

CHAPTER 20: VISUAL COMMUNICATION—DOCUMENT DESIGN, FIGURES, AND TABLES

Chapter outline

- Document design for written deliverables
- Figures
- Tables

In the first half of this textbook, you have seen that much of engineering design depends on visual communication—sketching during brainstorms, preparing mockups for user testing, and presenting slides and mockups in design reviews. Visual communication also includes document design and page layout so your reports will be attractive and easy to read, as well as effective use of figures and tables to communicate information clearly, concisely, and professionally. (Additional types of visual communication—posters and PowerPoint slides—are discussed at length in later chapters.)

20.1 DOCUMENT DESIGN (PAGE LAYOUT) FOR WRITTEN DELIVERABLES

A document’s appearance and organization have an immediate effect on a reader. If it looks professional and makes information easy to find, readers are more likely to read it and to understand and be persuaded of your ideas. For advice about the overall appearance of EDC reports, see Chapter 23. For designing pages that are easy to read, follow the directions below.

Each page of a document should look neat and professional, and be easy to read. This section explains how to use line spacing, margins, fonts, page numbers, and headers and footers to achieve those goals.

20.1.1 Line spacing and paragraphing

Use single-spacing and left-justified block margins for most of the documents you write in EDC: memos, reports, even documentation in your project note-

book. Skip a line between paragraphs. In long reports, skip two lines between main sections.

Use double-spacing for essays. Do not include an extra space between paragraphs; instead, use an indented first line to indicate a new paragraph.

Whichever style you use, start paragraphs with a strong, clear topic sentence because readers of technical documents often skim the document to find the material they need. When they skim, they focus on the beginning of paragraphs. See Chapter 24 for more advice about writing effective paragraphs.

20.1.2 Margins

Margins affect a document’s readability because readers need sufficient white space to read easily. Follow these guidelines for margins:

1. Use 1-inch margins in all documents. Place headers and footers less than one inch from the top or bottom of the page, but surround the body text by at least one inch of white space.
2. Use a “ragged right,” not right-justified, margin for all body text.
Research has shown that reports with ragged right margins are easier to read
3. For the left margin, use block paragraph form (no indentation) if you single-space. Use indented paragraphs if you double-space.
4. Indent block quotations one additional inch at the left margin. This extra indentation signals the quotation, so omit quotation marks.
5. Headings

Technical reports tend to organize material with headings, which makes them look different from papers in English composition. In the latter, you present your ideas and supporting information in a continuous flow of sentences and paragraphs because teachers read the material from beginning to end to see how you develop your line of thinking. Engineering audiences, in contrast, tend to skip around to find what they want.

In a long report or proposal, you may need several levels of headings to indicate the main sections (1st level headings), subsections (2nd level), sub-sub-sections (3rd level), and so on. It’s unlikely that you will have more than four levels of headings, and if you do, you probably won’t number them.

Here are guidelines for writing clear, useful headings.

1. Be precise and concise. To do that you can choose among the following options:
 - Use a key word or phrase that identifies the purpose of the section. However, avoid using headings such as “Research,” which tells readers little. Instead, say “Lab Test of Umbrella Mockups.”

- Phrase the heading as a short question the section will answer (for instance, “What are the benefits of this design?”) If you decide to use question headings, use them consistently throughout the document, or at least throughout that section of the document. Question headings are particularly useful as subheadings within a section of a document.
 - Word the heading as a short statement that the section will explain: “Users Prefer Design A.”
2. Use parallel structure. Use the same grammatical form for headings at the same level of generality. For example, if you use “Procedures for user testing,” followed by “Results of user testing,” your next heading should be “Next steps for user testing,” and not “What will we do next in user testing?”
 3. Make headings stand out visually.
 - Skip at least one line above a heading. For first-level headings, skip a line below the heading.
 - Use boldface, italics, underlining, or a larger font, but don’t overwhelm the text with excessively large headings.
 - Use decreasing levels of emphasis in decreasing levels of headings. For example, you might use a 14-point font in boldface for headings of main sections, 12-point boldface for the second level, and an underline or italics for the third level. Use the same size and typeface for headings at a given level.
 - Place headings on the page so readers can identify their level. For example, you might place main headings at the left margin, second-level headings indented a few spaces, and third-level headings on the same line as the body text (in which case, you should underline or italicize the heading).
 4. Make sure headings appear on the same page as the body text they introduce.
 5. Capitalize only the first letter in a heading. In long documents, however, capitalize all letters in main headings, as in a chapter title.

For examples of the effective use of headings, see the progress reports in Appendix M.

20.1.3 Lists

Most of the material in a report is written in complete sentences and paragraphs because that provides the best way to explain logical relationships and make a persuasive case. However, the strategic use of lists can complement paragraphs, particularly when you want to highlight steps in a process and parts of a whole. Lists may consist of single words, phrases, sentences, and even short paragraphs.

To present lists effectively, follow these guidelines:

1. Use numbers to present a sequence or series; otherwise, use bullets. Numbers also allow you to refer back to a point in a list.
2. Use parallel construction to indicate that items in a list are of the same kind. For example, in the list you are reading, each item begins with a command verb: “Use,” “Make,” “Organize.” Use either uppercase or lowercase letters, but be consistent. In the chart below, the list on the left is not grammatically parallel because two items are adjectives, two are nouns, and one is a complete sentence. The list on the right is grammatically parallel because each item is the same part of speech: an adjective or adjectival phrase.

Example 20.1: Wrong and right ways to create a grammatically parallel list

Wrong: not grammatically parallel	Right: grammatically parallel
<p>The key requirements are that the design be:</p> <ul style="list-style-type: none"> • easy to use • cleanability • users can store it under table • portability • water resistant 	<p>The key requirements are that the design be:</p> <ul style="list-style-type: none"> • easy to use • easy to clean • storables under table • portable • water resistant

3. Make sure all items are logically, as well as grammatically, parallel. For example, if you were listing equipment needed to build a prototype, your list should include all nouns and the nouns should be pieces of equipment.
4. Organize the list in a logical order. For example, you might list user groups from most to least important; you might list components of a design in the order in which the user will use them.
5. For a list of more than seven items, create subcategories so readers can see the logical relationships among the items. A team designing a desk organizer created this list of the items on the client’s desk:

Example 20.2: Uncategorized list

loose papers (about 15 sheets)
telephone
computer monitor
CPU tower
paper clip holder
printer
picture frames (3)
stack of CDs
pen cup
mouse pad and mouse
catalogues (6)

brochures (8)
file folders (5)
rubber bands
phone book
speakers
answering machine

The list is random and difficult to understand. In their progress report the team should subcategorize the list so they and their instructors can understand what the client needs help organizing:

Example 20.3: Categorized list

- Computer equipment
 - CPU tower
 - monitor
 - printer
 - speakers
 - mouse pad and mouse
- Pamphlets
 - brochures (8)
 - catalogues (6)
- Work-related papers
 - loose papers (about 15)
 - file folders (5)
- Office supplies
 - pen cup
 - paper clip holder
 - rubber bands
- Phone supplies
 - telephone
 - answering machine
 - phone book
- Personal items
 - picture frames (3)
 - CDs

A word of warning about using lists: It's easy to get carried away and write entire sections of reports and memos in list format. Resist that temptation. Over-listing will make it much harder for readers to follow your line of thinking. Use lists in conjunction with, not instead of, sentences and paragraphs.

20.1.4 Page numbers

Include page numbers in every document, even drafts that you submit. The page number may be placed in either a header or footer. See Chapter 23 for when to use Roman numerals in a report’s “front matter.”

20.1.5 Headers and footers

Use headers and footers to provide additional information about the document, such as title, date, and version number. These are not required, but if they are used, they should be formatted consistently and not contain so much information that they detract from the body text.

20.1.6 Fonts

In general use no more than two font styles in a document, one for headings and one for body text. Use the same font for all body text. A standard, readable font is 12-point Times or Times New Roman. Don’t use fonts larger than 14 point or smaller than 9 point. Avoid changing sizes too often, as this will make your work appear amateurish. Use boldface and italics sparingly and consistently.

20.2 FIGURES

Figures are crucial in technical communication. They help readers understand and visualize information that is often hard to understand from text alone. The word “figures” covers a wide range of items, including photos, sketches, drawings, graphs, diagrams, flow charts, and maps.

As with all communication, keep your audience and purpose in mind as you plan your figures. Consider, for instance, the final report written by a team designing a desk organizer for a client overwhelmed with clutter. The team created highly detailed, dimensioned drawings of their final design, but the client didn’t have the knowledge necessary to read them. To accommodate their client, the team used photos in the body of the report—the part that the client would be most interested in—and put the dimensioned drawings in the appendix for the woodworker hired to construct the product.

When you consider using a figure, ask yourself the following questions:

- Audience: Who will be looking at the figure, and will they know how to interpret it? If not, should I include an explanation of how to interpret it or should I use a different figure?
- Purpose: What point do I want the figure to illustrate? Does the figure illustrate that point clearly, or do I need to use a different one? For instance, if the desk organizer team wanted to illustrate how to use the

product, a series of sketches or photos might be better than a single illustration.

- **Labeling:** Does the figure stand on its own or does it need explanatory labels (i.e., arrows that connect the components of a design to phrases identifying those components)?
- **Visual clarity:** Are the important components easily visible and sharply defined, or is the figure cluttered with too many details and labels? Is the figure large enough?

20.2.1 Guidelines: How to present figures

Here are rules for presenting figures clearly and correctly:

1. **Label the figure.** Give each figure a number and a title that concisely describe what the label represents—for example, *Figure 6: Top View of Desk Organizer*. Place the figure number and title below the figure. (Note: This is different from tables, where the number and title are placed above the table.)
2. **Indicate the source.** When you include a figure from another source, include a source line under the figure number and title that indicates where the figure was originally published. For instance:

Figure 3: Tube desk organizer

Source: Crate and Barrel ([http://www.crateandbarrel.com/
store/details.asp?category=86&index=0](http://www.crateandbarrel.com/store/details.asp?category=86&index=0))

3. **Refer to your figure in the text.** Always refer to figures in the text, explaining their significance and key points. You can't expect readers to focus on the details that impress you about the figure unless you guide their view. The reference should precede the figure and identify it by number (“Our proposed design has two sliding trays that allow you to work easily with two documents at the same time. See Figure 4.”). The amount of explanation for each figure depends on the figure’s complexity.
4. **Position the figure effectively.** Place it as close as possible to its reference in the text. Avoid placing the figure and accompanying text on separate pages.
5. **Don’t clutter figures with too many details and labels.** Include only those details and labels that readers need to understand key points.

20.2.2 Examples: Effective use of figures

The examples below illustrate the effective use of drawings, photos, and graphs.

1. **Effective use of a dimensioned drawing.** The following drawing, from a final report for a redesign of the stage area in a church meeting hall

(Balash, Lee, O’Sullivan & Zhang, 2002), is clearly labeled and includes details only on the ramp entrance to the stage, which is the focus of this section.

Example 20.4: Effective use of dimensioned drawing

The new entrance to the meeting room/library is wheelchair accessible. Located inside Fellowship Hall is an ADA-compliant 1-to-12 ratio ramp (Figure 4) that consists of inclines, platforms, railings, and rounded turns to decrease the amount of area and increase the safety. The ramp is positioned so that the landing/stage platform in Figure 4 can double as part of the stage (labeled “Stage 2 platform”) being developed by the other Northwestern stage design team. Our collaboration in these projects has allowed us to develop this feature, which will incorporate a handicap-accessible stage in the center of the space.

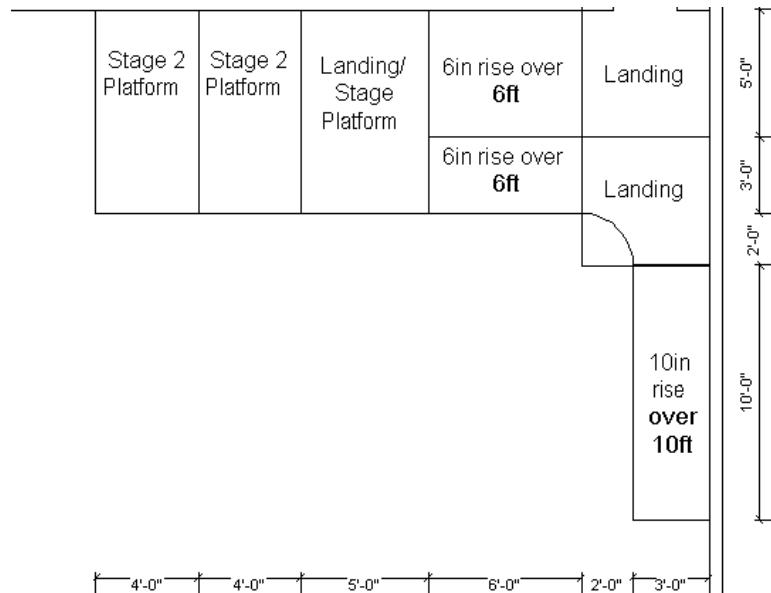


Figure 4: Ramp entrance to meeting room / library

2. **Effective use of photos.** The photos below effectively illustrate a prototype of a clip for attaching a bicycle light (Cameron, Collins, Rauwerdink & Woodward, 2003). The juxtaposed photos and accompanying figure titles show clearly what the team wants the client to see: the clip in open and closed positions.

Example 20.5: Effective use of photos

Our prototype demonstrates the mechanics of our design. Figures 5 and 6 show our prototype clip in the open and closed positions.



Figure 5: Prototype in open position



Figure 6: Prototype in closed position

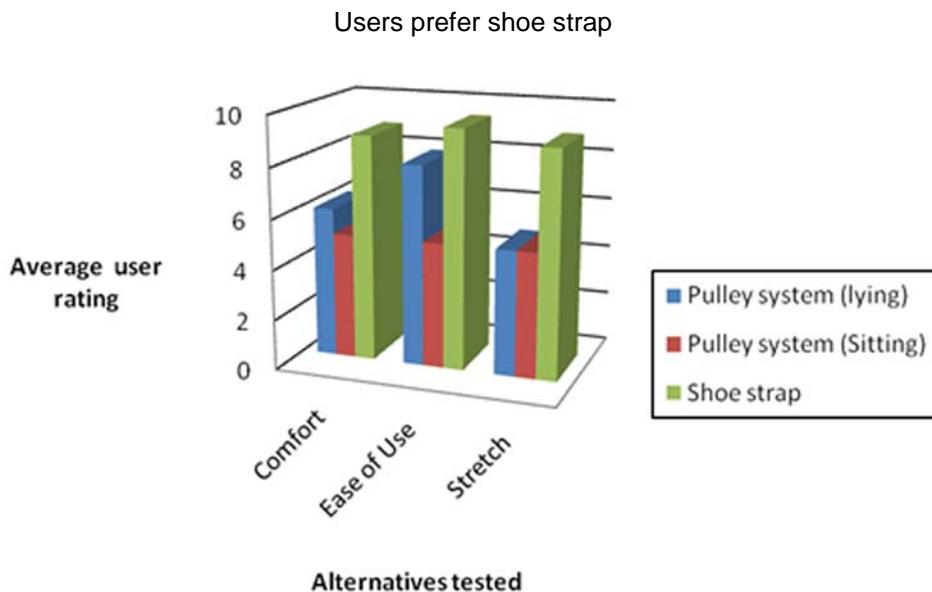
3. **Effective use of graphs.** Graphs are useful to help your readers visualize data and see relationships. For example, you might use a bar graph to emphasize that users preferred one mockup to two others. Or, if you've surveyed users about their preferences on a design's features, you might use a pie graph to show the percentage of users that favored each feature.

Designing good graphs requires that you follow some key guidelines:

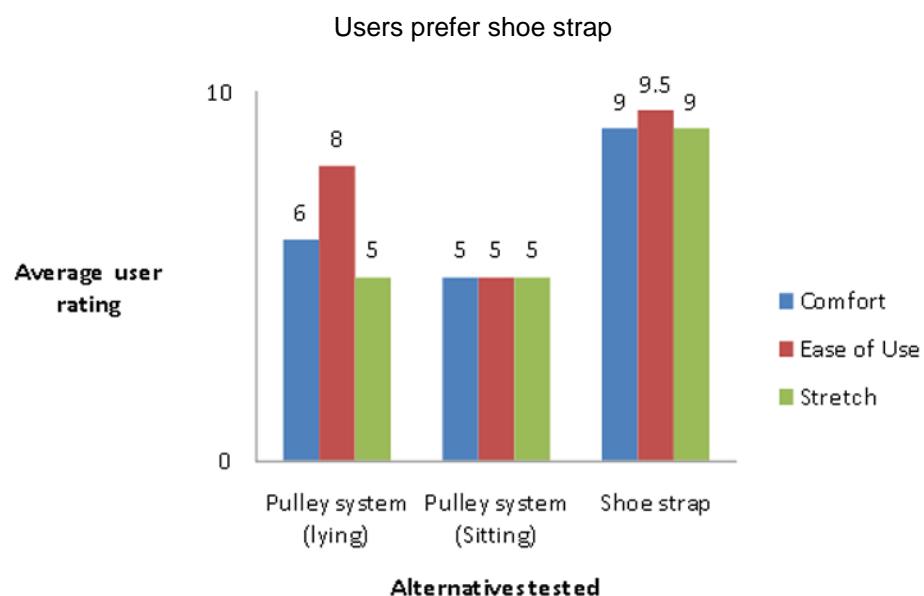
- a. Choose the right type of graph to convey your information. For example, you would not want to use two side-by-side pie charts for comparing information when a reader would understand the comparison more easily if you used a paired bar or column chart.
- b. In designing graphs, eliminate all extra “ink” and clutter. For example, avoid 3-D, unnecessary gridlines, and unnecessary lines around graphs, so the data stand out. If you need gridlines, make them gray rather than black. In other words, avoid graphs like Example 20.6

(which may be encouraged by your software’s default views) and instead design graphs to be more like Example 20.7. (Note: your software’s default may encourage bad practices, such as 3-D views, so you may need to change the default.)

Example 20.6: Badly designed graph



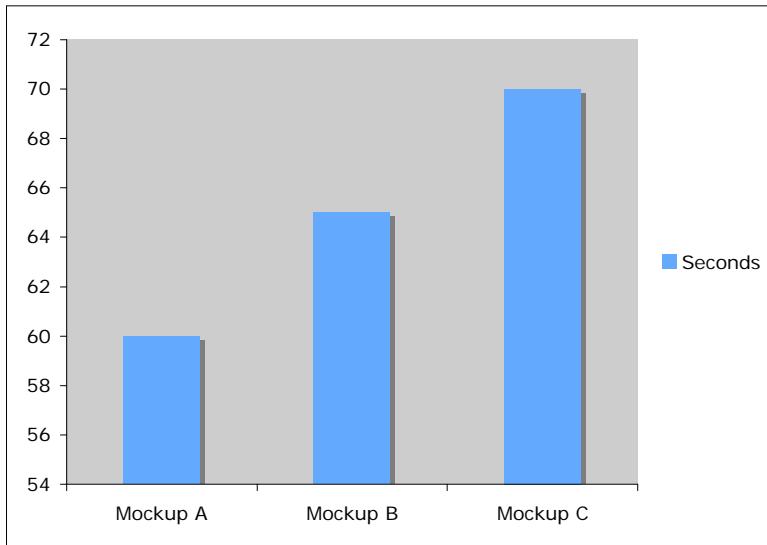
Example 20.7: Better graph design



- c. In addition, be sure to design your graph so that it represents the data honestly and accurately. Imagine a team that has tested three mockups

to determine which one users can operate in the least amount of time. In the graph below (Example 20.8), it appears that mockup A is significantly better than the other two. However, that is only because the starting point is made to be 54 seconds.

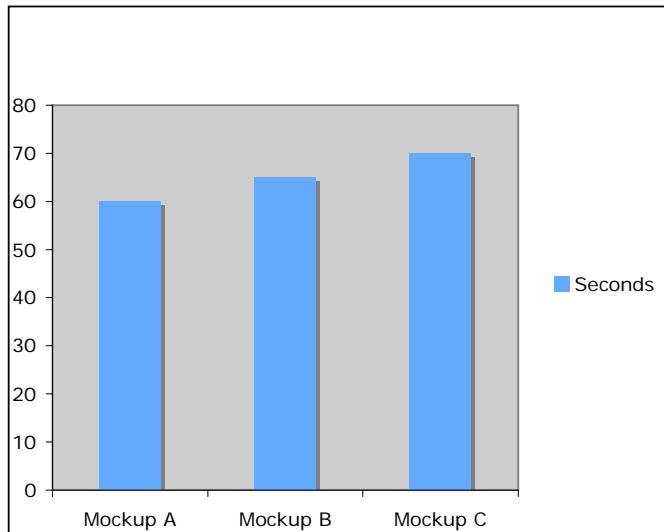
Example 20.8: Graph is misleading due to distorted scaling



Example 20.9: Graph Presents Data Without Distortion

When the scaling begins at 0 seconds, as in Example 20.6, the differences among the three mockups no longer seem significant:

Example 20.10: Graph presents data without distortion



For a good discussion of graphs and charts, refer to Sedlack, Shwom and Keller (2008)—see References.

20.3 TABLES

Tables allow readers to see relationships between numbers and concepts at a glance, without having to read painstakingly through a paragraph and visualize these relationships.

20.3.1 Guidelines: When to use tables

Use a table to (1) present categories with several shared characteristics or variables; (2) show the presence or absence of specific characteristics; (3) compare items with a paired logical relationship. Each situation is discussed below.

1. Use a table to present more than two categories or items with several shared characteristics or variables (this type of table is called a matrix).

Below is an example of such a table. The team redesigning a space in a church asked church members for their reactions to three mockups (Balash et al., 2002). After compiling the data, the team created a matrix. The first column lists the criterion (the user requirement), the second lists the relative importance, or “weight,” of that criterion, and the last three columns list the average rating of a particular criterion used to test each mockup. The bottom row gives the weighted score for each mockup. The team used this table in deciding on their final design direction and to justify their decision to their client and instructors.

Example 20.11: Decision matrix for church space redesign

Criterion	Weight	Library (mockup 2)	Library & meeting (mockup 1)	Library & meet- ing & storage (mockup 3)
Maximize space usage	1	8.6	9.6	6.5
Maximize bookshelf space	0.8	9.7	9.2	7.4
Minimize clutter	0.7	9.5	9.4	8.6
Maximize ease of accessibility	1	8.8	7.6	8.9
Maximize comfort level	1	8.7	9.3	6.3
Maximize capacity	0.9	9.5	9.6	8.6
Maximize safety	1	9.6	10	9
Maximize mobility	0.9	8.5	8.3	6.8
Score		66.31	66.55	56.5

KEY

The averages for the three mockups are based on a rating system of 1 to 10, with 10 being the best and 1 the worst.

2. Use a table to show the presence or absence of specific characteristics.
The church space redesign team created this kind of table—which uses Xs, checks, or pluses/minuses—to decide whether to make the space accessible by means of an electronic lift or wheelchair ramp (Balash et al., 2002). The two alternatives appear in the top row, and the requirements are in the first column.

Example 20.12: Sample decision matrix for church stage project

	Lift	Ramp
Cost	--	++
Ease of use	+	-
Use of space	++	--
Total	+	-

KEY

++ = satisfies requirement well

+ = satisfies requirement adequately

- = does not satisfy requirement adequately

-- = satisfies requirement poorly

3. Use a table to compare three or more items with a paired logical relationship, such as before and after, features and benefits, and users and functions (in other words, a table correlating two or more lists). Below is an example from the conclusion of a final report from the team designing the user interface for an electronic kiosk to help shoppers find restaurant and entertainment information for downtown Evanston (Chen, Johnson, Kidd, Lesperance & Marvin, 2002). The table helped the team emphasize the benefits of every feature in their design.

Example 20.13: Features/benefits of electronic kiosk interface design

Feature	Benefits
Touch screen	Is easy and intuitive to use Has large buttons accessible to a wide variety of people
Link trails	Allows users to quickly go back to earlier stages for quick navigation
Color-coded buttons	Make certain categories stand out to users as being different from the other selections

Example 20.13: Features/benefits of electronic kiosk interface design

Search by type	Makes selections and comparisons of similar businesses easy
Search by location	Allows users to find businesses in a specific district
Search by price	Allows users to find restaurants within their budget
Index	Provides basic contact information in an easy to read format

20.3.2 Guidelines: How to present tables

Here are rules for presenting tables clearly and correctly:

1. Label the table. Give each table a number and a title that concisely describes what the table represents (for instance, Table 12: Features/Benefits of Electronic Kiosk Interface Design). Center the number and title above the table. (Note: This differs from figures or illustrations, where the number and title are placed below the figure.)
2. Footnote when necessary. Provide footnotes (at the bottom of the table), using lowercase letters or asterisks, to indicate explanations at the bottom of the table. For example, use a footnote to indicate that N/A in a cell refers to omitted data.
3. Indicate the source. Use a source line to indicate where a table from another source was originally published:
 Source: Adirondack Video Astronomy
http://www.astrovid.com/starlight_xpress_ccd_camera_comp.htm
4. Refer to the table in your text, and explain its significance and key points. The reference should precede the table. Refer to the table by number (“As Table 11 indicates, the lift is preferable to the wheelchair ramp to make the redesigned space accessible.”). Alternatively, if the table immediately follows its reference, refer to it by position (“As the table below indicates”). The amount of explanation each table requires depends on its complexity.
5. Position the table effectively. Place the table immediately below its reference in the text. If you refer to a large table repeatedly throughout the text, place the table in an appendix.
6. Include a key when necessary. The key appears just below the table and explains what the values in the body of the table mean. For example, if the table contains the results of user ratings, the key would indicate that the

numerical values mean the following: 1=did not like at all, 5=liked very much.

20.4 REFERENCES

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