

The deuterium-labeled substrate gave rise to the partial ^{1}H NMR spectra shown in Figure 2a,b.

As seen in Figure 3b–d, the catalytic wave shows a small but distinct decrease upon addition of the nucleophile.

Parts a and b of Figure 4 illustrate that the voltammetric plateau current depends on the number of enzyme monolayers.

Curves c–e of Figure 5 were obtained for various methyl groups in the protein.

POOR EXAMPLES OF FIGURE CALLOUTS IN TEXT

Figure 2c and Figure 2D show… *should read* Figure 2c,d shows…

Figure 3 and Figure 4 show… *should read* Figures 3 and 4 show…

Chemical structures and schemes should not be numbered as figures; they should be labeled according to separate sequences. See Chapter 17, Chemical Structures.

How To Prepare Figures

At one time, almost all publishers required that figures be submitted as camera-ready artwork. Today, most publishers accept, many encourage, and a few require that figures be submitted in electronic format. Most scientists store their data on computers and create their figures using computer software, and good-quality document scanners are in common use. Thus, the submission of electronic files is simpler than ever before and has the advantage of keeping original data and photographs in the author's own hands. Satisfactory results in the final publication are not guaranteed, however, and the burden rests on authors to prepare figures to suit the requirements of the medium in which they will be published.

Publication Medium

The traditional method for publishing books, journals, and other documents is by *print publishing*, that is, the application of ink on paper. Newer avenues include publishing on the Internet, usually called *Web publishing*, as well as other formats that are viewed on a computer monitor, such as CD-ROMs. The requirements of ink-on-paper and pixels-on-screen publishing are quite different and may affect your choices regarding figure creation and final electronic format. For printed materials to be satisfactory, the figure files must have much detail and therefore must be prepared at a higher resolution, that is, a higher number of pixels per inch (ppi). Paper printers also use a scale called dots per inch or dpi, which you may need to use sometimes. Materials viewed on a computer monitor do not require the same level of detail but—on the Web especially—they must download quickly, so they are prepared at a low resolution. Only for printed materials is color significantly more expensive than black-and-white, so in print, color is used conservatively. Conversely, on a computer monitor, color costs nothing additional and is used widely.

◆Publishing with ACS: When preparing figures for ACS journals—which are published in print and on the Web—prepare your figures to the higher standard required for print. ACS routinely prepares the Web figures from files provided for the print figures.

Types of Figure Artwork

The two broad categories of figure artwork are line art and continuous-tone art. *Line art* consists of black markings on a white background, with no additional colors and no shades of gray (see Figure 15-1A). Line art contains lines, solid shapes, and type (letters or words). Examples of line art include line graphs, flow charts, and scatter plots. (Structures and schemes are usually line art as well; see Chapter 17.) *Continuous-tone art* (also called *halftone art*) contains shades of gray (or color) (see Figure 15-1B). Examples of continuous-tone art include photographs (whether black-and-white or color) and drawings or sketches with midtones.

In print publishing, line art is straightforwardly rendered by ink on paper. To print continuous-tone art, the shading must be converted into dots through a process called *screening*. The size and spacing of the dots produces the illusion of shading to the reader's eye. Halftones do not reproduce type or fine lines well because screening distorts the edges of the letters and lines. On a computer monitor, all text and images are converted to uniformly sized pixels.

Until recently, publishers strongly encouraged authors to submit figures as line art, with halftones reserved for photographs. Currently available software and the prevalence of electronic file submission is bringing a third category of art into more common use. *Grayscale line art* is black-and-white art that contains gray shading alongside fine lines and type (see Figure 15-1C). Grayscale line art may be used for pie charts, bar graphs, and area graphs, where different sections are distinguished by different shades of gray.

A fourth category of art is a combination of a photograph with some type, or a *combo* (see Figure 15-1D). An example might be a photomicrograph with a unit-of-measure legend in one corner; another might be a photograph with callouts identifying parts of an image, such as a piece of equipment. If there is only a small amount of type (as in the first example), then a combo can be handled like other halftones. When there is more type (as in the second example), then a combo requires special handling, because screened type loses legibility very quickly.

◆Publishing with ACS: For ACS journals, line art should be created and saved at 1200 ppi. Grayscale art, including grayscale line art and combos, should be created and saved at 600 ppi. Halftones, whether black-and-white or color, should be created and saved at 300 ppi.

A
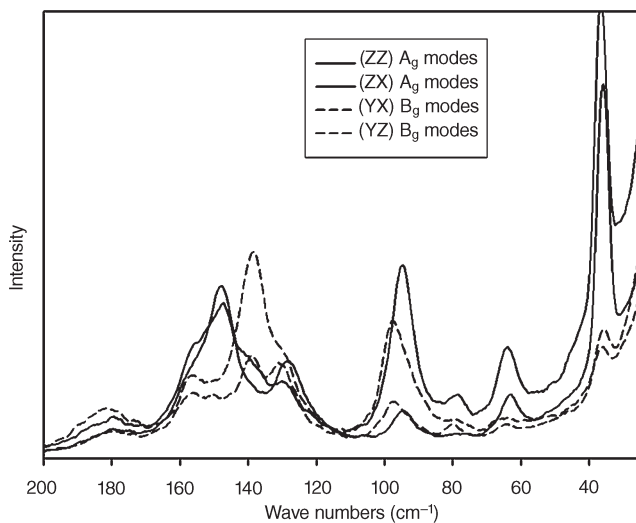
B

Figure 15-1. Examples of categories of figure art: (A) line art, (B) halftone or continuous-tone art, (C) grayscale line art, and (D) a combo.

Sources: (A) Reprinted from Stevens, L. L.; Haycraft, J. J.; Eckhardt, C. J. *Cryst. Growth Des.* **2005,** *5,* 2060–2065. Copyright 2005 American Chemical Society. (B) Photograph courtesy of Raj Mehta. Reprinted from *Reagent Chemicals,* 10th ed. Copyright 2006 American Chemical Society. (C) Reprinted from Watanabe, K.; Niwa, S.; Mori, Y. H. *J. Chem. Eng. Data* **2005,** *50,* 1672–1676. Copyright 2005 American Chemical Society. (D) Adapted from Odelius, K.; Plikk, P.; Albertsson, A.-C. *Biomacromolecules* **2005,** *6,* 2718–2725. Copyright 2005 American Chemical Society.

C
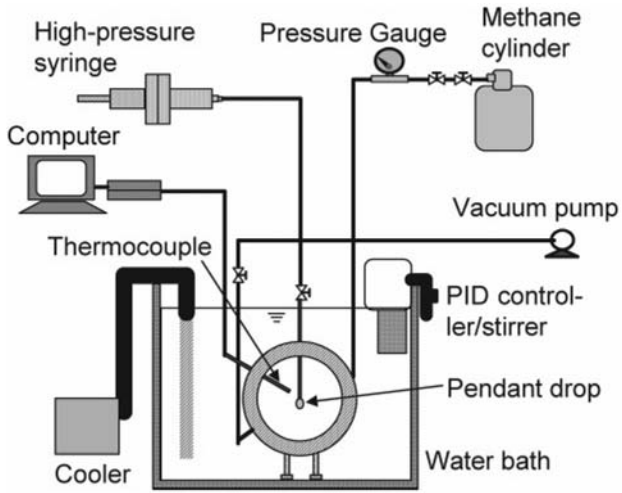
D
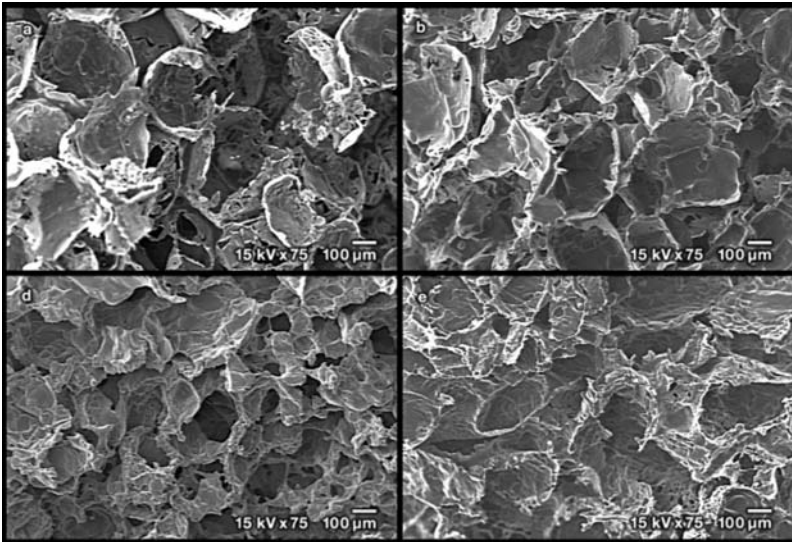
Figure 15-1. *Continued.*

Use of Color

The use of color in figures depends partly on the medium and partly on a particular publisher's preferences. As mentioned earlier, color can be used in Web publishing at virtually no cost, so the only restrictions have to do with scientific effectiveness and good taste. Color in print publishing adds to the cost, so before preparing figures in color, you should ascertain a publisher's policies on color.

◈**Publishing with ACS:** ACS journals do not require authors to pay the cost of color illustrations. Authors who publish color figures in ACS books are asked to pay half the cost.

In publications, color is produced by one of three modes:

- Black-and-white, or B&W: For print publications, where only one color of ink (usually black) is used.
- Cyan–magenta–yellow–black, or CMYK (also called four-color): For print publications, where all shades of color are produced by layering screened dots of four standardized inks.
- Red–green–blue, or RGB: For Web publications and others viewed on computer monitors, where all shades of color are produced by overlapping red, green, and blue light.

Most publishers can switch electronically from CMYK to RGB, although it is always better to use the publisher's preferred format. Switching from one of the color formats to B&W may produce unsatisfactory results, however. If the gray tones that result are hard to distinguish from each other, a figure that was intelligible in color can become meaningless in B&W. For this reason, it is always better to prepare art that will be reproduced in black and white as B&W.

Electronic File Formats

Many software packages are available today for drawing, scanning, and manipulating figures. When a figure is saved in a format that can be read or reopened only by the software that produced it, the file is called an *application file*. Examples include files with names that end with the suffix .cdx, which can be opened only in Cambridgesoft ChemDraw, or files with names that end in the suffix .psd, which can be opened only in Adobe Photoshop. Application files often pose problems in both Web and print publishing because the publisher (or reader) might not have the necessary software to open or view the file. Many publishers will not accept application files for figures.

There are a handful of file formats, however, that can be opened in many different software packages. Drawing and scanning programs generally provide the option of saving to one or more of these formats. For example, ChemDraw and

Photoshop will both export figures as TIFFs, a format frequently used for print publications. The most universally accepted of these formats are the following:

For Print
- Encapsulated PostScript, or EPS. PostScript is a programming language developed by Adobe to describe pages, graphics, and fonts; an EPS file is coded to be embedded in a large PostScript file.
- Tagged Image File Format, or TIFF. TIFFs describe an image by dividing it into a grid of pixels and assigning a value to each square. The quality of a TIFF image depends on its resolution (in ppi), that is, the size of the original grid.

For Web
- Graphics Interchange Format, or GIF. GIF is a pixel-based format like TIFF, except the resolution is preset at 72 ppi, which is appropriate for the Web but seldom acceptable for print.
- Joint Photographic Experts Group, or JPEG. JPEG is another pixel-based format like TIFF but capable of higher resolutions than GIFs. JPEGs, however, are actually compressed files, and they lose small amounts of digital information every time they are opened, recompressed, and saved, so JPEG images tend to degrade with repeated processing. Only "fresh", high-quality JPEGs are suitable for print publication.

For Print and Web
Many publishers now accept properly created Portable Document Files, or PDFs. A PDF document is created when an application file produced by any of a number of software programs is "distilled", using software such as Adobe's Acrobat Distiller. The PDF document can be viewed on any platform using viewing software such as Adobe's Acrobat Reader, regardless of whether the viewer has the original application software.

◆**Publishing with ACS:** For ACS journals, figure art that will be submitted in PDF format should be distilled using Adobe Acrobat Distiller's "Press Quality" setting.

With so many different software packages and file formats, there is no single "right" way to prepare figures for publication. A few common paths are listed here:

- A line-art figure is drawn in an application such as Adobe Illustrator, Macromedia Freehand, or Corel Draw and exported as an EPS or a TIFF file.
- A B&W photograph is scanned with the scanner's software and saved as a grayscale TIFF.

Table 15-1. Image File Formats and Their Suitability by Publication Medium and Type of Figure[a]

File Format	Optimal ppi[b]	Publication Medium			Best Used To Represent			
		Web	B&W Printing	Color Printing	Line Art	Photo-graphs	Grayscale Line Art	Combos
For Web								
GIF	72	H	X	X	R	R	R	R
RGB JPEG	72	R	X	X	R	R	R	R
For Print								
B&W JPEG	300	X	R	X	X	R	R	R
CMYK JPEG	300	X	X	R	X	R	R	R
	600–1200	X	X	R	R	X	X	X
Bitmap TIFF	1200	X	H	X	H	X	X	X
Grayscale TIFF	600	X	H	X	X	H	R	R
CMYK TIFF	300	X	X	H	X	H	R	R
EPS	N/A	X	R	H	H[c]	X	H[c]	H[c]

[a]H indicates highly recommended; R indicates recommended; X indicates not recommended.

[b]The optimal number of pixels per inch (ppi) for art prepared to the size at which it will be published. It is always permissible to supply art with a higher ppi than what is listed here.

[c]EPS files are the best way to submit grayscale line art and combos, but the fonts used must be embedded or converted to outlines.

- A color digital photograph cropped in Photoshop is saved as a 72 ppi RGB GIF file for the Web or a 300 ppi CMYK TIFF file for print.
- Grayscale line art is drawn in an application, such as Illustrator or Freehand, and saved as an EPS file.

Table 15-1 lists image file formats commonly accepted by publishers and their suitability for different publishing media and types of artwork.

Several software packages that are in common use can produce satisfactory GIFs for Web publishing but do not export images in a form that is acceptable for the more rigorous requirements of print. Corel WordPerfect and Microsoft Word, Excel, and PowerPoint cannot save figures as valid PostScript files or export directly to TIFFs. Box 15-3 offers suggestions for preparing publishable figures in that program.

Sizing Artwork

Always determine the size at which your figures will be printed and prepare the final electronic version to those dimensions. Consult guidelines from the publisher first. If there are no guidelines, use the following:

- For a Web publication, size your artwork so that it is visually appealing and all parts of the graphic are easily readable on your monitor at 100%.

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Box 15-3. Tips for Submitting Figures Created in Excel

Microsoft Excel and PowerPoint are widely used to create graphs and other figures, but they are unable to export to TIFF or any PostScript file format. Therefore, if figures prepared with these software programs are destined for print publication, they must be printed on paper first and then scanned. (It may also work to submit the figure as a PDF.) Moreover, the default settings of these programs will not produce satisfactory figures. The following tips help you get the best results from Excel.

- Do not use color to differentiate areas of the figure. Use black only for a color, and use gray tones to differentiate areas of the figure.

- Be sure that the weight of all lines is at least 0.5 point. Some lines in Excel default to 0.12 point, which is too thin for scanning. If the figure will be printed large and then reduced, calculate the width of lines accordingly (see the chart below).

- Be sure that the type and symbols also will scale down accordingly.

- It is better for tick marks to extend into the figure, rather than extend outside.

- Print the figure on clean, opaque, white paper, using a fresh ink or toner cartridge. Do not use a dot matrix printer. Set the laser or inkjet printer to a resolution of at least 600 ppi.

- Scan the figure to the correct size, and save it as a 600 ppi bitmap TIFF.

If your publisher requests the Excel application file, be sure that the source data are embedded (not linked) in the file you send.

Line width for a typical figure created in Excel, printed landscape on 8.5 × 11 in. paper, and destined to be printed at a width of 20 or 27 picas:

	20 picas (single-column journal)	27 picas (6 x 9 in. book)
Approximate reduction	38%	50%
Type size in Excel	14 pt	14 pt
Type size after reduction	5 pt	7 pt
Line width in Excel	1.5 pt	1 pt
Line width after reduction	0.5 pt	0.5 pt

Table 15-2. Column Dimensions Most Common in ACS Publications

Publication	Column Width			Page Length		
	picas	inches	centi-meters	picas	inches	centi-meters
Books, trim size						
6 × 9 in.	27	4½	11	42	7	17½
7 × 10 in.	33	5½	13½	51	8½	21½
8 × 11 in.				56	9	23
single column	20	3¼	8¼			
double column	42	7	17½			
Journals and magazines, two-column format				60	10	25½
single column	20	3¼	8¼			
double column	42	7	17½			
Magazines, three-column format				60	10	25½
single column	13	2	5			
double column	27½	4½	11			
triple column	42	7	17½			

- For a printed publication, you can determine the column width and page length by measuring a sample copy of the journal or a similar book from the same publisher.
- For ACS journals, try to design figures to fit the width of one column. Table 15-2 gives the column widths and page lengths of many ACS publications.
- Do not put unnecessary frames or boxes around your figures.
- Remember that the length that you measure or take from Table 15-2 is the *maximum* space available for the figure *plus* captions or notes. Therefore, the art must be small enough to leave space for the caption.
- Finally, the width and depth of a figure should not exceed the needs of that figure. Be economical; do not waste space.

Working with Line Art

If you are creating line-art figures with a computer program, save them in an appropriate format (see Table 15-1) or print them on white, high-quality, smooth, laser-printer paper and scan them. If line-art figures are being drawn by hand, use black ink on white, high-quality, smooth, opaque paper, and then scan them. Box 15-4 provides tips for successful scanning.

Here are some ways to improve the quality of the line-art figures you submit:

➤ Select software that will yield the best results for the line art you wish to create.

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Box 15-4. Tips for Successful Scanning

- If possible, use a flatbed scanner, where the art rests flat on a glass surface and is scanned by a moving scanner's eye, rather than a sheet-fed scanner, where the art is rolled past the scanner's eye. Flatbed scanners are less likely to distort your figure.

- Use your scanner's optical (that is, actual) resolution capability, not the interpolated (that is, calculated) one.

- Scan photographs at a minimum resolution of 300 ppi.

- Scan line art at a resolution of minimum 600 ppi, but 800, 1000, or 1200 ppi is even better. (Line art for ACS publications must be 1200 ppi.)

- If possible, determine the final size of your figure in print and calculate the percentage of expansion or reduction. Then scan the photograph at that percentage.

- If you are not sure about the final size, scan your photograph at a larger size (say, 150% with 300 ppi) or higher resolution (say, 100% with 450 ppi). Scan your line art at 150% with 600 ppi or at 100% with 1000 ppi. It is better to submit image files with too much information than too little.

- Do not adjust contrast or color according to what you see on your monitor. Instead, use the automatic adjustments that come with the scanning software or use the calibration curves that come with image-editing software, such as Photoshop.

- Do not apply any screening in the scanning or editing software, even if you know the figure will be screened before it is published. Let the publisher and the publisher's printer determine the appropriate screening.

➤ Create the line art to the exact size at which it will be published.

➤ Keep line-art figures clear and simple. Keep words to a minimum. Lengthy explanations should go in the caption or a note accompanying the caption.

➤ Scale the length, width, type, symbols, and lines of the art proportionally; keep the symbols, lines, and type at uniform density, or darkness.

- Make the lines at least 0.5 point wide and usually not more than 1.5 points wide.

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Box 15-5. Type Size and Font

In publishing, type is measured in points; space is measured in picas. There are 72 points to an inch; there are 6 picas to an inch. The size of the type you are reading on this page is 10 points. The column is 28 picas wide, and the text page is 44 picas long.

You can use a pica ruler to measure space, but it is hard to find a type gauge for measuring type; you must compare it to known type sizes. For example, in 10 point type, no character actually is 10 points high.

The font (or typeface) is the style or design of the letters. There are literally hundreds of fonts, but plain, simple fonts such as Helvetica or Times Roman are best for scientific art.

Type also comes in different weights. Most of the type you are reading is lightface; **this is boldface type**. Type may be *italic* or roman. Generally, you should use lightface, roman type for figures.

This is 12 point Times Roman.
$^{14}C_6H_6$ shows subscripts and superscripts.

This is 12 point Helvetica.
$^{14}C_6H_6$ shows subscripts and superscripts.

This is 14 point Times Roman.
$^{14}C_6H_6$ shows subscripts and superscripts.

This is 14 point Helvetica.
$^{14}C_6H_6$ shows subscripts and superscripts.

- Select a type size of 7–10 points; for ACS journals, select a type size of 5–6 points.
- Make the symbols at least the size of a lowercase letter "oh" (about 2 mm) (see Box 15-5).
- Use a clear type font, preferably Helvetica or Times Roman (see Box 15-6).
- Disparities between the size of the type and the symbols make for illegible or unattractive art; if the type is the right size, the symbols will appear too small or too large, and vice versa. Likewise, the proportion between the overall size of the figure and the type and symbols should be appropriate (see Figure 15-2).

➤ Use simple, common symbols that would not be confused with each other and would be readily available in any publishing house, for example, ○, ●, □, ■, △, ▲, ▽, ▼, ◇, ◆, +, ×, ☆, and ★. (Even if you provide a legend within the figure, you may wish to refer to the symbols in your text.)

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Box 15-6. Tips Regarding Fonts

The fonts used to create some types of electronic figure files occasionally cause problems for publishers, in both print and Web publications. The problems can include character substitution, distorted spacing between letters, and copyright infringement.

The software behind a font is covered by copyright law. Whereas some copyright holders allow open access to their fonts, others exercise some sort of limit. Publishers respect the copyright on fonts and will not use a font without proper permission.

Only some electronic files embed font software in the files.

- GIFs, TIFFs, JPEGs, and other pixel-based files embed only the images of letters, not the font software itself, in their files. Type in these files can be erased, but it is not truly editable.
- EPS and PDF files must have font software fully embedded to be usable. Type in these files is fully editable.

TrueType is a font format designed by Microsoft for maximum legibility on a computer monitor, and it prints well on dot-matrix, inkjet, and laser printers. Microsoft permits free use of the fonts it provides (such as Times New Roman and Arial), but other companies that provide TrueType fonts may have use restrictions. TrueType fonts perform well in Web publishing, but they often pose technical problems in print publishing. TrueType fonts are fine for producing GIFs, TIFFs, and JPEGs, as well as PDFs intended for the Web.

PostScript is a font format designed for high-end graphic arts. These fonts are designed for maximum legibility on paper and for maximum compatibility with high-quality, high-output printing equipment. PostScript fonts are generally covered by copyright and have limitations on their use. They seldom pose technical problems in print publishing, but the copyright issues may limit their usefulness in Web publishing. PostScript fonts are best for EPS files and PDFs intended for print.

OpenType fonts are a relatively new format intended to combine the virtues of both TrueType and PostScript fonts.

STIX (scientific and technical information exchange) fonts were developed by a group of six scientific publishers to establish a comprehensive set of fonts that contains essentially every character that might be needed to publish a technical article in any scientific discipline. STIX fonts are available as a free download, under license, at www.stixfonts.org. A white paper by Tim Ingolsby on the STIX fonts project is available at www.aipservices.org/newsroom/white_papers/pdf/STIX-fonts.pdf.
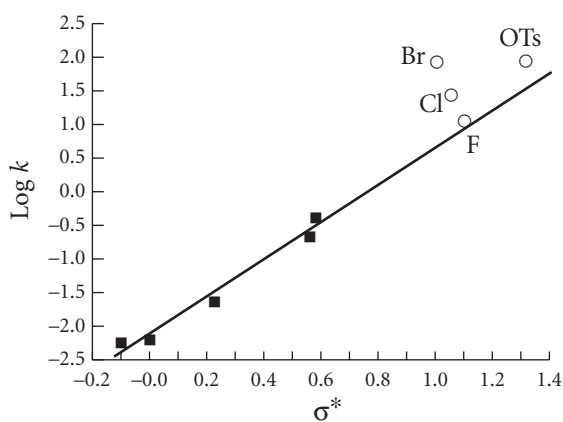
A
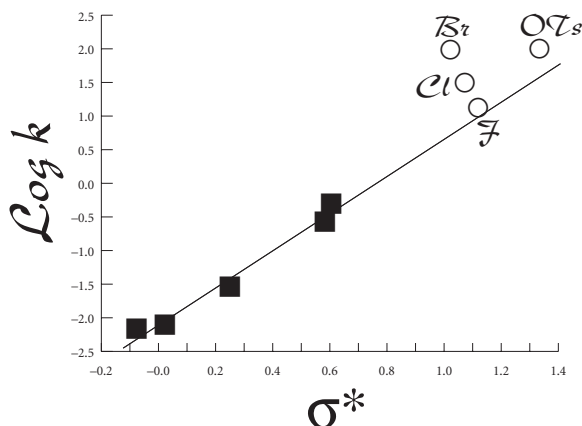
B

Figure 15-2. (A) Example of a poorly rendered line graph, with lines that are too thin, a type font that is too ornate, and type and symbols that are sized disproportionally to the figure. (B) Example of the same line graph properly rendered.

Source: Adapted from Alunni, S.; De Angelis, F.; Ottavi, L.; Papavasileiou, M.; Tarantelli, F. *J. Am. Chem. Soc.* **2005,** *127,* 15151–15160. Copyright 2005 American Chemical Society.

➤ Lines may be differentiated by the use of varying line styles, such as solid, dashed, dotted, and various weights (but never less than 0.5 point wide).

➤ You may combine curves plotted on the same set of axes, but do not put more than five curves in one figure. (If you have more than five curves, consider splitting the figure into two parts or two separate figures.) Label all curves clearly. Leave sufficient space between curves; they should not overlap so much that they become indistinguishable.
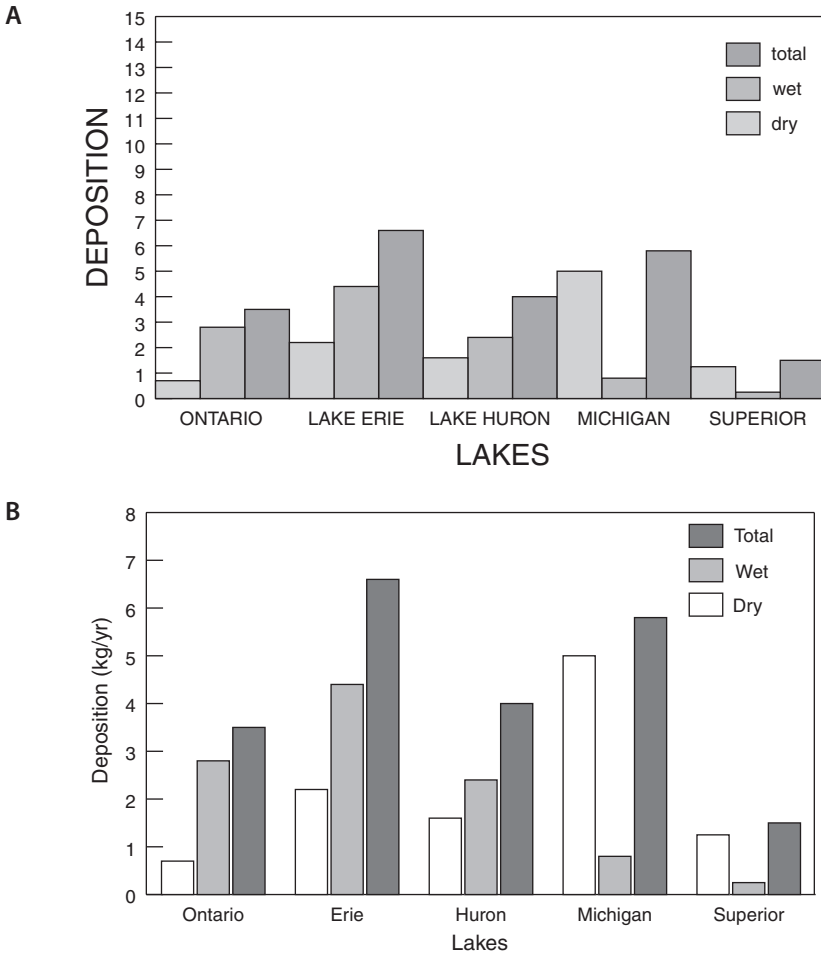
Figure 15-3. (A) Example of a poorly rendered bar graph, with excess white space at the top, shading that is difficult to distinguish, and poor and incomplete labels. (B) Example of the same bar graph properly rendered.

Source: Adapted from Ma, J.; Venkatesh, S.; Li, Y.-F.; Daggupaty, S. *Environ. Sci. Technol.* **2005,** *39,* 8123–8131. Copyright 2005 American Chemical Society.

➤ Keep line-art figures compact; draw axes only long enough to define the contents. For example, if the highest data point on the curve is 14, then the scale should extend no longer than 15. Furthermore, the origin or lowest point on the axes does not have to be zero. For example, if the lowest data point on the curve is 4, then the axis can start at 3. Put grid marks on the axes to indicate the scale divisions.

➤ Use complete and consistent axis labels (see Figure 15-3).

- Label each axis with the parameter or variable being measured and the units of measure in parentheses.

- Use initial capital letters only, not all capitals: Time (min), Reaction Temperature (°C), Thickness (μm).
- Place all labels outside and parallel to the axes. Numbers and letters on the abscissa and ordinate should read from left to right and from bottom to top, respectively.
- Do not place arrowheads on the ends of the axis lines.
- Label the tick marks on an axis in type that is one or two points smaller than the axis labels (but not smaller than 7 points in general, 5 points for ACS journals).

➤ Do not draw a box around line-art figures.

➤ For insets, labels, or legends within the figure, use initial capital letters and use the same size type as for the axis labels.

➤ Save electronic figure files with a minimum of white space around the edges.

➤ If you are printing line-art figures for subsequent scanning, always check that the toner or ink cartridge is fresh, and never use a dot-matrix printer.

➤ If you print a hard copy to submit with the electronic file, print it with one figure per page and be sure that the figure number appears on the page.

Working with Photographs and Other Halftone Figures

Good reproduction of photographs begins with good photographs. When you are selecting photographs for figures to accompany your text, consider the following points:

➤ As much as possible, the photograph should show what is important to your text, and only what is important. Clutter and unrelated objects should be cropped out. (This is easy to do with electronic images.)

➤ Photographs always lose some detail in reproduction, so be sure to take the photograph in good focus and, for digital photographs, with sufficient resolution. See Figure 15-4.

➤ Photographs in print will tend to lose contrast and become muddy or gray, so take a few steps to ensure that your photograph has good contrast and tonal definition:

- Adequately light objects that you are photographing.
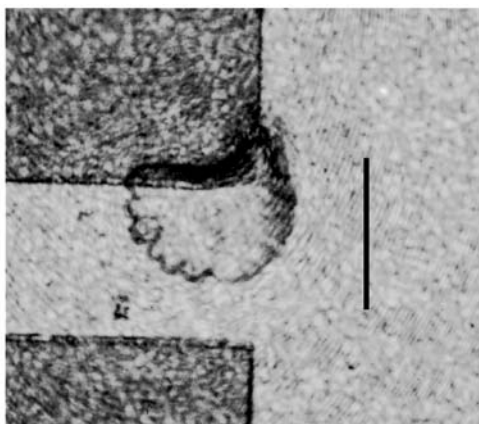- Place objects on light or dark backgrounds that are plain or solid.

A
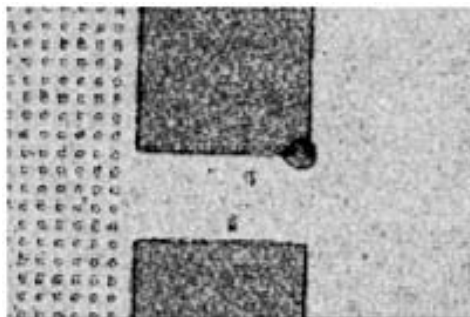
B

Figure 15-4. (A) Example of a photograph with a resolution that is too low for print, so the pixels show as squares, instead of blending to show tones. (B) A similar photograph with a true resolution of 300 ppi.

Source: Adapted from Balss, K. M.; Avedisian, C. T.; Cavicchi, R. E.; Tarlov, M. J. *Langmuir* **2005,** *21,* 10459–10467. Copyright 2005 American Chemical Society.

- Take several photographs at different settings, so that you can select the one with the best contrast and tonal definition.

➤ Photographs can have tricky copyright and permissions issues. Be sure you understand whether permission is needed to publish the photograph. (See the section called "Common Misconceptions about Copyright" in Chapter 7.)

➤ If you are scanning photographic prints, see Box 15-4.

➤ If you are using a digital camera, select a setting that collects enough digital information. The lowest setting might be sufficient for GIFs, but the higher settings will be necessary for print publication.

When you are working with the electronic files of photographs and other halftones, keep the following in mind:

➤ Do not adjust the ppi upward without adjusting the overall dimensions downward. Simply changing the ppi setting from 72 to 300, even if your software allows it, does not put digital information in that was not there before. The file might indicate that the resolution is 300 ppi, but the art will still print as fuzzily as a 72 ppi picture.

➤ You can adjust the ppi downward without changing the overall dimensions. This throws away information that is not necessary and makes a file more portable if, for instance, you scanned at a higher resolution because you were not sure how much you would crop it.

➤ You can switch from RGB to CMYK color modes and vice versa.

➤ If you switch from either RGB or CMYK to B&W, you will probably need to adjust the contrast of your photograph to get the black areas black and the white areas white.

If you are providing photographic prints instead of electronic files, the following points are important to remember:

➤ Submit a good-quality photographic print, preferably not the only original you have. Some publishers try to return original art, but many do not.

➤ Label photographs by writing on an adhesive label (such as a mailing label) first and then applying the label to the back of the photograph, or by writing on a separate sheet of paper and taping it to the back. Writing directly on the back of the photographic print might damage the front: ballpoint pens can break the smooth surface of the photograph, and felt tip pens can bleed through.

➤ Handle photographs with care. Most flaws on a photographic print will be reproduced in the published photograph. You can damage photographs by paper clipping, folding, stapling, or using tape on them. Depending on the amount and location of the damage, you might have to reprint the photograph.

➤ Do not submit prescreened illustrations, that is, illustrations that were scanned from a print source (which is already screened) or scanned using a screen setting.

➤ Do not submit color prints to be reproduced in black and white. Use a professional photo lab to prepare B&W prints from color originals because photo labs use special paper to make B&W prints from color originals.

Working with Grayscale Line Art

Grayscale line art for print publication of such figures as pie charts, bar graphs, and area graphs should be submitted only in an electronic format, preferably EPS. EPS files use mathematical formulas to produce lines and shading, so lines and type are never screened, and gray areas are screened only when the printing plates are made. (Rescreening screened art creates a distortion called moiré.) As a result, the lines in EPS files remain crisp even when the gray tones have been screened.

➤ Always fully embed the fonts or the font outlines in an EPS file. Otherwise, a different font may be substituted at the publisher's, with unsatisfactory results. Be sure that you have rights to embed the font—you will be safest if you use Times Roman or Helvetica.

➤ Use screen shadings that are different by at least 20 percentage points. For example, you could fill in the sections of a bar graph with 10%, 30%, 50%, 70%, and 100% black. (0%, 20%, 40%, 60%, 80%, and 100% also work well.)

➤ If you choose to screen lines within a line graph (never the axes), assign the lines a 1.5 or 2 point weight, and do not use symbols to mark points on the lines.

Working with Combinations of Type and Photographs

As mentioned in the earlier section, "Types of Figure Artwork", a photograph that has a simple measuring scale or a few single-letter labels can be adequately handled like other halftones. However, if the photograph (or other halftone artwork) must be accompanied by text to convey meaning, then you should prepare a combo.

One way to do this is to prepare the photograph as a grayscale or color TIFF and then import the photographic image file into a drawing program, such as Illustrator or Freehand. Use the drawing program to add type, lines, axes, tick marks, and so on, and save the file as an EPS with an embedded TIFF.

An alternative is to create the combo in a word-processing program, such as Word or WordPerfect, and then export the page as a PDF file. Simply assembling the type and photograph in the word-processing program and submitting the application (.doc or .wpd) file is seldom acceptable to publishers other than ACS journals.

How To Submit Illustrations

If you follow the recommendations presented in this chapter, you should be well on your way to trouble-free submission of your figure files. Keep the following points in mind for submitting to publishers other than ACS journals.

✦**Publishing with ACS:** For manuscripts submitted to ACS journals through Paragon, illustrations should always be embedded in the text document before submission—that is, illustrations should *not* be submitted as separate files from the text. Illustrations submitted through the Paragon Plus environment can be embedded in the text or supplied separately. Before being embedded, however, the illustrations should be prepared outside the word-processing program to the correct size and resolution as recommended in this chapter. Each illustration should be "inserted" (not "pasted") into the text document so that it maintains its original resolution, and it should not be adjusted for size after insertion. Graphics taken from Web sites should not be used because, at 72 ppi, their resolution is not adequate for print publication.

For All Figures

➤ Submit a clean photocopy or printout of all figures to accompany your manuscript.

➤ Unless a publisher instructs otherwise, do not put the figures in the midst of text; put them on separate pages at the end.

➤ Put one figure on each page, and label the page with the figure number only. Submit captions as part of your text.

For Electronic Files

➤ Be sure that the art is oriented correctly in the file.

➤ The file name should be brief and consistent, preferably something like Smith_fig02.tiff or Jones_chap5_fig10.eps.

➤ Unless the publisher requests that you submit via a Web site, write the files to a CD, DVD, Zip disk, or 3.5 in. floppy disk. Label the disk with the author name, manuscript title, and general contents, such as manuscript number, figures, tables, and so on.

For Camera-Ready Art

➤ Note the figure number and the first author's surname either on the back or on the front of each piece of artwork, about 1 in. (2.5 cm) clear of the image area. Do not write on the front or back of the image area; write only in the margins.

➤ Indicate the top of the illustration with the word "top" if the correct orientation is not obvious.

➤   Do not fold or roll artwork or photographs; protect art with cardboard or heavy paper for transport. Do not staple, clip, or punch holes in photographs or any artwork.

How To Prepare Figure Captions

Every figure must have a caption that includes the figure number and a brief, informative description, preferably in nonsentence format.

GOOD EXAMPLES OF FIGURE CAPTIONS

Figure 2. Mass spectrum obtained when laboratory ambient air containing 2.5 ppm of **1** was introduced into the MS system.

Figure 4. Change in carotenoid contents during maturation of three varieties of grapes: (A) Concord grapes; (B) Thompson seedless; and (C) Chilean red.

Figure 6. Variable-temperature NMR spectra of **3d** in CD_2Cl_2 solution at 500 MHz.

Figure 7. Reaction rate constants as a function of proton affinity for the reactions shown in eqs 5–7: k_{exp}, experimental; k_c, calculated.

Figure 1. Specificity of bovine muscle LDH antibodies in a sandwich ELISA. Data represent the averages of three replicates.

If more information is necessary, use complete sentences and standard punctuation. The caption should be understandable without reference to the text (this is essential in Web publishing because the figure may open in a separate frame) and should not include material that is at odds with the text. Use similar wording for captions of related figures.

If a figure contains symbols that require long explanations or has more than four or five symbols, then the key to the symbols will be large and give the artwork a cluttered appearance. In this case, put the key to the symbols in the caption. Make sure that the symbols and abbreviations in the caption agree with those in the figure itself and in the text and that the symbols are typographically available.

Submit the figure captions separately from the artwork, typed double-spaced on a page at the end of the text. Verify that the numbers in the caption agree with the numbers on the figures and in the electronic file names. Bear in mind that figures and captions are handled differently in both Web and print production; captions are usually typeset in a font and size that follow the style of the publication, whereas figures are used as is. If you place the caption on the art, the editors usually will delete it and have the caption typeset according to the publication's style. At best, this creates additional work and an opportunity for errors to occur; at worst, the presence of captions with the text and on the art may cause confusion if they are inconsistent.

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➤ If you construct a figure or a table from data that were previously published as text or use data from a table to create an original figure, you do not need permission, but you should reference the source of the data (e.g., "Data are from ref 7."). However, if you are using a portion of a table that has been previously published, even very small portions such as a few data points, permission is needed from the copyright holder.

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➤ If you are thinking about using a previously published figure or table, consider carefully whether citing it as a reference would be adequate.

Box 15-7. Credit Lines in ACS Publications

In ACS publications, credit lines for art reproduced from previously published work appear at the end of the caption in parentheses in one of two formats and follow three possible wordings, depending on the original source:

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