

Making Maps That Communicate

by Charlie Frye, ArcMap Products Team Manager/Lead Cartography Product Specialist

Just as a well-written and eloquently delivered speech effectively communicates a message, every map has a purpose. It requires both skill and conscious attention to make an effective map.

Most cartographers will tell you that a great many of the maps produced today—particularly those created using GIS software—are poor quality cartographic products (i.e., they don't communicate well). These cartographers will tell you this problem is getting worse because it has become increasingly easy for anybody with a computer to make a map.

Although few of us make our living by giving speeches, most of us have taken a speech class. Relatively few of us have taken a cartography class. Many people who use GIS to make maps are professionals in fields other than geography and use GIS infrequently. Most GIS users who are geographers weren't required to take more than one cartography class. A cartographer who has a master's degree has taken four or five cartography classes but really begins learning to make professional-quality maps on the job. A professional cartographer has the experience and practice it takes to make many kinds of maps.

So you might ask, "What entitles most of us to even think we can make a good map?" The axioms listed below support the idea that anybody can make a good map. This article will delve a bit deeper into each of them.

1. Know some basic principles.
2. Rely on common sense and well-designed software.
3. Get more help (after all, you're not a cartographer).

1. Know Some Basic Principles

There are many kinds of maps, each with general and possibly specific requirements. While a skilled cartographer is usually required to make maps with specific or special requirements, anyone can make good general and informative maps by following the simple guidelines included in this article. These guidelines have been organized into seven areas that you can use as a checklist for improving your maps.

Purpose

Every map has a purpose. Maps can show where something is located or how it is distributed in geographic space. Maps can show the impact of a problem or why a location is important. Typically, a map does not have more than one purpose. Trying to communicate too much in one map—having more than one purpose for the map—tends to blur the message and confuse the map reader. Using two or more maps, each focused on a single message, is always a better strategy.

Audience

Who will read your map? Target your map to the person least prepared to understand your map's message. What won't that person know about the data or places depicted on your map? Include in your map any information needed to support this hypothetical reader.

Next, how able is this person to accurately comprehend your map? The

requirements for a map being used by a few colleagues can differ greatly from the requirements for a map with a potential audience of hundreds of millions of people. The larger and broader the audience, the more factors you must consider to successfully communicate with all of them. For instance, the visual perception of one in every 20 people is limited by some form of color blindness. Will the intended audience understand discipline-specific terminology? Will they share your culturally driven perceptions of color and symbology? See the resources listed at the end of this article for additional information on cartography that will help you address these and other issues.

Size, Scale, and Media

The physical size of the map relative to the geographic extent shown on the map will dictate the scale of the map and determine how you will represent the actual size of features shown on the map. The map's media—whether it's high-quality paper, newsprint, a Web page, or a slide presentation shown on a 40-foot-high screen—will dictate how you handle some mapmaking details. Each media has its own challenges.

Depending on how it will be used, your map will fall into one of three categories: handheld (road maps or analytical maps), tiny (newspapers, Internet, PDA, or other mobile devices), and large format (poster size or larger

for viewing from a distance). Here are some guidelines for making maps in each category.

Handheld Maps

Commercially produced maps that use relatively high-quality paper can support text sizes as small as six points. Maps printed on typical inkjet printers or maps created for a general audience should use text sizes of 9 points or larger. It should be possible to read and understand the map at a distance of about 24 inches. Maps of this type can support complex and detailed symbology.

Tiny Maps

Show only what is absolutely necessary. Keep the content and symbology as simple as possible. Shrinking a handheld map doesn't work—map readers will not be able to see the necessary details. Do not use complex symbols on tiny maps. Use only the strongest or most indicative part of a complex symbol. For instance, a red interstate highway line symbol—shown on a handheld map with casings and a centerline—should be shown on a tiny map as a medium- or narrow-width red line.

Large-Format Maps

As with tiny maps, show only information that is absolutely necessary and show it as simply as possible. Symbology and annotation on large-format maps must be larger than on handheld maps. Text sizes need to be at least 25 percent larger; marker symbols will need to be 50 to 100 percent larger; and line widths should be 100 to 300 percent larger. Again, complex symbols should not be used; although the map is much larger, the typical map reader will view the map from too far away to appreciate any fine details. Use brighter and stronger colors than you would for a printed map. ArcMap color ramps are divided into two categories—Bright and Light to Dark. Use the Bright ramps for large-format maps.

Scale is the relationship between a distance or area in the real world and the corresponding distance or area represented on your map. Making maps at an appropriate scale does not require that you know how scale works. However, it does require that you decide whether

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This tiny map was created by shrinking a larger map. Although this map looks fine when zoomed to 200 percent in page layout view, as shown here, it has too much detail and some details are too small to be read at the size at which it will be viewed.

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features on the map are too densely depicted or are concentrated in a relatively small part of the map. In the first case, show fewer features or use a larger format for the map. In the second case, change the extent of the map to more closely match the area of interest containing those features.

Focus

Does the map reader know where to look first? Cartographers take advantage of the figure-ground phenomenon to make sure the reader knows what's important about the map. [Figure-ground refers to the way your eye and mind organize a visual array into contrasting areas—the figure and the ground. The figure is an area perceived as a distinct shape above or in front of its surroundings. The ground is the amorphous area that recedes from and surrounds the figure.] Use warm colors—colors containing a high percentage of red or yellow—or solid black to represent important features on the map or things the reader should focus on first. Use cool colors—blues, greens, or light grays—in the background or for areas adjacent to the focus of the map.

Correctness

Is what your map shows correct? As a mapmaker, you are responsible for what your map communicates to its intended audience. Ideally, you will know the source, nature, and intended uses of the data in your map. Realistically, you don't, so take the time to cross-verify your map with other similar maps. Check the spelling of any text, the relative location of features, and the correctness of data values. When using data produced by another organization, it is customary to give that organization credit on the map. In some cases the organization supplying the data will provide specific guidance on the attribution.

Balance

How does your map look on the page or screen? Are the parts of the map properly aligned? The following tips will help you produce a balanced and refined-looking map.

- Place the map title slightly closer to the elements on the map than the edge of the page. This placement associates the title with the map. Otherwise, the title will appear to the reader as a separate piece of information floating on the page.
- If your map has a neatline, make sure none of the elements are too close to it. As a rule of thumb, with a letter-sized page, all elements should be at least an eighth of an inch from the neatline.
- Most standard templates for layouts don't



This tiny map, designed for reproduction in newspapers or on the screen of a mobile device, shows only what is absolutely necessary and can be understood at that scale.

superimpose elements because the placement of elements depends on the message and content of the map. Use common sense if you need to overlap elements. For example, if you're creating a map of an irregularly shaped place like Florida, it might be better to place the legend in the Gulf of Mexico.

- The body of the map should be the dominant element in the map design. The most important part of the map should occupy the central position.
- Be flexible about how you add elements to the page. Legends don't have to be a single column with the symbols on the left and descriptions on the right. Look at the shapes of the elements and fit them together, like the pieces of a jigsaw puzzle, in an efficient manner that uses the entire page.

Completeness

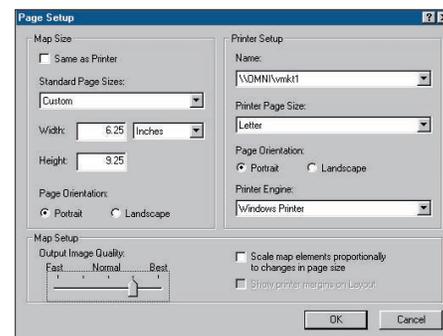
Introductory cartography classes teach students that maps must include certain immutable elements. While it is true that most maps

should have the basic elements—title, legend, scale bar, and North arrow—there are some exceptions. Instead of adding elements by rote, the mapmaker should consider each map's requirements. The elements in a map should communicate what the map represents and the meaning of the symbols used, indicate how distance is represented, and orient the reader. Here are some common sense tips for deciding what to include in a map.

- A map with a graticule (i.e., lines of latitude and longitude) does not need a North arrow. Every line of longitude runs north and south, and every line of latitude runs east and west. The cardinal directions are already shown.
- All maps should use a projection to depict the data. However, some projections, designed to show a large portion of the earth, do not depict distance uniformly across the map. A standard scale bar or reference scale is of little use to readers of these maps. However, most of these projections are based on what are called



This large-format map was designed to be projected onto a large screen during a presentation.



For maps that will be inserted into a Web page or published as part of another document, make the page size just a little larger than the size of the map by changing the settings in the ArcMap Page Setup dialog box.

standard parallels or lines of true scale. Although maps in these projections are not used to measure distances, indicating which latitudes shown on the map are least distorted and including a scale bar will help readers understand distance on the map.

- The scale bar and north arrow can be eliminated if the map's audience will be familiar with the area depicted by the map and will not be expected to scale or take measurements from the map.
- Don't include a legend if all the symbols on the map will be self-evident to the map's audience. Extraneous information, even when seemingly appropriate, detracts from the map's message. In this "information age," people spend less time focusing on all types of information—including maps. No matter how simple the map, it takes time to communicate to the map reader. If the reader is wasting time focusing on an intensively informational, but unnecessary, legend, the reader isn't focused on what's important.
- As a general rule, omit the title of maps that will appear as part of a document. Typically, the map will be introduced and explained in the body of the text.

- When communicating quantitative information, round numbers appropriately so the information is easy to digest (e.g., round 9,042,344 to 9,000,000).
- If you're making a map that will be printed rather than displayed on a computer screen, use light, conservative colors. Bright, strong colors that look good on a monitor cannot be effectively printed. The effect is heavy-handed and the resulting map is garish.
- If your map will be seen only on computer screens, bright colors may be more appropriate. This is especially true if the map will be viewed by more than one person at a time. ArcMap color ramps are divided into two categories—Bright and Light to Dark. Use the Light to Dark ramps for printed maps and the Bright ramps for maps that will only be viewed on a computer screen.
- Setting up the page is important when the map will be inserted into a Web page or published as part of another document. ArcMap exports maps to file formats such as Enhanced Metafiles (EMF) and Windows bitmap (BMP) based on the extent of the page size. Make the page size just

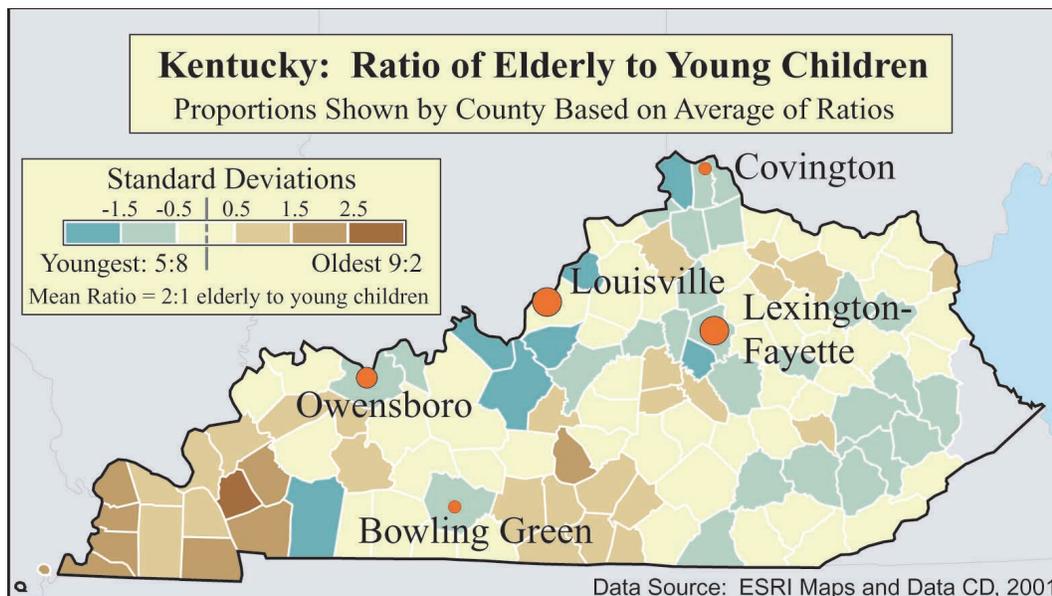
a little larger than the size of the map by changing the following settings in the ArcMap Page Setup dialog box.

1. While in Layout View, use the Select Elements tool from the Drawing toolbar to select all the elements in the map. From the Drawing menu in the same toolbar, choose Group.
2. Double-click on the grouped elements on the map to bring up the Properties dialog box. Click on the Size and Position tab and note the width and height of the grouped elements.
3. Close the properties dialog box and choose File > Page Setup from the main menu bar.
4. In the Page Setup dialog box, go to the Map Size section and uncheck the box for Same as Printer. Change the drop-down box under Standard Page Sizes: to Custom. Change the width and height so that each dimension are one-eighth of an inch larger than the dimensions of the grouped map items. The Page Orientation can be left as portrait since ArcMap will use the custom settings.

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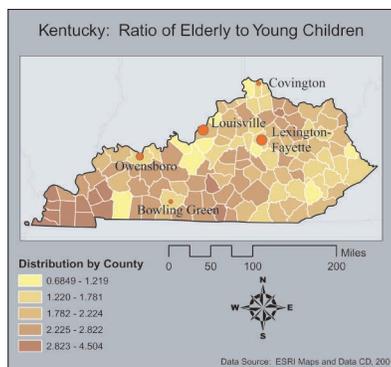
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This map applies some of the suggestions for making a more balanced map. The title, legend, and source text are all overlaid on the map. The data has been classified using standard deviations. The legend was extensively customized so that the numbers are easier for the map reader to understand. This map took approximately two hours to make.

The maps on this page show how some of these ideas about balance can be put into practice. The goal for each map was to make a map showing the ratio of elderly people to young children in a hypothetical newspaper article highlighting aging issues in western Kentucky.



This map was created by accepting all the software defaults and making a few modifications. A map template was used to lay out the map elements. This map took about 15 minutes to make.

- In the Map Setup section, uncheck the box next to Scale Map Elements Proportionately to Changes in Page Size. Click on OK to close the dialog box.

Map Publishing Tips

For tiny maps that will appear in a newspaper or book, consider exporting the map in Adobe Illustrator format. Most publishers know how to use this format. Alternatively, Windows Bitmap or JPEG formats are almost universally readable but require fairly high resolution, typically 300 dpi, to ensure good quality map reproduction.

For maps published on the Internet there are two choices. If the map will be viewed online, the JPEG format at the monitor's default resolution of 96 ppi will be just fine. If the map is being distributed on the Internet but will be printed out, consider creating an Adobe portable document format (PDF) file. This format, produced at the default resolution setting of 300 dpi, will preserve the detail and annotation of the map unless the text is very small (6 or 7 points). In that case, set the resolution to 600 dpi.

Use the Windows Printer setting if you're printing a map created in ArcMap to a desktop printer or a plotter. From the ArcMap menu choose File > Page Setup and select Windows Printer as the Printer Engine. This choice will use the manufacturer's printer driver, which will probably have the most options.

If the map will be printed commercially, tell the printer that ArcMap can output PDF, Adobe Illustrator, and Encapsulated PostScript

(EPS) format files. Usually the printer will recommend a format. Alternatively, the printer may recommend that you install a specific driver on your computer and print to a file using the Windows Printer Engine with that driver.

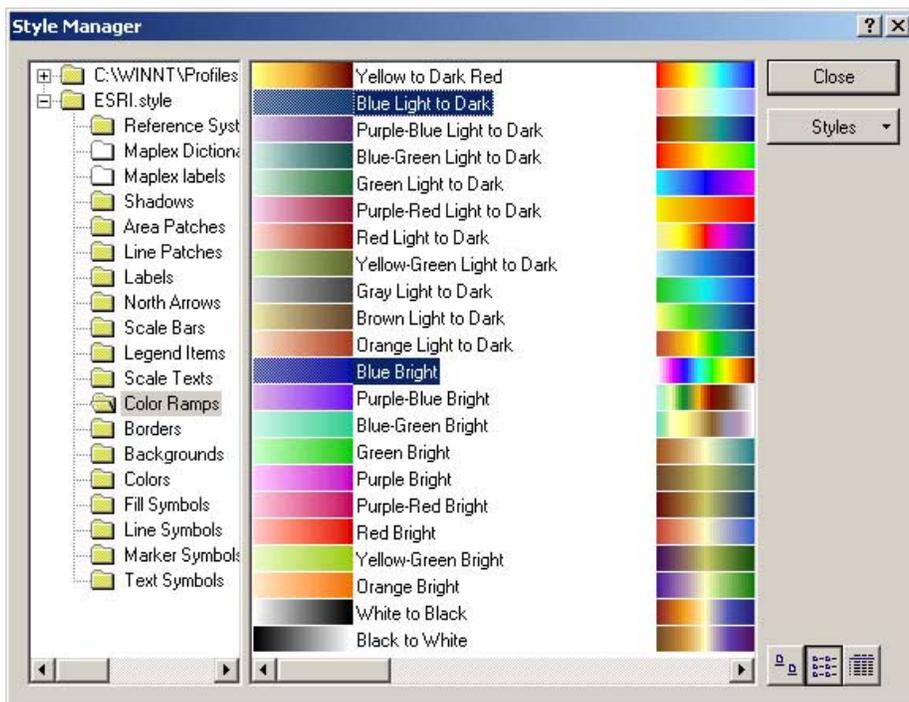
If a printed map doesn't come out the way you expected, the paper you are using may be the problem. If you are using the cheapest paper from the local office supply store, it may not be able to hold all the ink the printer puts on the page when it is set to the best quality mode. Take 10 minutes. Read the printer manual. You will probably find paper recommendations for each print mode. The user interface for the printer driver will usually lead you to the right settings if you pay close attention to the "fine print."

2. Rely on Common Sense and Well-Designed Software

Common sense is your best ally when making a map. If it doesn't look right, it probably isn't right. ESRI's mapping software is designed to provide the most commonly needed and cartographically correct options and default settings. However, the GIS and cartography communities produce a tremendous variety of maps. It is impossible to foresee and address every cartographic application for the software, so the goal is to provide users with the means for creating the most appropriate maps.

Additional Thoughts on Creating Maps

- Just because you can doesn't mean you should. If there was ever an activity that



Maps should be as simple as possible, elegant in form, and easy to read.

ArcMap color ramps are divided into two categories—Bright and Light to Dark. Use the Light to Dark ramps for printed maps and the Bright ramps for maps that will only be viewed on a computer screen.

epitomized this age-old advice, cartography is it. Maps should be as simple as possible, elegant in form, and easy to read. Using every color in the spectrum and every stylish typeface on one map will degrade that map's ability to communicate your message.

- Historically, maps have been imbued with artistry. The artistic merit of a map was often a hook for selling the map as well as a way to give the map credibility. If the map exhibited superior technical expertise and exacting detail, the information used to produce it must be equally good. A fallacy to be sure, but profitable nonetheless. However, you don't need to be an artist to make a good map.
- Don't try to mimic or create special effects that you've seen on professionally published maps, especially if you don't have a lot of time to make your map.

3. Get More Help (After All, You're Not a Cartographer)

If you haven't achieved the desired results or if you are representing abstract or quantitative information and want to be sure you are conveying the correct message, consult one or more of the resources listed below and visit the *ArcUser Online* Web site for links to helpful sites.

Resources

Dent, Borden D. *Cartography: Thematic Map Design*, 4th edition. New York: WCB/McGraw-Hill, 1996.

Mitchell, Andy. *The ESRI Guide to GIS Analysis Volume 1: Geographic Patterns and Relationships*. Redlands, California: ESRI Press, 1999.

Monmonier, Mark, and J.J. DeBlij. *How to Lie with Maps*. Chicago: University of Chicago Press, 1996.

Muehrcke, Phillip C., and Juliana O. Muehrcke. *Map Use: Reading, Analysis and Interpretation*. Madison, Wisconsin: JP Publication, 1998.

Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill. *Elements of Cartography*, 6th edition. New York: John Wiley & Sons, Inc., 1995.

Slocum, Terry A. *Thematic Cartography and Visualization*. Upper Saddle River, New Jersey: Prentice Hall, 1998.

Conclusion

Cartographers have someone else review their work—repeatedly. This iterative review process produces high-quality maps that fulfill their purpose. If you follow these simple guidelines, review every item on the checklist, and put forth a modest effort, you will make better maps.