

Mapping: Methods & Tips

Achieving Historical Map Effects with Modern GIS

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Introduction

Historical maps have long captivated map readers with their aesthetic qualities and the intrigue they impart, partly because they were done by hand. In this paper, historical maps were examined to determine if they illustrated design techniques and symbology that are adaptable for maps today. If so, the design techniques were then replicated in a modern map making environment using geographic information systems (GIS). With this "history of cartography" approach, we attempt to discover the underlying technical process of creation.

One might ask why anyone would want to do this when cartographers now have better tools (*e.g.*, computers) to produce maps in greater quantities, with more consistency, with higher accuracy, and (arguably) with greater efficiency. One answer would be that though there are better mapping tools, that does not necessarily mean there are better mapping techniques; however, there really is more to it than that. Firstly, the symbology and mapping techniques on historical maps could be used to enhance the affective design, that is, "the look and feel", of maps made today. The use of these techniques does not necessarily result in period reproductions. For example, a parchment fill and a special font could be used to promote a more freeform, hand drawn albeit modern and artistic affective design.

Secondly, in some cases, using these techniques and symbology can actually improve the effectiveness of maps. For example, one technique for creat-

ing a coastal vignette using horizontal dashed lines, or "coastal rakes", was used historically because it was difficult to achieve fine gradations of ink. Today, with half tones, this effect could be easily achieved by substituting color for line-work. The historical coastal rake technique is useful today for black and white maps and maps intended for photocopying where fine gradations of ink are difficult to achieve and reproduce. As another example, pictorial symbols, such as hillsigns or town and building symbols may be easier and more intuitive for quick map-reading when a user is looking for landmark features. Maps do not always require detailed terrain and cultural feature depictions; instead it may be more useful to provide a stylized caricature of key landmarks.

Finally, the symbology and design techniques described in this paper can be used to make maps that are more eye-catching for the map reader. The reader is drawn to the map and the map holds the reader's attention longer because of the increased novelty, beauty, and density of information on the map.

As regards novelty, creating maps using fonts and symbols that differ from the status quo offers the opportunity to produce unique and visually arresting designs. Uncommon yet appropriate fonts, symbols that are new to the reader, and decorative borders or cartouches create a fresh look, despite their historic ancestry.

As regards beauty, the map effects described in this paper are designed to be pleasing to the eye. Many people are familiar with the effects (*e.g.*, cartouches, ocean art) through casual if not calculated knowledge of historical maps. A hand drawn look with slight variations in the symbology (*e.g.*, slightly varying line widths, watercolor fills, and curves that are not perfectly round) mitigate the cold "machine" look that computers cannot help but render. Understanding this appeal, software companies are now starting to package tools to achieve such effects in their software, and GIS software has new functions that also produce some of these effects. For example, the wave geometric effect (an ArcGIS Developer's Sample for use with cartographic representations) modifies rendered straight line segments so they have sinusoidal curves.

As regards density of information, the old-style symbols add complexity, information, and detail to the map. Pictorial symbols are more complex and detailed than their more abstract yet uncomplicated geometric counterparts, such as circles or squares. Pictorial symbols carry meaning that is more immediately under-

stood by the reader since the symbol is intended to mimic the feature it represents. "Mimetic symbols are desirable on maps when they are unambiguous and easy to understand" (Robinson, et al. 1995). Mimetic symbols can be used to represent either quantitative or qualitative variation in the attribute being mapped. For example, town symbols can be used to represent quantitative variation in the amount of population, while different hill symbols could be used to distinguish among different qualitative types of physiographic features, such as mountain ranges, volcanic cones, rolling hills, high peaks, etc.

Cartographers can learn from historical maps to improve aspects of modern maps. What visual effects are evident on historical maps? What techniques were historically used to create them? How can they be replicated or improved using modern data and technology? Do the effects actually improve the design of modern maps? And, can the techniques be used to improve the map production process? In this paper, these questions are explored and the conclusion is that some effects can be replicated, some results are better than others, and some require data manipulation and data processing. The closing sentence – don't they all require data manipulation and processing?

This paper is organized by three rough time periods: the late sixteenth to early seventeenth century, the early to mid-nineteenth century and the late nineteenth to early twentieth century. For each, a map was created to test the development of some of the cartographic effects found on maps from the associated time period. Selected cartographic effects that could be replicated using computers and GIS are then described and illustrated.

Late Sixteenth to Early Seventeenth Century

A Caribbean Sea map was created to develop and demonstrate techniques found on maps from the late 1500s to early 1600s. On the Caribbean Sea map (Figure 1), the cartographic techniques explained in further detail include the following.

- A. Hillsigns used to symbolize physiographic features such as mountain ranges and hills.
- B. Coastal rake used to symbolize the shoreline areas.
- C. Decorative north arrows connected by rhumb lines (lines of constant bearing).
- D. Various illustrated map surrounds, including the ocean art, such as ships and sea serpents.

Hillsigns

Denis Wood (1992; 153) termed the mountain symbols that depict physiographic features "hillsigns"

(Figure 2). These symbols were applied to point GIS data with an attribute that was added to distinguish the type of landform. Physiographic features were classed into fourteen categories based on their names, but other classification methods could be used. Each feature type was assigned a slightly different hillsign. Some features were assigned symbols composed of groups of hillsigns; these were used for physiographic features such as mountain ranges and ridges

Coastal Rakes

Coastal rakes (Figure 3) were used as an alternative to the more commonly seen coastal vignettes that use graded colors. One advantage is that while historical maps had to be laboriously etched or engraved and then painted, all by hand, these methods can be replicated quickly and easily with GIS. Both effects can be achieved using either constant or variable width buffers; the difference lies in how the buffers are symbolized. The coastal rake effect is achieved by symbolizing the buffers with fill patterns composed of a set of dashed lines each with different irregular spacing for the dashes.

Figure 4 illustrates variation in one of the line symbols that were created for the Caribbean Sea map. A variety of fill patterns were created for the various buffers on the Caribbean Sea map, with near-shore fills composed of more closely spaced dashes.

Rhumb Lines

For rhumb lines, the north arrows were used to digitize lines as GIS features connecting points of equal bearing. Because the lines are GIS features, they can be placed under the land masses, helping to promote figure-ground (Figure 5).

Ocean Art

On this map, there is also decorative ocean art, including ships and sea serpents (Figure 6). These were created as marker symbols placed in a focused data frame. In other words, the point symbols were added to the map as graphics that are spatially referenced to the geographic data.

The symbols for the ocean art were created as drawings and saved as image files in Enhanced Metafile or .emf format. In the GIS, marker symbols were created as picture marker symbols based on the .emf files (Figure 7).

These types of marker symbols can be created so that they are angled to rhumb lines in a Mercator projection. This is done by defining in the drawing software the angle of the image at the origin point as the

degree of the rhumb line. An example is the cherubs in Figure 8 puffing wind to indicate the various compass directions.

To see how some additional effects found on maps from the late 1500s to 1600s could be achieved, a map of England was created, then a larger scale map of Devon and Cornwall was compiled (Figure 9). Design effects on the Devon and Cornwall map that are explained in further detail include the following.

- A. Cultural features such as cities shown with mimetic symbols.
- B. Stippling for the ocean fill.
- C. Wide tapered streams.

Mimetic City Symbols

The cities were symbolized using mimetic point symbols. Five symbols were created for five classes based on city population. The various symbols were assigned to the five population classes. In the GIS, these marker symbols were created as character marker symbols that reference glyphs in True Type fonts. One advantage of referencing font characters instead of image files (as was the case with the ocean art in Figure 7) is that the multiple layers in the symbols can be easily colored separately (Figure 10). Another advantage is that scalability of the vector font is usually superior to the scalability of an image in the marker symbol.

Ocean Stippling

The stippling in the oceans areas was created using a dotted fill pattern placed over a parchment fill (Figure 11). The parchment fills and stipple pattern were created as .emf files. These were then combined in a multi-layer picture fill symbol.

Stream Tapering

Another design technique that was replicated with GIS was stream tapering. This was achieved using “representations” which is a new software enhancement in ArcGIS 9.2. The taper geometric effect creates polygonal symbology from linear input geometry; the fill symbol changes in width from one end of the line to the other according to values chosen by the cartographer. The tapered stream effect will be available as a download from the ESRI Support website

Early to Mid-nineteenth Century

To test the development of some of the mapping methods from the early to mid-1800s, the map of Devon and Cornwall was further modified (Figure 13). This map contains many of the design effects described above; additional techniques described in detail in-

clude the following.

- A. Symbology for the populated areas using building point symbols placed alongside roads.
- B. Use of a decorative border calibrated to the graticule.

Point Symbols along Roads

The effect that was used to symbolize building points alongside roads was driven by GIS data processing (Figure 14). First, the city areas were buffered using three different size buffers based on population. These buffers were used to clip the road lines so that it was possible to identify where to show the building points – that is, where the roads ran through populated areas. The line symbol was created with two layers – one for each side of the road. Each of the layers was offset to one side of the road, and a marker line symbol with staggered points from a different template was used. These line symbols were then placed alongside the cased roads in the populated areas only.

Border Calibrated to the Graticule

The calibrated border is actually very easy to replicate with ArcGIS – it is simply a property of the data frame, so if the data in the data frame is resized or repositioned, the border will update automatically (Figure 15). This effect was created using a graticule border that was shown with a double line symbol, and the axis ticks were spaced and sized to fit between the double lines.

Late Nineteenth to Early Twentieth Century

To test the development of some mapping methods from the late 1800s to early 1900s, a map of Washington State was created (Figure 16). On this map, many of the cartographic effects described above are used, but the color palette is limited to a sepia tone. This would be useful for a limited color palette such as black and white map production or grayscale conversion.

Sepia Tone

The sepia tone effect was created using a number of methods. First, the data frame background was symbolized with a neutral parchment fill. Then the hillshade was symbolized using a dark to light-brown color ramp. Finally, the mapped area was highlighted using a transparent sepia-colored polygon fill for areas outside Washington. Together, these effects create a subtle map coloring that could be used to create interesting variation on the map even when the color palette is limited.

Conclusion

Many stand in awe of historical maps knowing that they were drawn by hand; they marvel at the detail and artistry involved. Maybe they also admire cartographers achieving the same or similar effects with computers. The advantage of a computer approach is that the precision and power of the computing environment can be used to deal with what computers handle best (data management and manipulation) and the cartographers can handle the things humans handle best (artistry and creativity). An additional advantage of using computer mapping techniques is that the flexible, repeatable computational power of the software allows map makers to relatively quickly achieve the results they want without having to spend countless hours on tedious tasks that could not be exactly replicated a second time if drawn by hand.

In this paper, historical maps were examined to determine if they offered techniques and symbology that could be adapted for maps today, and if so, how that could be done. Ten mapping methods were described, illustrating ways to reproduce some of the historical cartographic effects found on maps from the associated time periods. These methods can be integrated within the design tools of GIS to give cartographers additional ways to enhance modern maps.

The techniques described can help to improve modern design and production for a number of reasons:

these enhanced effects allow greater design flexibility which is appreciated by both cartographer and map reader; some of the effects can be used for challenging black and white map design; some of the symbols are intuitive and easily understood by the map reader; some create a unique and unusual look that draws the map reader in and keeps his or her attention; and some add beauty and intrigue to maps. Of course, as with all maps, the effects should be used on the right type of map for the right purpose and the right audience.

Note

The ArcGIS styles shown in this paper, along with the maps, can be downloaded from the Basemap Data Model page of the ESRI Support Website (support.esri.com/index.cfm?fa=downloads.dataModels.filteredGateway&dmid=3).

References

- Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimerling, A.J., and Guptill, S.C. 1995. *Elements of Cartography*. Wiley & Sons. 674 pp.
- Wood, D. 1992. *The Power of Maps*. New York: The Guilford Press. 248 pp.

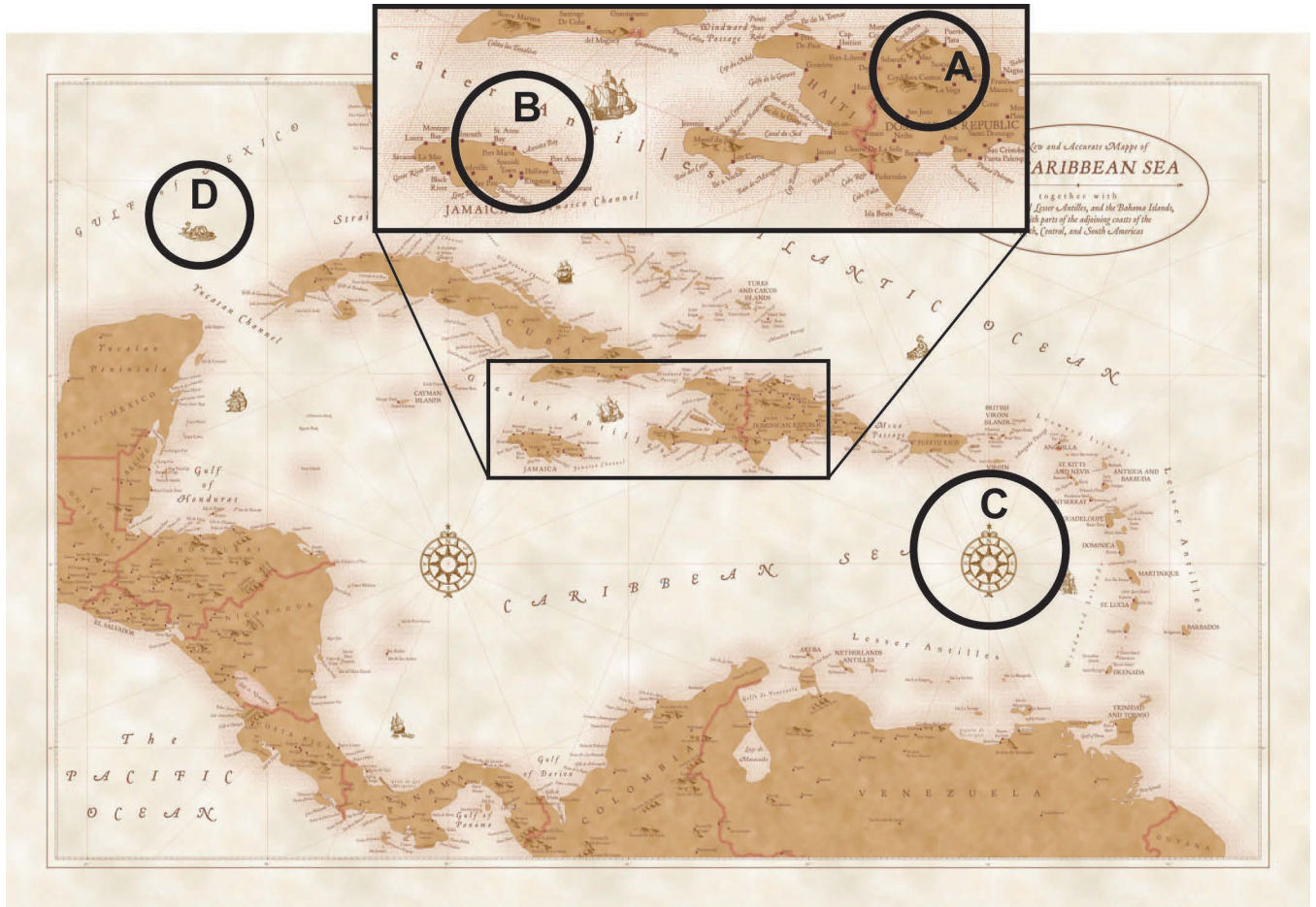


Figure 1. The Caribbean Sea map by David Barnes (2006) illustrating A) hillsigns, B) coastal rakes, C) north arrows connecting rhumb lines, and D) ocean art.



Figure 2. Hillsigns used to symbolize various categories of physiographic features.



Figure 3. Coastal rakes used as an alternative to graded color coastal vignettes.

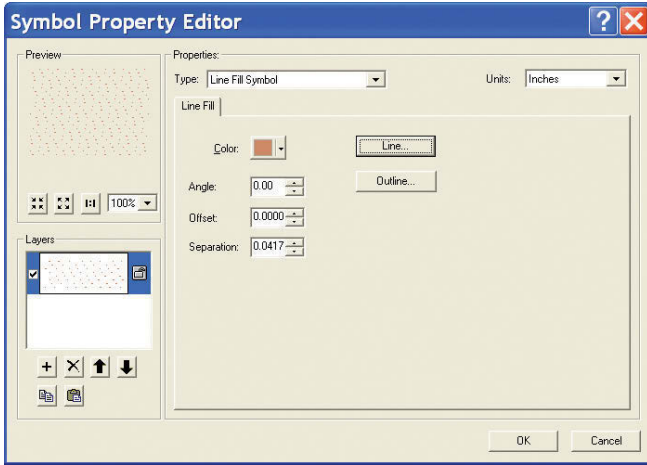


Figure 4a. Definition of one of the line symbols used for coastal rakes on the Caribbean Sea map.

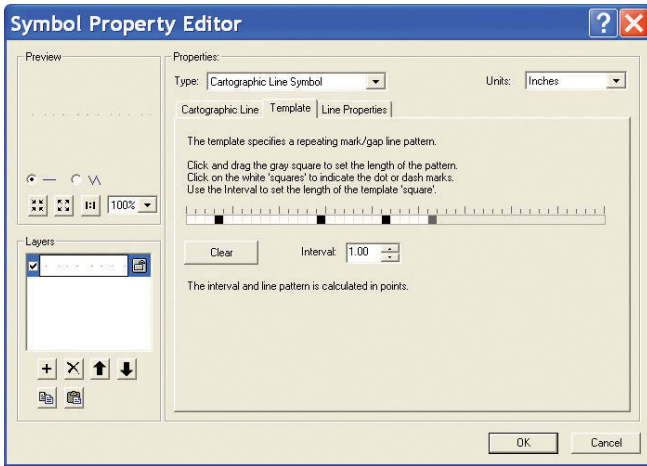


Figure 4b. Line symbol template.



Figure 6. Various marker symbols were used to decorate the open ocean areas.

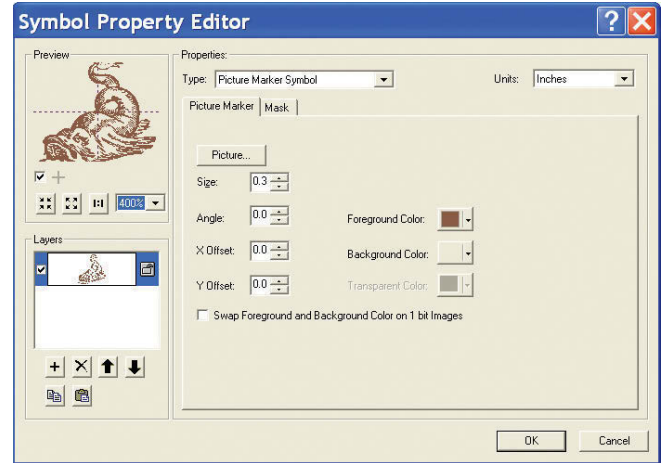


Figure 7. This sea serpent is a picture marker symbol that can be colored, resized, angled, and offset. A background color can also be set for the image.

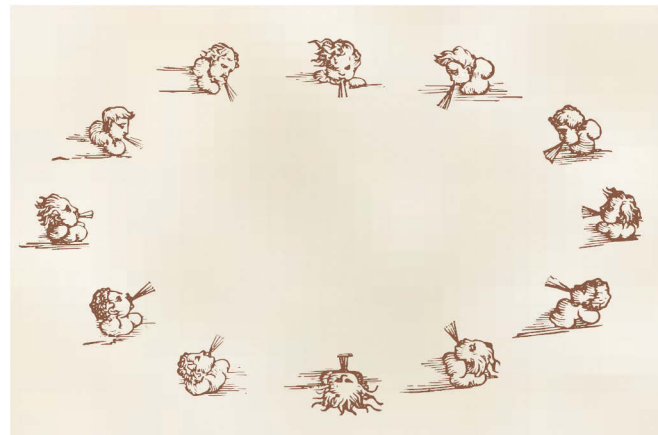


Figure 8. Windy cherubs can be used to indicate compass directions on a Mercator projection.



Figure 5. Rhumb lines are placed under land masses to help promote figure-ground.

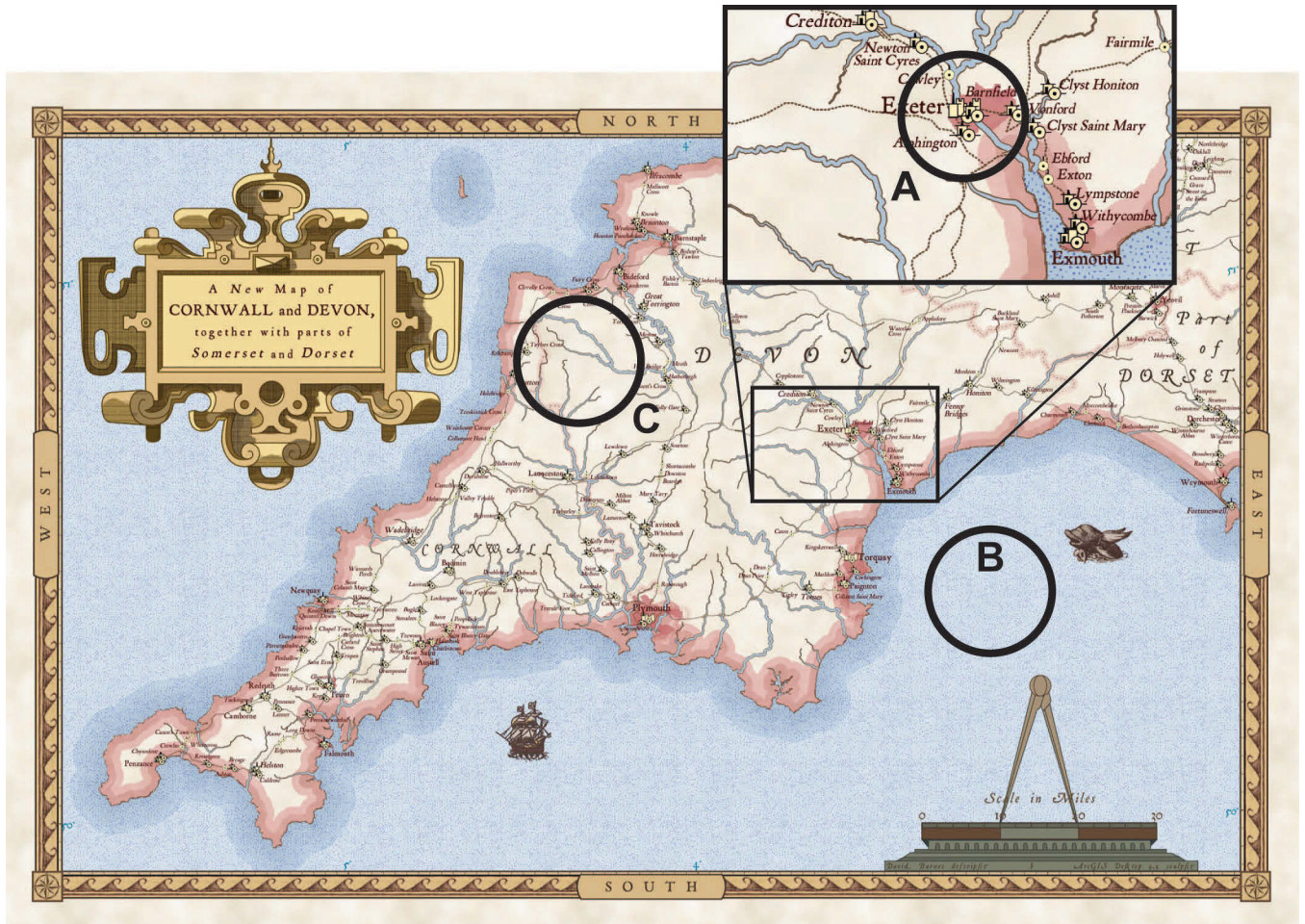


Figure 9. The Devon and Cornwall map by David Barnes (2006) illustrating A) mimetic symbols for the cities, B) a stipple pattern for the ocean, and C) tapered streams.

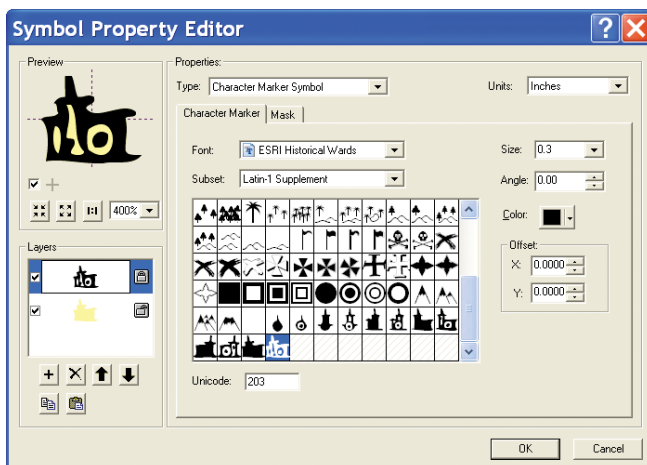


Figure 10. This city symbol is a multi-layer symbol. The top layer is colored black and the bottom layer is yellow.

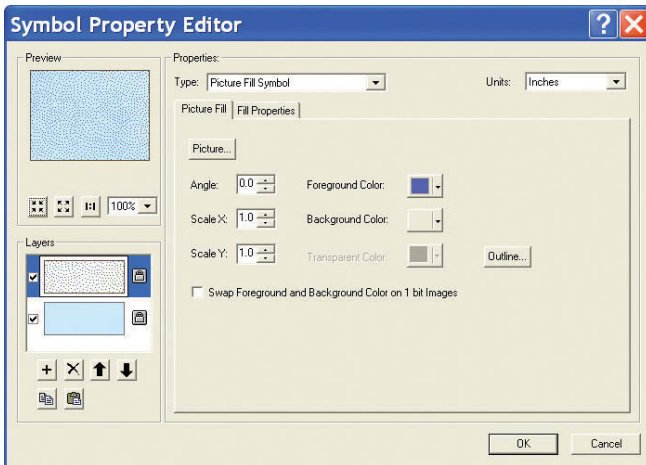


Figure 11a. This ocean fill stipple pattern is part of a multi-layer fill symbol. The layer is an .emf file.

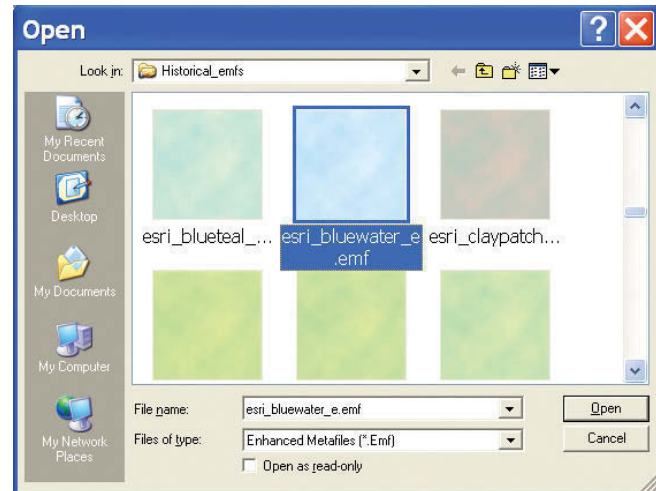


Figure 11b. Parchment fill for ocean stipple pattern. The symbol is an .emf image file.

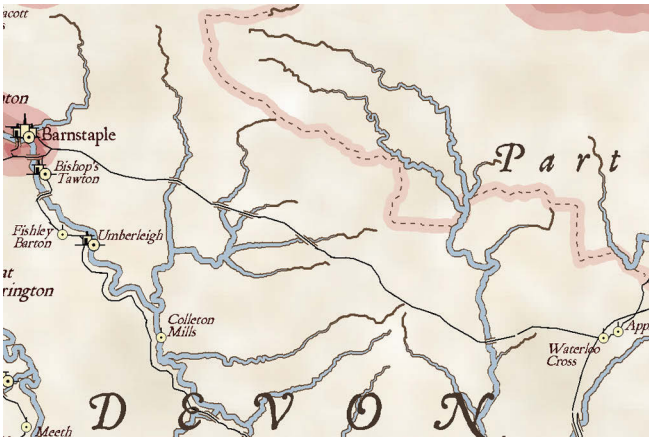


Figure 12. Stream tapering is an effect that uses a fill symbol that changes in width from one end to the other for linear features.

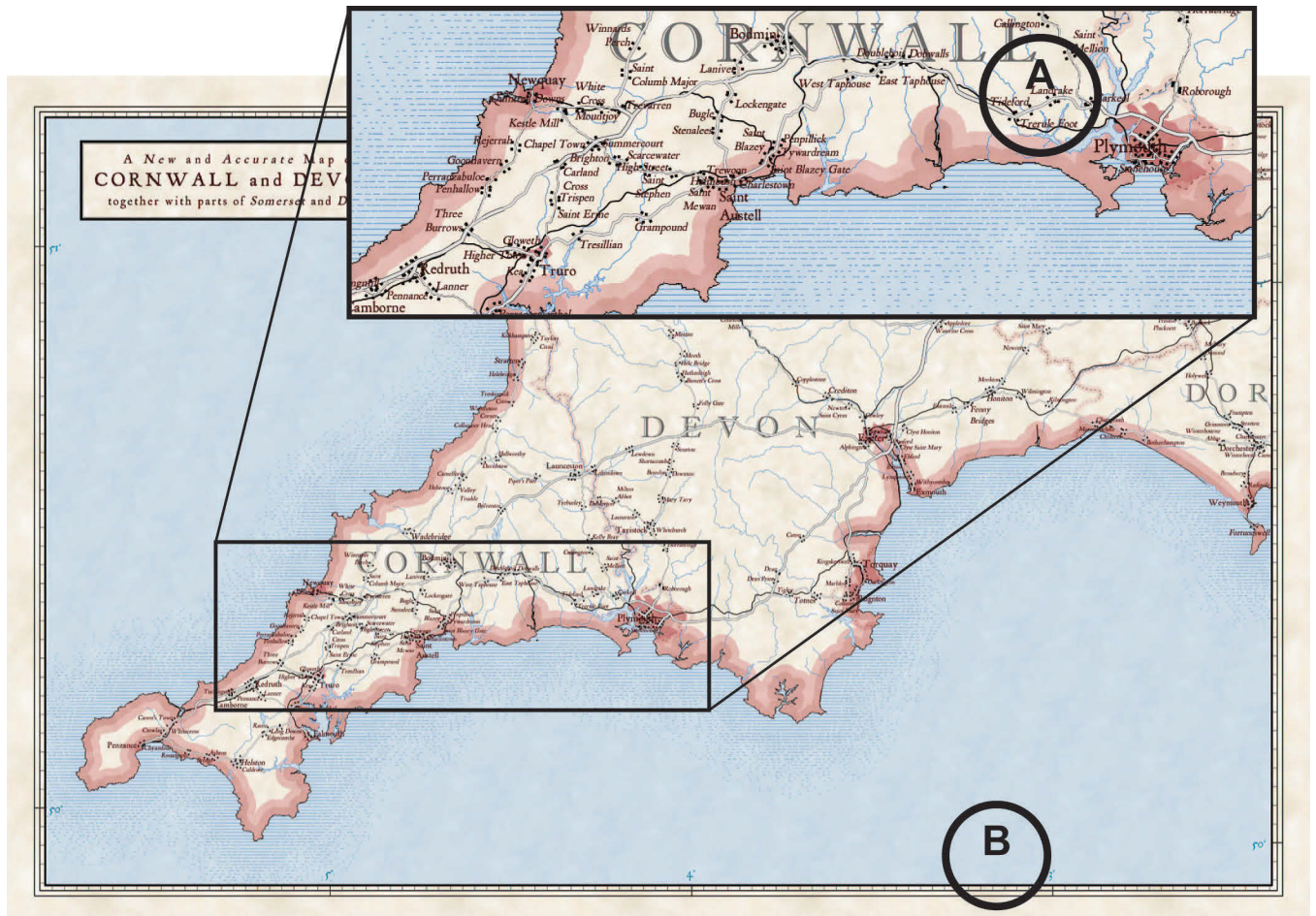


Figure 13. The Devon and Cornwall map by David Barnes (2006) illustrating A) point symbols placed alongside roads to symbolize populated areas and B) a decorative border calibrated to the graticule.

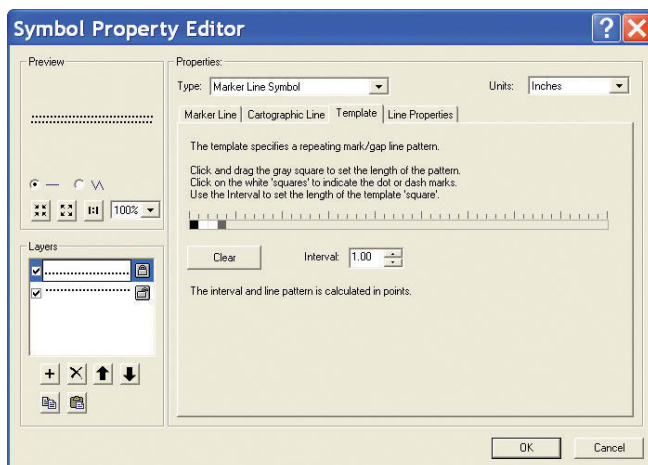


Figure 14. The building points were created as marker line symbols composed of two layers, each with a different staggering of points. Each layer was also offset to an opposite side of the road.

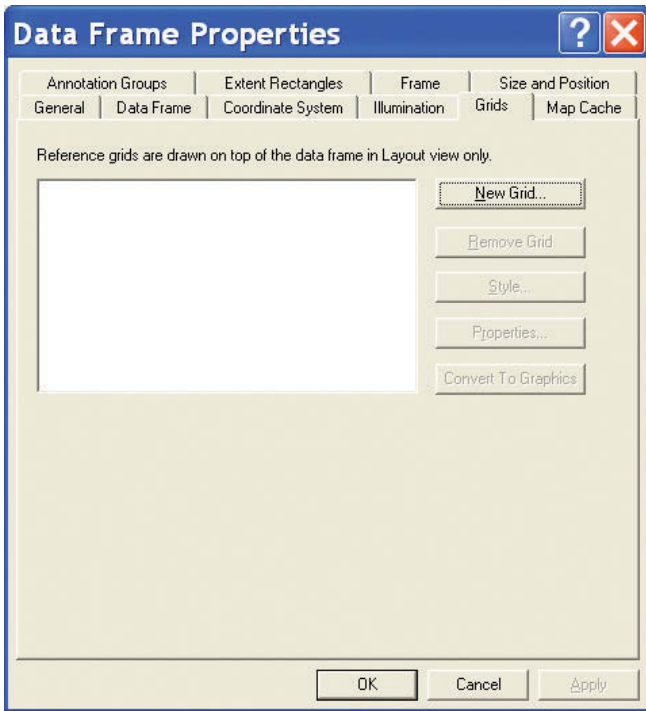


Figure 15b. Graticule grid wizard.

Figure 15a. A graticule grid can be used to create the decorative border calibrated to the graticule.

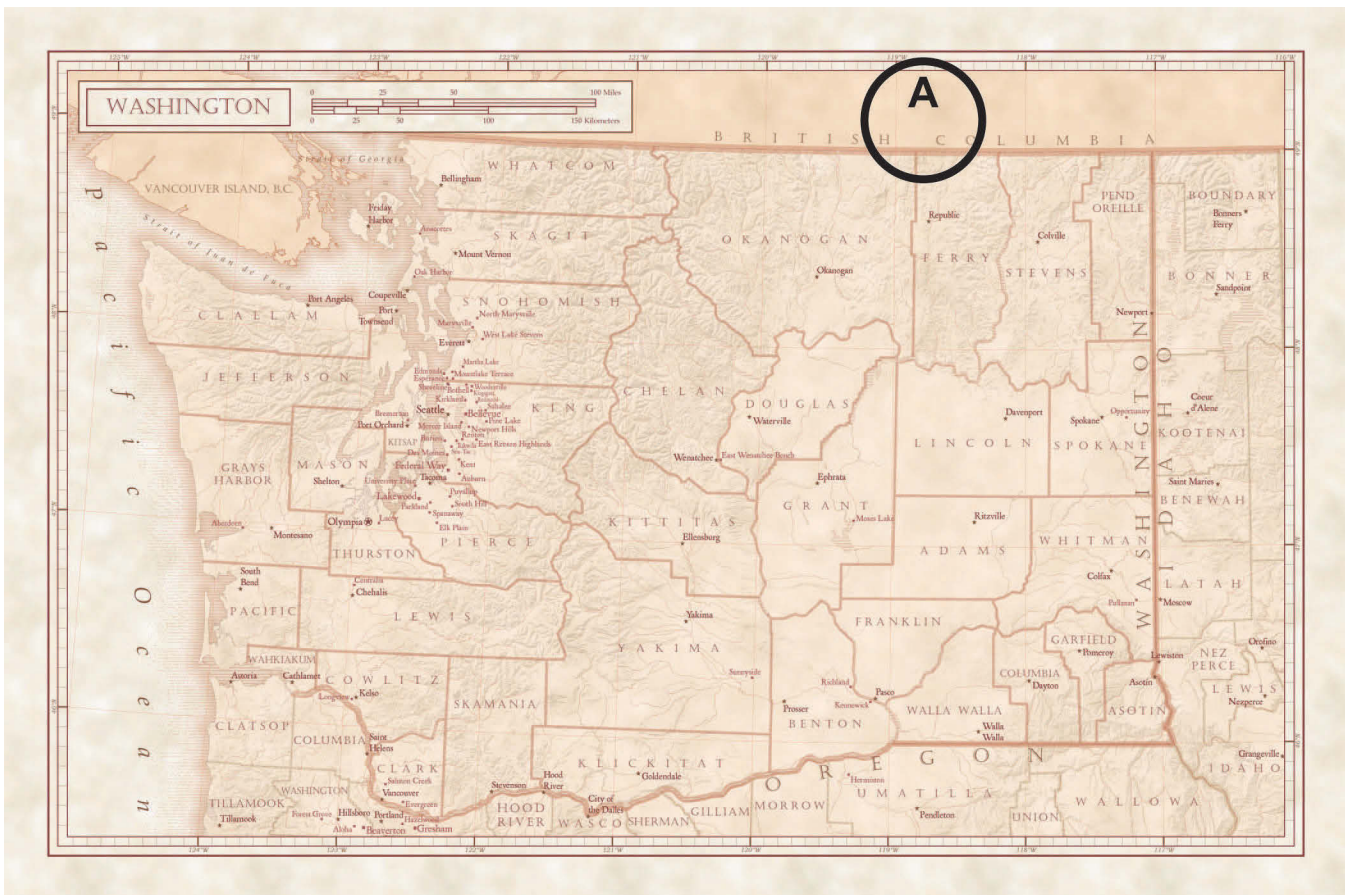


Figure 16. The Washington map by David Barnes (2006) illustrating A) sepia tones.