

plans of Spanish cities continued to be idealized until the start of the eighteenth century.

In chapter four, on "Military Architecture and Cartography in the Design of the Early Modern City," Martha Pollak examines two seemingly irreconcilable activities, the construction and the destruction of cities. Theorists conceived and planned the ideal city based on principles such as aesthetics and symmetry. For three centuries the radial plan and the orthogonal plan were the two dominant urban designs. The control afforded by this geometry suited sixteenth century dictatorships and seventeenth century absolute monarchies and became the ideal fortresses of seventeenth century military architects. War was important in the creation of early modern states. Conflict resolution through the siege of cities transformed both their appearance and their function. Treatises on military architecture debated the number of sides that offered a city and its fortress the best defense, and military theorists used their personal experience in war and in architecture when creating plans. The fortress, built on the side of the city, not only defended the city but also subdued local unrest and provided shelter to a city's ruler.

The relationship between military architecture and cartography becomes evident in the seventeenth century when the need for representations of fortifications and the relationships between their parts was understood to aid in their evaluation. The creation of plans, elevations, and profiles supported design development, afforded a visual check of fortifications before they were built and aided in their restoration after war damage. The quality of surveying improved because accurate topographic plans were needed to lay siege and to rebuild. The plan, the most abstract and hardest to read, became the most common

urban plan. Its scale and vertical view offered knowledge of the entire city, not just the foreground or prominent buildings. Historic urban cartography is tied to military planning because the defense of the city was the source of the seventeenth century cartographic movement that came to influence our perception of the city.

Chapter five, by David Buisseret, studies three dimensional representations of reality in "Modeling Cities in Early Modern Europe." The author first reviews the history of city models that began in sixteenth century Europe. The models were created by those who already made good use of maps and the towns modeled were typically either French, Italian, Bavarian, Spanish or Dutch. Although the English were aware of them, models were not typically done by the English. Their use continued into the nineteenth century, but they were less used after the advent of contour mapping. More recently, models were used during World War II for the D-Day invasion of continental Europe. Today digital imagery and terrain modeling make traditional modeling less important, however, models are still built by students of architecture. Some cities use models to orient tourists and have developed tactile models for the blind.

Buisseret examines in detail selections from among nearly 125 plans-relief. They were constructed over two centuries, from 1660 to 1870, and are the survivors of a famous collection housed in Paris. First mentioned in the 1550s, no models from that period survive. Models were most in vogue from 1663 until about 1760 and were created for cities of strategic importance, for example, frontier

**Visual Explanations: Images and Quantities, Evidence and Narrative.** Edward R. Tufte. Cheshire, CT: Graphics Press, P.O. Box 430, Cheshire CT 06410, 1997. 156 pp, maps, diagrams, illustrations, index. ISBN: 0 961 3921 2 6. \$45.00

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Geographers and cartographers are accustomed to creating, interpreting, and analyzing maps. However, we tend to focus our efforts on the display of spatial information in the form of a two-dimensional representation as a map, often forgetting that maps are but one member of a larger class of graphical formats for the presentation of quantitative information. Although most methods for the display and interpretation of quantitative information are inherently spatial, relatively few scholars within our discipline have investigated the processes whereby individuals sense, assess, interpret and assimilate spatial information in graphical form. Perhaps no one has done more to further our understanding of how humans interpret information spatially than has Edward R. Tufte, a professor who teaches courses in statistical evidence, information design, and interface design at Yale University. In 1983, Tufte published *The Visual Display of Quantitative Information*, followed in 1990 by *Envisioning Information*. Whereas Tufte describes his first book as being about 'pictures of numbers' and the second about 'pictures of nouns', the present volume, *Visual Explanations*, is about 'pictures of verbs'. This triad of books addresses big questions, in some ways filling the void between Huff's *How to Lie with Statistics* and Monmonier's *How to Lie with Maps* by demonstrating, mostly by the correct application of graphical techniques, design

mised that there may be a spatial pattern to the residences of individuals affected by a devastating cholera epidemic in London during the early 1850s. By mapping incident cases and the locations of eleven water pumps in the area, Snow identified a pattern of clustering in the neighborhood of one, the Broad Street pump. In a series of events that has assumed the status of myth in the annals of epidemiology, Snow persuaded civil authorities to remove the pump handle, thereby eliminating access to a presumably contaminated water supply. Such is the fabled account found in introductory epidemiology and medical geography texts; Tufte explores the matter further, revealing not only the brilliance, but also the limitations of Snow's pathbreaking exercise in field epidemiology. Snow's famous map does not show trends in cholera incidence over time, nor does it reveal the behavior of the residents of the crowded London neighborhoods involved. While it is true that the epidemic soon abated, this is a natural feature of the temporal sequence of infectious disease outbreaks. Coupled with the fact that many persons fled the city or had already contracted cholera, it is not surprising that the epidemic waned. Would this have happened irrespective of Snow's intervention? We'll never know - but Tufte's point is that there's always more than meets the eye, even when the subject is an example of visual explanation that has achieved the status of an icon.

The second example in this chapter is the space shuttle Challenger disaster on January 28th, 1996. In addition to providing the most comprehensive account of the antecedents and investigation of this disaster, Tufte also presents conclusive graphical evidence to demonstrate that the nature of the O-ring defect was known and could have been avoided. As Tufte concludes from these examples:

"there are right ways and wrong ways to show data; there are displays that reveal the truth and displays that do not" (p. 45).

"Explaining magic" is a fascinating chapter in that it deals specifically with the methods whereby magicians, charlatans and other practitioners of sleight-of-hand build disinformation into their routines. Tufte presents this material because the process of creating illusions is "to engage in disinformation design, to corrupt optical information, to deceive the audience" (p. 55).

"The smallest effective difference" deals with the data graphics principle that visual expressions should use "just notable differences, visual elements that make a clear difference but no more" (p. 73). In some cases this means choosing line weights or labels that provide information while not detracting from the graphical image. In other cases color schemes for different map elements can obscure or elucidate quantitative information included in a map.

"Parallelism: repetition and change, comparison and surprise" focuses on strategies of visual parallelism that have their analog in the use of parallel structure in oratory and prose. Tufte introduces this topic with a series of exquisite examples of this graphical design principle in practice. These include parallel images of a sculpture of a horse by Degas, landscape designs by Repton, and Isaac Newton's scientific diagrams. Multiple parallels are also considered in a variety of graphical contexts, as are graphical user interfaces in software applications, a chart depicting aspects of a lengthy stays at a Russian space station, and examples from the field typography and letterforms. Unfortunately, it is easier to err in the use of parallelisms, and Tufte provides several thoughtful examples to depict pitfalls we should strive to avoid. Almost poetically, Tufte concludes this chapter: "And

by establishing a structure of rhythms and relationships, parallelism becomes the poetry of visual information" (p. 103). "Multiples in space and time" builds on the previous chapter by illustrating the use of spatial and temporal multiples in a variety of settings.

"Visual confections: juxtapositions from the ocean of the streams of story" pulls the various elements described previously into a four-dimensional array of visual verbs and nouns, depicted over time and at points in time as a 'plane of events'. Examples are provided from the fields of art, architecture, the news media, and museum guides, among others. Tufte defines a visual confection as "an assembly of many visual events, selected . . . from various Streams of Story, then brought together and juxtaposed on the still flatland of paper" (p. 121).

Once again, Tufte has advanced our understanding of the logic of depicting and displaying quantitative evidence. Technically elegant, the book is profusely illustrated and referenced, in a readily readable format that makes its content accessible to its readers. The book might be improved by providing an annotated flow diagram that incorporates all of the data visualization principles explored in the three volumes. But then again, Tufte's major point is that, while there are design principles, these are most obvious when viewed in the breach. Data graphics may be the language of science, but their design remains, to a great extent, an amalgamation of science with art!

As with his previous books, *Visual Explanations* is a masterpiece of technical and artistic detail, both in content and production. Written, designed and published by the author, it personifies the practice of self-exemplification to which so many of us adhere but rarely actualize. Geographers and cartographers who add this book and its

principles and research on visual perception, "How Not to Lie with Data Graphics."

The book consists of seven chapters, each with intriguing titles that provide a glimpse of the contents and beckon the reader to look within. "Images and quantities" is concerned with how assessments of quantity are represented in visual expressions. While Tufte devotes much of this chapter to a discussion of a scientific visualization exercise in which a thunderstorm was animated in three dimensions, then redesigned by Tufte to illustrate design principles for 'pictures of verbs', many of the other examples in this chapter are drawn from the field of cartography.

"Visual and statistical thinking" focuses on displays of evidence for making decisions. Tufte uses two effective illustrations, one well-known to medical geographers (Dr. John Snow and the Broad Street pump) and the other a catastrophe that captured the popular imagination (the explosion of the space shuttle Challenger). Snow was an astute clinician who sur-

### *cartographic techniques*

#### Creation of Publication Quality Shaded-Relief Maps with ArcView GIS

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#### Introduction

This article describes a project to design a quality map entirely within ArcView GIS. I will briefly outline the purpose and data used, then describe in greater detail the creation of the shaded-relief base

map, and conclude with some comments about proofing and printing the map.

#### Designing the Map

In order to produce a quality map, we first had to settle on the purpose of the map and the area it would cover, as well as the format of the final product. We decided to make a map of the Salt Lake City region showing the extent of urbanization and the locations of cities, towns, and major roads in the context of the surrounding terrain. As our final product we planned to publish a quality color map using four-color process printing.

#### Acquiring Data

The next step was gathering the data for the map. For this map we downloaded DEM files from the USGS website, and browsed various publicly available CD-ROM data sets including ESRI sample data. The DEM files are compressed with the GNU "gzip" utility and can be downloaded as compressed or uncompressed files. These files can also be uncompressed with gzip or WinZip, both of which can be acquired from the Internet.

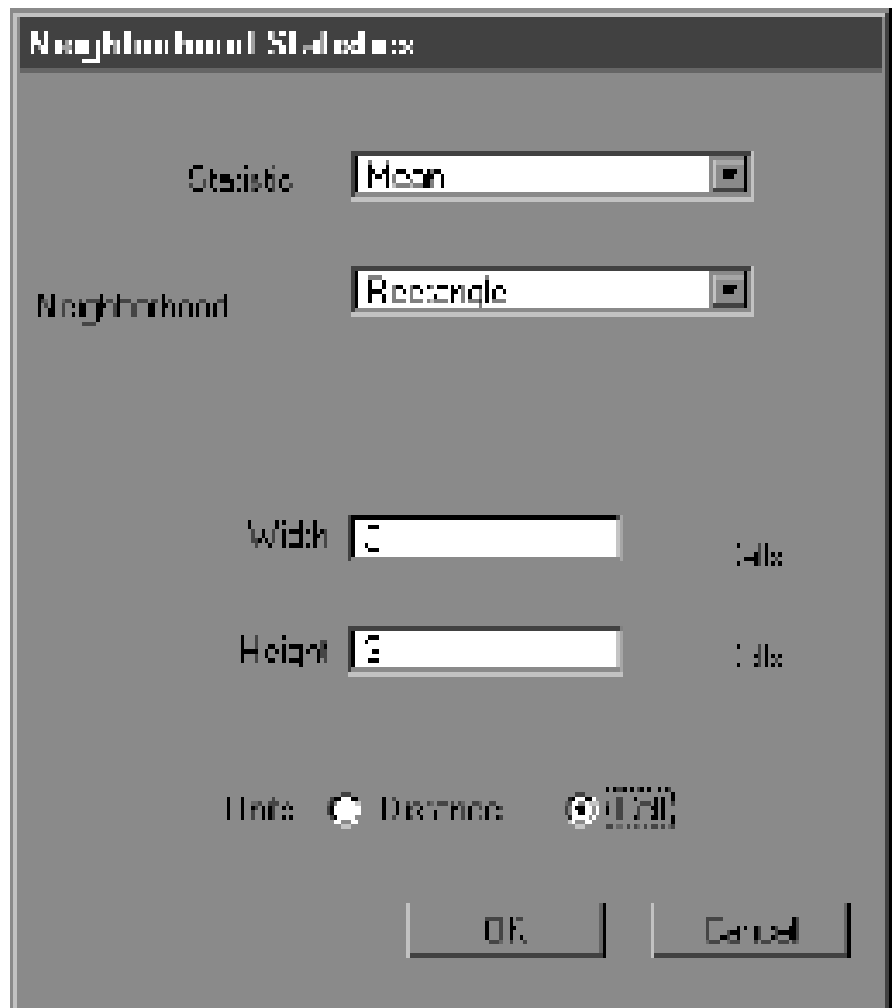


Figure 1. Neighborhood Statistics dialog from the Analysis menu of Spatial Analyst