

## cartographic techniques

### Designing Dynamic Maps

by Nicholas Springer

The visual limitations of the computer monitor are immediately apparent when compared with a finely printed image. With the evolution of maps into the digital realm, the cartographer has had to embrace new techniques and overcome these limitations by seeking solutions through innovative map design. Until computer screens get closer to producing images as fine as on paper, we cannot ignore the need to adapt and in some cases compromise. There are design techniques we can employ now to overcome some of the restrictions of digital map display.

A good image manipulation application like Adobe Photoshop can produce fine-looking maps even in the low-resolution environment, using anti-aliasing techniques for text, impressive blending, and overprinting effects as well as realistic relief shading. However, producing these kinds of fine digital images requires many hours of work for each one, which is not feasible for a dynamic map system. Maps in a dynamic map system can be panned and zoomed to an infinite number of views and scales. The maps need to be drawn on the screen automatically from a GIS library, using a set of rules for the design elements. That gives the designer little control over the look of any individual map view, meaning that the design rules have to be very carefully thought out.

The automatic nature of the map drawing in a dynamic map system means that anti-aliasing, dithering, and blending all significantly slow down the application performance. A slow and unresponsive dynamic map interferes with the exploration of the data being presented. To keep

things fast means drawing the maps at low resolution and with no interpolation of colors or pixels.

While most desktop computer systems are capable of displaying 1024 by 768 pixels with 8-bit color, the default settings on these machines out of the box is usually 800 by 600 or even 640 by 480. The average user will not change the monitor resolution and it is difficult to change it through programming, so we are forced to design digital maps with the low-resolution user in mind. With limited resolution, many designs can end up looking clunky and heavy-handed.

Thoughtful use of line symbology, typography, and color can minimize some of these problems along with concise data selection.

### Line symbology

One of the graphic limitations of low-resolution mapping is that there is very little subtlety when it comes to line weights. Even a 1-pixel line looks heavy and dominating on a map, especially when combined with many others, as in a detailed road map. Giving the line a color that is close in value to the background color can create an illusion of a thinner line (fig. 1A). Likewise, bordering a polygon on the map with a line that is just slightly darker than the fill color adds just enough of an edge to allow the fill color to be very close in value to the

background, allowing the element to recede visually (fig. 1B).

### Typography

Sending some objects to the visual background is very useful for many of the low-resolution issues, and works equally well to minimize the dominance of type and symbols. Typography has its own problems in the digital medium. Most fonts designed for output to a printer don't render well on a screen at small point sizes. Anti-aliasing can be very slow and tricky to generate on the fly so it tends to not be a good option for dynamic mapping.

In standard computer system fonts such as Times, Arial and Helvetica, the bitmap, or screen font sizes are designed letter by letter to maximize their legibility at sizes as small as 8 or even 6 point. These fonts also have the benefit of being installed on almost every desktop machine, meaning that the maps will look the same on the most systems without installing custom fonts. Picking a specific screen font, rather than one rendered from an outline, will always give predictable results at a given size. Since the designer cannot see every label being created in dynamic mapping system, it is important to preview the entire alphabet in a given font and size to make sure all the letters are legible.

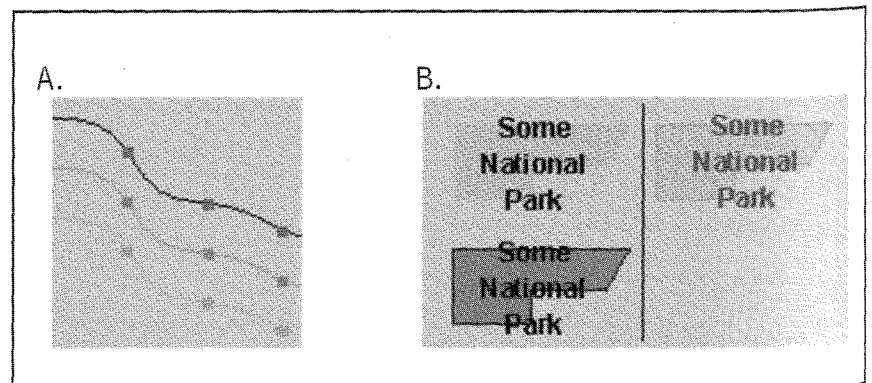


Figure 1.

## RGB color and palettes

Computer monitors are poor imitations of nature. The additive color space of RGB does not come close to covering the gamut of colors perceivable to the human eye. It is difficult to produce on a computer screen some of the softer natural hues we see every day. Printing CMYK inks on paper can achieve some of these tones, but RGB is limited by the inherent brightness of the Cathode Ray Tube (CRT). When not limited by low bit-depth or specific palette issues, many subtle and subdued shades of color can be produced in the RGB space. Reducing saturation goes along way to making RGB colors more appealing. Try picking and adjusting colors with Hue, Saturation and Value (HSV) scales in Photoshop or another graphics utility and then convert to RGB.

Digital map design usually does require some kind of color palette constraint. Maybe it's because the maps are being viewed on the wide world web, or the application drawing the map restricts the maximum number of colors. Most likely, the users system is set to a low bit depth. Most maps can be drawn nicely with fewer than 256 unique colors except when showing high-resolution raster images. The main problem is when the set of 256 colors is constrained to a specific group, defined by criteria other than the map, such as the application's user interface or the need to use an operating system palette. Web maps should use the 216 browser-safe colors to be sure that they will look the same on all platforms. While palette constraints usually mean compromising on design to some degree, these restrictions may even encourage better map designs, as more careful thought is given to color selections.

As mentioned before, many computer systems are set to 8-bits of color depth by default. As long as a design has fewer than 256 indi-

vidual colors, it should look fine on an 8-bit system, although you may have some palette flashes when switching between programs. Some systems will dither the colors if you have more than 256, which might look fairly good, but others will start replacing colors with the nearest match and you will start to see banding or worse.

The best solution is to always use as few unique colors as possible, or use whatever palette is being used by the system displaying the map. Designs should be previewed at various resolutions and bit depths, and when possible on different monitors. Many monitors are darker or lighter, either due to the users preference or poor monitor adjustment. A small difference in the brightness and contrast of a monitor can cause dramatic shifts in colors. Also, the exact same color on a Mac will look very different on a PC, so cross-platform designs should be viewed on both. Make sure to view any screen design on a system that has specifically been set to only display 256 colors. This should make any palette problems obvious.

When designing maps for the web, there is the added constraint of the browser-safe palette. This set of colors was not chosen because of their aesthetic value, but by a mathematical formula, combining multiples of 51 (e.g. 102, 255, 153 or 204, 51, 0). This system was originally designed by programmers to be consistent and ordered, with no thought given to the resulting colors. These 216 colors are therefore common to both the PC and Mac system palettes, so web images using them will look the same in the cross-platform world of HTML. A quick survey of the resulting colors shows that there are very few subtle, muted colors suitable for making attractive maps. So why use this palette? Not using the web browser-safe colors will cause unpredictable dithering on the web, although this may not look so bad.

Lynda Weinman's books and her web site provide excellent examples of how to use the web palette successfully (<http://www.lynda.com/hex.html>).

One work around for creating more subtle colors out of the browser-safe set is to dither them together manually (see sidebar). By alternating pixels of two colors near in value, the bit pattern will not be visible and optically they will produce a third color. Try alternating the palest yellow (255, 255, 204) with white (255, 255, 255) to produce a color that is very nice for map backgrounds. Adding the nearest browser-safe gray to a color will result in a much more muted tone (look at the color 255, 204, 255 and then alternate it with 204, 204, 204).

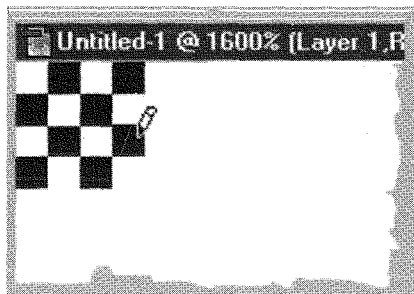
If the design is constrained to the browser-safe palette, the same color rules apply as with an unlimited palette. As much as is possible, try to find muted or light colors. Do not feel the need to use black for all labels; try a dark maroon or a muted dark blue instead. Use colors close in value to each other to make some map elements recede to the background. Look for colors in the same basic hue range to tie themes together. Avoid saturated colors of different hues that are close in value, as they will produce visual vibration.

### Data Selection

Overall the best way to make digital maps clear and readable is to reduce clutter of the map elements. Make sure you understand the use of the map, and only present the necessary data. With dynamic mapping the user can zoom in on the map if more information is desired, so the cartographer should not be tempted to show all of the data possible at a given view. The cartographer's job here is not to generalize individual map elements, but to generalize the map as a whole without losing the salient details.

### Creating manual dithers in Adobe Photoshop:

1. Create a new document using white for the contents and in RGB mode. Keep it small, maybe 64x64 pixels.
2. Add a new layer and zoom in to at least 400%. With the pencil tool set to the one-pixel brush, add a set of an even number of alternating pixels:



3. Make the background layer invisible and then select the new layer again.
4. Select just this group of pixels and from the Edit menu choose "Define Pattern."
5. Now select the entire area of the new layer, and from the Edit menu choose "Fill..."
6. In the Fill dialog, select "Pattern" from the "Contents" drop-down and click "OK."
7. The new layer should now be filled with an alternating pattern of transparent and non-transparent pixels. Deselect all.
8. In the layers palette, click on the new layer and check the "Preserve Transparency" checkbox. Make the background layer visible again.
9. Now to experiment with dithering combinations, just fill the background layer with one web color, and the new layer with another (the "preserve Transparency" option will allow you to color only the non-transparent pixels with the "Fill" command/
10. At 100% zoom, you should not see any pixels with a good combination of colors.

### Concluding thoughts

At its most basic level, designing maps for computer screens is no different than designing for paper. There must be a well thought out plan from the beginning and a careful execution that considers all the limitations of the medium. Every design task has its restrictions and it is just a matter of learning how to work around those constraints. Dynamic mapping is a new way for people to use maps and therefore cartographic designers must incorporate new and creative design solutions to meet the needs of this new medium.

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MapPoint 2000 -

<http://www.microsoft.com/mappoint>

Streets & Trips 2000 -

<http://www.microsoft.com/expedia>

Expedia Maps -

<http://www.expdiamaps.com>

Encarta Virtual Globe -

<http://encarta.msn.com/evg>

### Map Design Enhancement for Terrain Visualization by Army Aviators

Wiley C. Thompson and  
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#### Introduction

The objective of this study was to determine if a non-traditional relief shading method can be used to redesign a 1:50,000 scale military topographical line map (TLM) in a manner that allows the Army aviator to more easily "read" the terrain in "3-D" while viewing the map under Night Vision Goggle (NVG) compatible blue-green lighting. This study is not in response to a crisis, but rather an exploration into a possible cartographic solution to a problem perceived by surveyed Army aviators. The aviator is a highly skilled map reader, but any advance that can help reduce the stress of the task-intensive NVG cockpit (Figure 1) should be explored.

While conducting map navigation at night with NVGs, Army aviators, as navigators, must create a "3-D" mental image of the terrain each time they look at the map. The navigator will then match this image to the corresponding terrain seen through the NVGs. The aviator currently must build this image under dim, blue-green lighting on a non-shaded map. A method that allows the aviator to visualize the terrain on the map and more quickly return his attention outside the cockpit where he can scan for wires, enemy, and other hazards will enhance the safe operation of the aircraft. Even a tenth of a second reduction in the time required to visualize terrain and look back outside could be the difference between spotting a hazard and falling victim to it.