

CHAPTER 1

An Introduction to Maps and the Internet

The Internet! Is that thing still around?

—HOMER SIMPSON

1.1 Introduction

It is impossible to know when the first map was made. Ancient pictures of animals on cave walls from 40,000 years ago indicate that these early humans could represent objects from the real world in abstract form as a series of lines and shapes (Kelly and Thomas et al. 2010, p. 303). As representations of the environment from above, maps require a more complex form of abstraction and subsequent representation. Maps from Mesopotamia from about 4300 years ago are still in existence (Thrower 2007, p. 14). Drawn on clay tablets, these maps depict land boundaries and physical features, such as rivers and mountains. The necessity for humans to communicate information about the environment makes it likely that maps were drawn much before this time, perhaps with a stick in sand, to be destroyed long ago by the agents of weathering.

Although we don't know when the first map was made, the most recent was created just a fraction of a second ago. It was a map made by computer and transmitted through the Internet as electronic impulses. No longer restricted to clay tablets or even paper, maps are now sent almost instantly from place to place. The number of maps that are distributed through the Internet is phenomenal. Within a few years after the introduction of the World Wide Web in the early 1990s, individual websites were responding to millions of daily requests for maps. An important milestone was reached sometime during the 1990s when more maps were being transmitted through the Internet than were being printed on paper.

The Internet was revolutionary for maps, similar to the invention of printing.

Maps were not duplicated in mass until the mid-1400s. Before this time, they were reproduced by hand and very few existed. As a result of printing, more people could use maps and thus had a better understanding of the world. Like printing, the Internet increased the availability of maps, but the Internet went further and combined the printing and distribution in a single step. One of the major benefits of this new age of mapping is that maps can be made available to the user in a fraction of the time required to distribute maps on paper.

The Internet also changed the way maps are used. Maps became interactive, allowing the user to select the information to depict and how it was shown. They also became more timely. Traffic maps, for example, are updated continuously throughout the day. Most importantly, maps can be accessed through a panning and zooming interface that overcomes the problem of producing maps in sections. It was once said that a map user's area of interest was always at the intersection of four map sheets. Internet maps can be continuous with no sectional breaks. All of these changes resulted in a user experience that engages the map user on a different level than with maps on paper.

Cartography, the art and science of making and communicating with maps, has evolved through the years to incorporate new tools and methods of map presentation. The discipline can trace its origins to Greek scholars over 2000 years ago, with a history marked by a number of intellectual accomplishments that have furthered our understanding of the world and its representation. Beginning in the early 1960s, the computer started to be used to make maps. Initially, paper maps were "digitized"—literally converted to numbers. Eventually, these digitized maps would be distributed between computers through the Internet. Along the way, new and related areas of study developed including remote sensing—the use and analysis of imagery taken by aircraft and satellites—and geographic information systems (GIS)—the input, manipulation, and analysis of geographic information by computer. Today, cartography and these new areas of study are under the umbrella of "geospatial technology." A central activity in all areas of geospatial technology is the making of maps.

Research related to cartography has expanded dramatically since the 1950s (see Figure 1.1). The left side of the illustration shows developments related to air photos and satellite remote sensing. A large amount of work has been directed at finding ways to automate the entire process of acquiring imagery of the Earth and extracting the relevant information. Photogrammetry deals mainly with determining elevation using stereo imagery, while the goal of multispectral pattern recognition is the automated identification of features on the Earth's surface based on reflectance differences throughout the electromagnetic spectrum.

Thematic cartography, with origins extending back to at least the 1700s, is the basis for a multitude of different areas of research represented on the right side in Figure 1.1. An academic interest in cartographic communication can be identified by the mid-1950s, oriented mostly toward thematic maps, but with the overall goal of improving maps as a form of communication. From there, cartographic research developed in a number of different directions.

Geographic Information Systems (GIS), influenced in part by research in remote sensing and image processing, emerged in the 1960s and 1970s based on the comparison and analysis of thematic layers. Further integrating the computer,

The Expansion of Cartographic Research

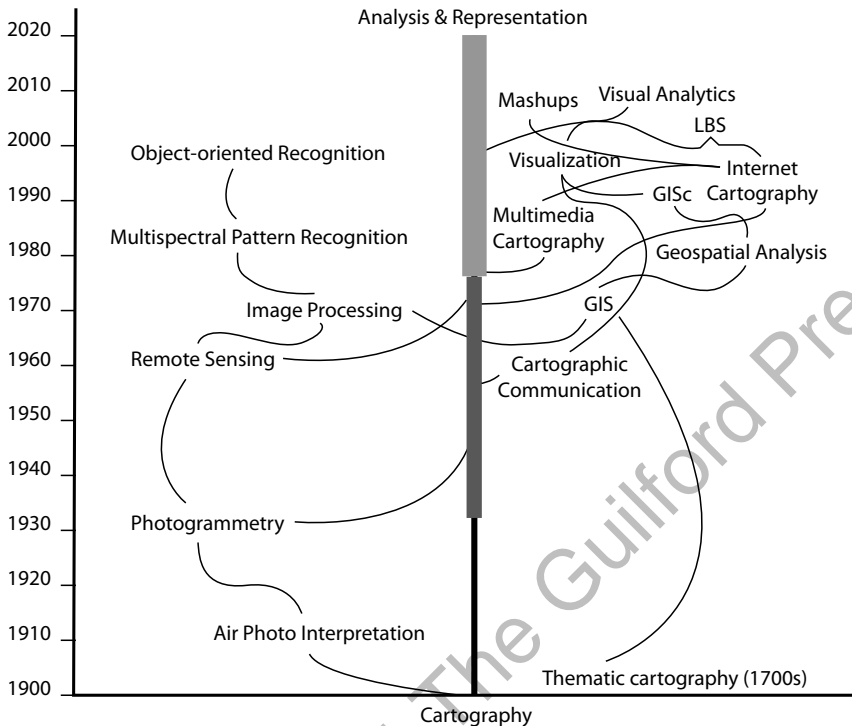


FIGURE 1.1. Development of research related to cartography since 1900. The expansion of research since the 1950s includes such areas as Geographic Information Systems (GIS), Geographic Information Science (GISc), and Location-Based Services (LBS).

areas such as geospatial analysis, multimedia cartography, cartographic visualization, location-based services, and visual analytics emerged during the 1990s. At the same time, developments related to the Internet gave rise to research in the distribution of maps through electronic networks. All of these interrelated areas of research, sometimes put under the umbrella of geospatial science, increase the body of knowledge related to maps and mapping.

These areas of research indicate that there are still many unanswered questions about how to best collect, process, analyze, and display geographic information. They also indicate the enormous amount of interest in using maps for a wide variety of applications. Maps are at the core of many different areas of research and development, and a common element of all of these areas of work is the intersection between maps and the Internet.

1.2 The Internet

The Internet has been described in many ways. In the simplest sense, it may be thought of as a system for transferring files between computers. These files,

manipulated as numbers and ultimately stored and transferred in binary 0s and 1s, may consist of text, pictures, graphics, sound, animations, movies, or even computer programs. Defined in terms of hardware, the Internet may be regarded as a physical collection of computers, routers, and high-speed communication lines. In terms of software, it is a network of networks that are based on the Transmission Control Protocol/Internet Protocol (TCP/IP)—a particular method for moving packets of data. In terms of content, the Internet is a collection of shared resources. Finally, and most importantly, from a human standpoint, the Internet is a large and ever-expanding community of people who use its resources and contribute to its content.

The beginnings of the Internet can be found in ARPANet, a computer network created for the Advanced Research Projects Agency and funded by the United States Department of Defense. The purpose of the network was to create a redundantly linked system of computers that would continue to communicate even after a limited nuclear attack. The initial Network Control Protocol (NCP) was first implemented in 1969 between Stanford University, the University of California at Santa Barbara, and the University of Utah.

The ARPANet model specified that data communication would always occur between a source and a destination computer. Further, the connection between any two computers is assumed to be unreliable and could disappear at any moment. It is therefore necessary to automatically reroute messages around nonworking computers. If a certain connection between two computers is inoperative, the initial computer reroutes the message to another computer that attempts to deliver the message. This important attribute of the Internet has proven to be especially useful in modern times to circumvent repressive governmental controls on communication.

Sending data from computer to computer requires that it be put in an “envelope,” called an Internet Protocol (IP) packet, with an appropriate “address.” A single file is divided into pieces before it is sent. All of these pieces may take a different route to the destination—to be reassembled again when they arrive at their destination. Dividing the file into parts speeds data transmission and assures that the pieces can be rerouted around nonworking computers.

Increasing demand on the network at the beginning of the 1980s forced the U.S. government to commission the National Science Foundation (NSF), an agency of the U.S. government, to oversee the network. ARPANet switched from the NCP protocol to the currently used TCP/IP (Transmission Control Protocol/Internet Protocol) on January 1, 1983 and became NSFNET. Many view this date as the beginning of the Internet. The first graphical World Wide Web browser, NCSA Mosaic, was introduced almost exactly 10 years later (see Figure 1.2).

NSFNET was primarily designed to distribute the power of five supercomputers at major universities. These universities and other institutions were connected with a high-speed Internet “backbone.” This significantly increased the speed of the Internet.

Internet service providers (ISPs) expanded the network toward the end of the 1980s to include telephone access from homes. High-speed, broadband access through cable television companies became widespread toward the end of the 1990s. Many people throughout the world now access the web through their mobile phones. For countries that lack telephone/cable infrastructure, the mobile network

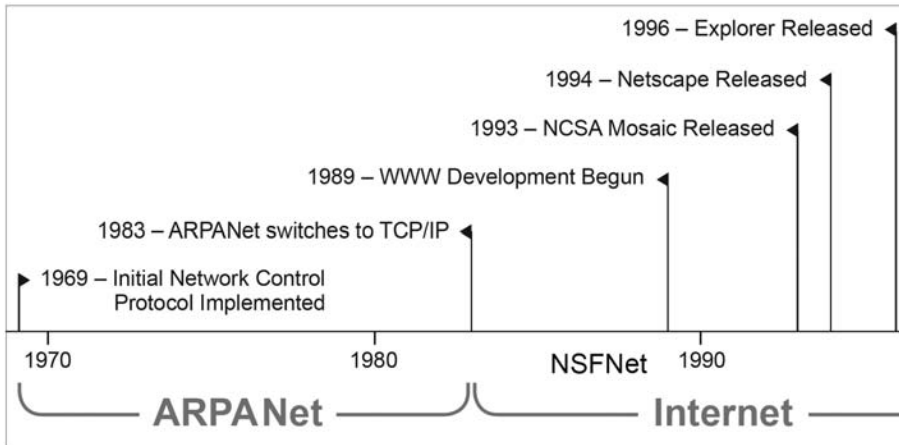


FIGURE 1.2. Time line of early Internet development. Initial work was begun in 1969. The introduction of NCSA Mosaic in 1993 spurred the development of other browsers and the widespread use of the World Wide Web.

represents the only way to access the resources of the Internet, and the speeds are often faster than the wired connections in the more developed parts of the world.

The Internet is a global computer network linking computers in different continents that are thousands of miles apart. It does not rely on a single computer, nor is it managed by any one entity. Rather, it is a system of computers and networks that are linked together in a cooperative, noncentralized collaboration.

1.2.1 World Wide Web

Conceived at the European Particle Physics Laboratory (CERN) located near Geneva, Switzerland, and introduced in 1991, the World Wide Web (WWW) was intended to assist researchers in high-energy physics by linking related documents. The developers wanted to create a seamless network in which textual information on high-energy physics from any source could be accessed in a simple and consistent way. Sir Tim Berners-Lee, director of the World Wide Web Consortium (W3C), played a major role in designing the system.

As originally conceived and implemented, the World Wide Web consisted only of text. Two university students in the United States, Mark Andreessen and Eric Bina, working at a supercomputer laboratory at the University of Illinois, recognized that the web would have limited acceptance as a text-only system. They added the display of graphics, sound and video with the Mosaic web browser introduced in March of 1993 (see Figure 1.3). Describing it as a “consistent and easy-to-use hypermedia-based interface into a wide variety of information sources” (Poole 2005, p. 2), the program was made freely available through the Internet and was widely used within a matter of months. Mosaic transformed the Internet by making it widely accessible.

In 1994, Tim Berners-Lee publicly chided Andreessen and Bina for developing Mosaic. He argued that it would result in a “flood of new users who would do

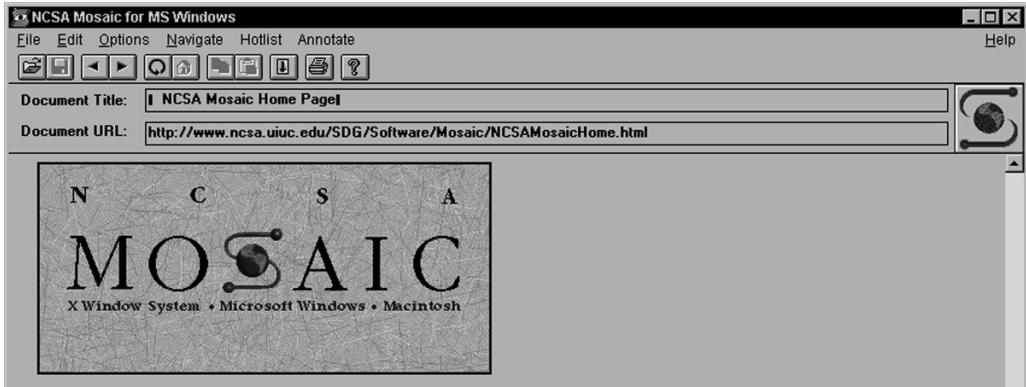


FIGURE 1.3. The Mosaic Internet browser was introduced in March 1993. Incorporating the display of graphics, it was the first widely used World Wide Web browser. The user interface has been imitated by all successive browsers. Courtesy of the National Center for Supercomputing Applications (NCSA) and the Board of Trustees of the University of Illinois.

things like post photos of nude women” (Maney 2003). Mosaic went on to become a “killer-app,” a distinction given to programs that become quickly adopted by a large number of users. While Mosaic was soon replaced by other browsers including Netscape, Explorer, Firefox and Chrome, the basic user interface that was implemented by the program has remained unchanged.

Interaction through the Internet is made possible through an interface that allows the user’s client computer to interact with a program running on a server. Long-distance access to the resources of a remote computer is the basis of the Internet. Every time we use the Internet, we are interacting with a distant computer—increasingly located in massive data centers.

Figure 1.4 depicts the amount of Internet traffic that can be attributed to various protocols. Although absolute web traffic is still increasing, its proportion relative to video content is decreasing. Internet video streaming has become a major way of distributing television programming and movies and is now dominating Internet traffic. Video transmissions require a large amount of data in contrast to web, email, data, and file sharing protocols.

1.2.2 Maps through the World Wide Web

On-demand web maps began appearing soon after the introduction of the Mosaic browser in 1993. One of the first of these online mapping programs was developed by Steve Putz (1994) at the Xerox Palo Alto Research Center (PARC). His Map Viewer program allowed the user’s client computer to create maps from a geographic database. Each interaction with Map Viewer would request a map from a server that was zoomed in on a specific point (see Figure 1.5). The server would respond with a new map that was embedded into a new web page.

A still-operational example of this type of interaction is the Earth and Moon Viewer available through the Fourmi Laboratory in Switzerland (see Figure 1.6). The site displays views of the Earth from the Sun, the Moon, or orbiting satellites, and includes the overlay of current cloud patterns of the earth derived from

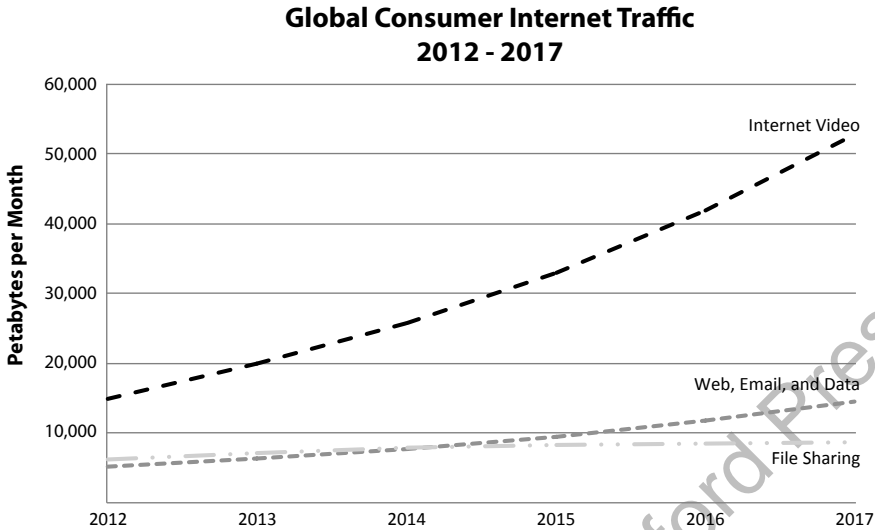
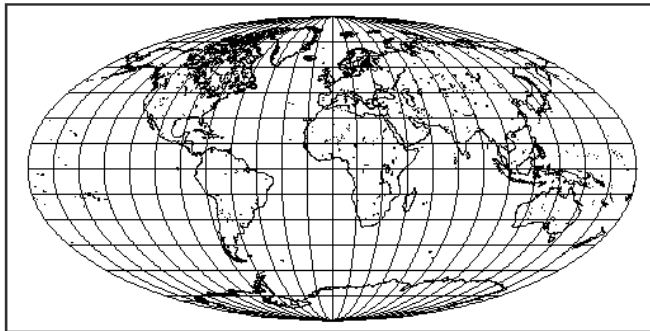


FIGURE 1.4. Internet traffic from various protocols. While World Wide Web traffic is still increasing, its proportion of Internet traffic is declining in comparison to video. Internet streaming and video downloads are dominating Internet traffic. Data from Cisco 2012.

Map Viewer: world 0.00N 0.00E (1.0X)



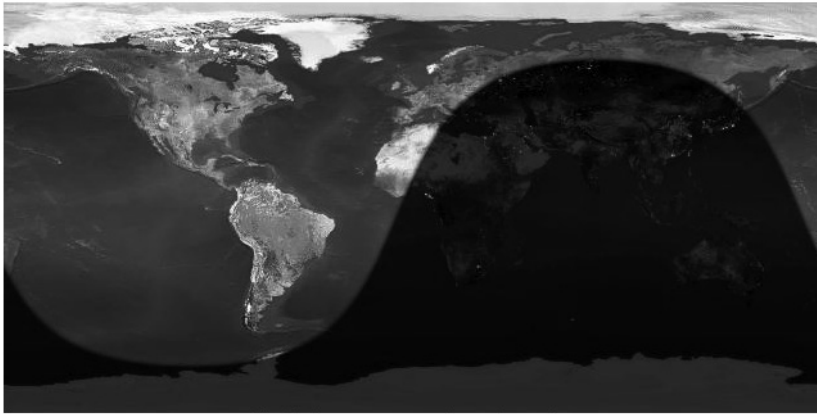
Select a point on the map to zoom in (by 2), or select an option below. Please read

Options:

- Zoom In: (2), (5), (10), (25); Zoom Out: (1/2), (1/5), (1/10), (1/25)
- Features: Default, All; +borders, +rivers
- Display: color; Projection: elliptical, rectangular, sinusoidal; Narrow, Square
- Change Database to USA only (more detail)
- Hide Map Image, No Zoom on Select, Reset All Options

FIGURE 1.5. Xerox Parc Map Viewer was an early example of an interactive web map. The user interacted with a program on a server through the Common Gateway Interface (CGI). The user was able to generate a map of the world at different scales. The resultant map was converted into a graphic file and inserted into a web page.

2010 Jul 6 18:40 UTC



Click in image to zoom in on that region.

Update

Display: Map, From Sun, From Moon, Night side

Lat: Alt: km

FIGURE 1.6. The Earth and Moon interactive mapping site from Fourmi Laboratory in Switzerland. In continuous operation since the mid-1990s, the site uses a Common Gateway Interface (CGI) to allow the web user to interact with the Earth program on a remote computer. Search: Earth and Moon Viewer.

satellite imagery. With this interface, the user selects the type of map to view and the server inserts the desired map into a new web page.

Almost exactly three years after the introduction of Mosaic, a new era in online mapping was introduced with MapQuest's user-defined street maps in 1996. Using the same client-server model, the site responded to user requests by inserting the desired map into a new web page. MapQuest quickly became the largest publisher of maps on the Internet. By 1999, MapQuest was responding to 20 million daily map requests (Peterson 2001). Developed by a map publishing company called GeoSystems, MapQuest was a major business success and was soon purchased by the Internet giant AOL in 1999 for \$1.1 billion (Rohde 2000, p. 64).

MapQuest held the distinction of having the greatest market share among mapping sites until 2009 when it was replaced by Google Maps. Competing against mapping services from Yahoo!, Microsoft (Bing), and eventually Google beginning in 2005, the phrase "I'll MapQuest it" was used to describe how to find a location, even if using a site other than MapQuest. All of these online mapping sites include the option of finding the shortest route between locations. A "satellite view," often taken from an airplane, is also included. Google extended the concept of the online map into a new type of search engine, thereby making it possible to search for features on the map.

1.2.3 Maps Outside the Browser

Not all maps on the Internet are presented through a browser. GeoBrowsers, such as Google Earth (see Figure 1.7) and NASA World Wind, are stand-alone Internet



FIGURE 1.7. Google Earth is a digital globe application that operates outside the browser. Many of its functions have been integrated within the browser-based Google Maps. Copyright 2013 Google.

mapping programs. Incorporating the third dimension and implementing flythroughs that simulate flying over a terrain, GeoBrowsers are an increasingly important aspect of online mapping. They standardize the user experience by avoiding differences between browsers, and they streamline the interaction with air photographs and satellite imagery. Associated scripting languages allow users to customize the display and include user-defined information.

Mobile operating systems like Apple's iOS for the iPhone and iPad, and Google's Android have fostered a whole new software industry (see Figure 1.8). The programs written for these devices, called *apps*, generally accomplish a specific task, thus the iconic statement: "There's an app for that." More programs are being written for these operating systems than for any other computing platform, and they are either free or sell for less than US \$5. Hundreds of thousands of apps have been written for both Apple's iOS and the Android operating systems.

Mobile phones and tablet computers represent another type of Internet medium for maps. Many have the added advantage of being able to display the current position of the user. Apps that provide spatial information use the positioning capability of the mobile device provided by (1) global positioning system (GPS) satellites; (2) Wi-Fi network IDs; or (3) a system that triangulates a location based on differing signal strengths from surrounding cell phone towers. Location-aware apps indicate the current position on a map and can provide information about the surrounding location such as stores and restaurants. Some apps also allow users to map the locations of family members and friends.



FIGURE 1.8. Apple's iOS operating system on the iPad. Copyright 2013 Apple.

1.2.4 Mapping in the Cloud

The term *cloud* is increasingly applied to the use of distributed data centers. Up to this point, data centers have been used primarily for the storage and retrieval of data. Cloud computing goes a step beyond this function by using the processing power of data centers. The National Institute of Standards and Technology (NIST) (Mell and Grance 2009) defines cloud computing as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” The U.S. government now mandates that all agencies either migrate to cloud computing or explain why it is more efficient to not use cloud computing. One of its major advantages is the added speed in processing and the ability to deal with large data sets (Yang 2011). It is also argued that the data is more secure and that cloud computing conserves electricity because it consolidates resources.

Cloud computing has major implications for online mapping. Most Internet maps are now stored at data centers. It is also where the programs reside that analyze and manipulate the underlying information. Finally, user data to augment and update the maps is centralized at these centers. The cloud is clearly the future for online mapping.

1.3 The Internet and Map Use

Although we have witnessed a revolution in the distribution of maps, many people still have difficulty using them. With paper maps, it was estimated that more than half of the population did not have basic map reading competency. This translated to a particular difficulty in performing tasks involving navigation. Map illiteracy may be related to a lack of specific education in using maps, differences in the way people conceive of space and spatial relationships, or the way maps are made and presented.

It may be impossible to determine exactly why some people have difficulty using maps. But, whatever the reason, the result is clear: Many people have poorly formed mental representations of the local environment and especially the space beyond their direct experience. Their conceptions of the world, both far and near, are restricted, and they are isolated by their limited conceptions of the world around them.

Before the Internet, the paper medium was the predominant form of map distribution. However, that medium does not facilitate interaction, an ingredient that many associate with learning. Although some are able to “make a connection” with the map on paper and mentally visualize what the map represents, others have difficulty doing so. Education may help overcome this barrier for some, but others might always have difficulty with this form of map presentation. Interaction may help make maps more useful for a majority of the population.

It has been argued that the incorporation of interaction increases the use of maps (Peterson 1995). No longer restricted to a single view, the user is encouraged to explore alternative methods of representation—different views that may better conform to the user’s mode of learning. The views that are presented may be targeted to specific users. The most difficult task in navigating with maps may be determining the current position. The addition of a symbol to show users their current location removes this requirement.

The Internet has already improved the distribution of maps. If maps are presented properly, Internet maps also have the potential for improving the quality of maps as a form of communication, thereby changing both the mental representations that people have of the world and how people mentally process ideas about relationships in our environment. This will provide more people with a better and more complete conception and understanding of the planet on which we live.

1.4 The Cost of Maps

Increasing the availability of maps is the best way to increase their use. But making and storing maps is expensive, and their distribution adds significantly to their cost.

Governments and the private sector have invested large sums of money to produce all manner of maps. Decisions about what to map is driven by both governmental and commercial interests. Governments make maps based on whose interests will be served. In general, making maps of the country, the world, and

even other celestial bodies is considered to be in the “national interest.” Businesses make maps based on the amount of return on the investment.

There is also an important interplay between government and commercial mapping. Maps that are made by governments, often at enormous expense to the taxpayer, are given to the private sector to be repackaged and sold as commercial products. Most maps that are sold to the public are based on government data.

The change in how maps are distributed to people has been dramatic. As late as the early 1990s, nearly all maps were distributed on paper. The only maps that most people could view were on this medium. By the end of the decade, the Internet had become the predominant form of map distribution. The most remarkable aspect of this transformation is that maps are now distributed at no charge. The free distribution of maps by the government is justified because there are no printing and warehousing costs and taxpayers have already paid for the making of the maps.

Businesses have developed a new model for financing the production and distribution of maps. Initially, online maps were financed by small advertisements that appeared on the web page with the map. Companies like Google began to use maps to augment their search engine and provide a way for people to find the location of businesses. The map itself is provided for free because it simply serves as a background to display sponsored information.

While most maps are now distributed freely, the costs associated with their use have risen sharply. Computers and computer software are needed to make the digital maps usable. While it can be argued that the digital products are now more functional than the previous paper version, it cannot be overlooked that these maps are only usable by individuals with computers, computer software, a fast network connection, and the appropriate training. The access to maps has been increased for some, but they remain beyond the reach of many. In addition, the demand and necessity for paper maps has been reduced, making it even more difficult for people without a computer to find a map.

For better or worse, the Internet is firmly entrenched in our society and our way of life. How we communicate and access all types of information has drastically changed. Maps, and geographic information in general, are a big part of this change.

1.5 About This Book

This book and the associated online materials introduce maps and map making in the era of the Internet. The text introduces and explains the basic concepts, while the associated electronic resources illustrate and expand on these ideas. The materials are designed to augment each other.

Knowledge may be divided into theory and practice. According to Van de Ven and Johnson (2006), understanding “the relationship between theory and practice is a persistent and difficult problem” particularly for those scholars who develop “knowledge that can be translated into skills that advance the practice of the professions” (p. 802). They point to several studies that academic research has become less useful for solving practical problems and that the “gulf between theory and practice in the professions is widening.”

Broadly defined, theory consists of concepts and ideas that have evolved through time along with the historical progression of these ideas. Practice, the type of information that can help you make maps, should be guided by theory. Underlying this notion is that practical knowledge (knowledge of how to do things) is based on research knowledge (scientific knowledge and scholarship more broadly). The gap between theory and practice is seen as a knowledge transfer problem in the sense that it is difficult to bring theoretical knowledge into the practical domain. Van de Ven and Johnson (2006, p. 802) point out that knowledge of theory and practice is sometimes viewed as “distinct kinds of knowledge. Each reflects a different ontology (truth claim) and epistemology (method) for addressing different questions.”

More popular distinctions between the two forms of knowledge simply state that they are distinct based on their usefulness: Theory is useless, and practical knowledge is useful. To further the distinction, it is often implicitly claimed that if knowledge is useful, then it cannot be theory. Finally, the distinction is often seen as a way of separating individuals who work in both domains with those dealing in theory given a higher status.

Whatever the exact relationship between theory and practice, it is clear that both types of knowledge are interrelated. To facilitate the development of both areas, it is important to alternate between theory and practice (see Figure 1.9). This is accomplished in the book through the close juxtaposition of the two.

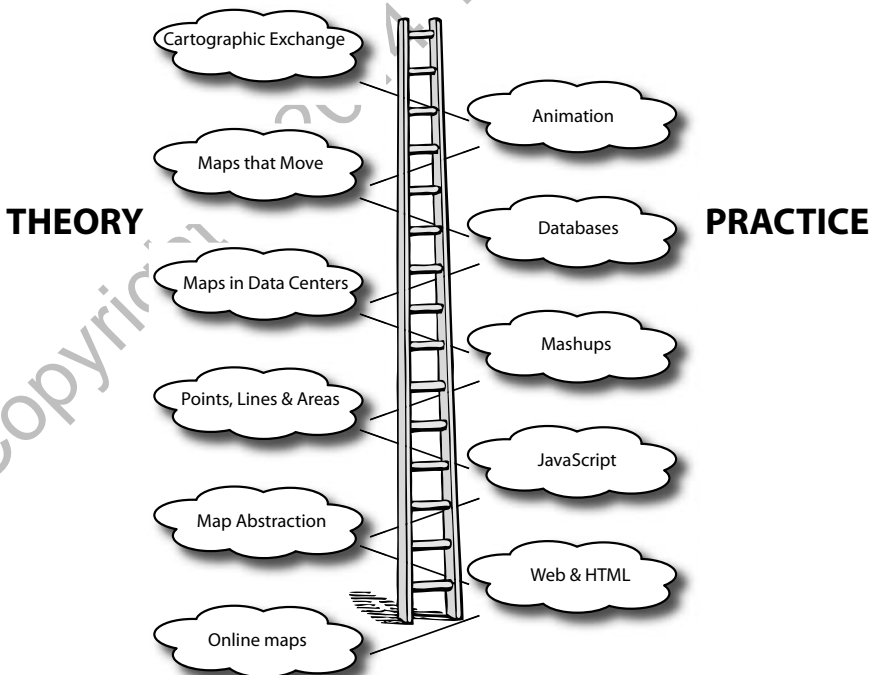


FIGURE 1.9. The ladder approach used in this book. Alternating chapters on theory and practice reinforce the major concepts.

The chapters that deal with theory examine how maps are processed in the brain, how mapping developed over time, the abstraction process in mapping, map input and the global positioning system, map layers and GIS, databases, and mobile and animated mapping. The “practice” chapters in this book involve making maps using online mapping systems. Code samples are included that implement the examples described in the book. Working through these examples will help you understand how easy it is to make maps using the available online tools, and how these maps can be made available to others.

If used in a classroom setting, the exercises are best done in a computer laboratory. Whether arranged by row or in circular “pod” fashion, a computer laboratory facilitates interaction with both computers and people. Sometimes the computers are provided, but students are increasingly bringing their own laptops to connect to the Internet and download class materials. The exercises can be challenging. As you try to follow them, you will at one point think you know how something is done and then, in the very next moment, feel completely lost. This is a normal experience in such a learning environment. While you simultaneously feel that you are lurching forward and falling behind, remember that the most important interaction for learning is not with the computer but with the other people in the classroom.

This book also addresses the quality of online maps. Unfortunately, many poor maps are available through the Internet. Some are simply illegible. Many are poorly designed, either from the standpoint of graphic quality or user interaction—or both. One way to evaluate the quality of online maps is to compare the available Internet maps to each other. A map gallery introduced in Chapter 3 outlines a format for displaying maps side by side to highlight differences in the maps. Interaction is a major component of Internet map design, and this book stresses ways of introducing interactivity to maps and discriminating good forms of interactivity from bad.

1.6 A Look Ahead

The next chapter takes a closer look at the Internet map landscape and how to create a website through a web-hosting service. Chapter 3 examines mental maps and how we process and store spatial information. Chapter 4 introduces the hypertext markup language (HTML) for the making of a map gallery page that provides links to maps on the web. These files are then uploaded to the Web hosting site. Maps as a mirror of civilization and the development of mapping through time is the topic of Chapter 5. The remaining chapters examine how maps are input, stored, and manipulated by computer, how they are integrated on web pages, and how they are distributed.

Beginning with Chapter 4, the remaining even-numbered chapters in this book include a file of code in the form of zip files (see Figure 1.10). These code files can be uploaded to the webserver as a zip file and unpacked. The files are called code04.zip, code06.zip, code08.zip, and so on. The zip file unpacks to a folder that contains an `index.htm` file that has links to all of the other files in that folder. It

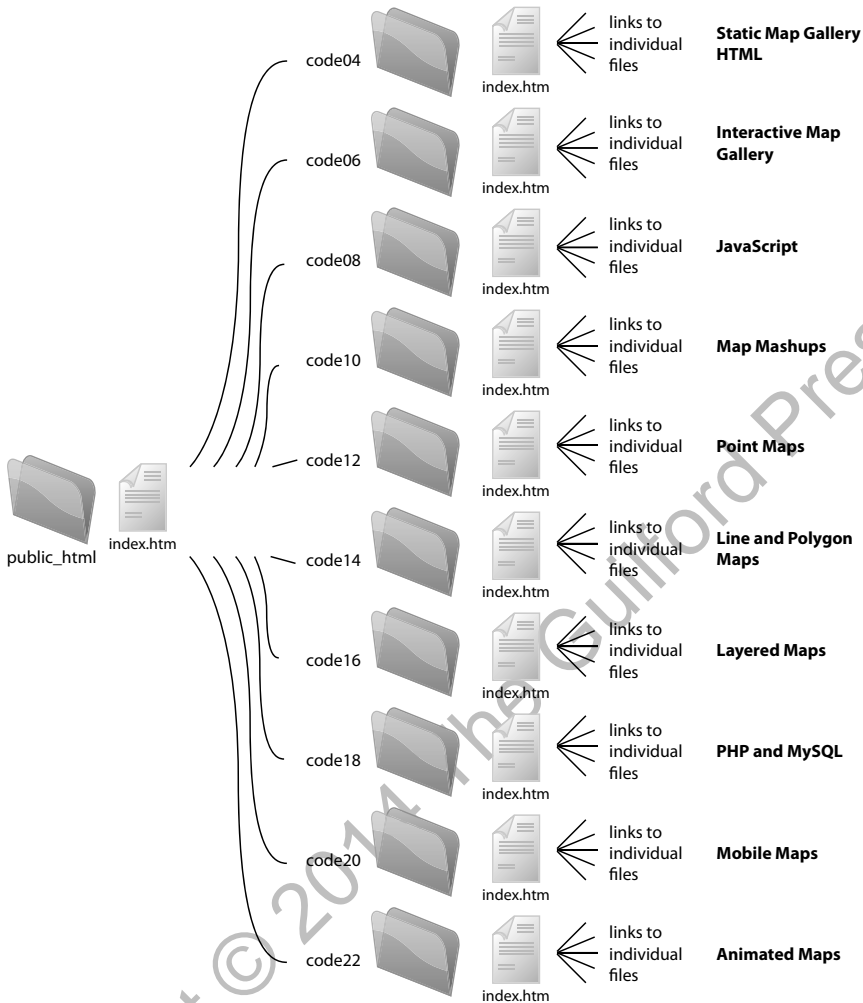


FIGURE 1.10. The public_html folder stores all files for a website. A file called index.htm is displayed when the site is accessed. It links to the folder of code for all of the even-numbered chapters in this book. Each of these folders also contains an index.htm file that has links to the examples.

is not necessary to create a link to the index.htm file because it is automatically displayed when a reference is made to the folder, as in this example: <http://maps.unomaha.edu/Cloud/>.

Some knowledge of programming is helpful to understand the exercises, but the book is designed for students with little or no programming experience. In most cases, all that is needed is the ability to work with a text editor and a willingness to experiment. Changes might involve such things as defining a new center for the map, a different zoom level, or the text for pop-up markers. Completing the exercises only requires understanding the code well enough to determine what needs to be changed to make the map you need.

1.7 Questions

1. What motivated the development of the World Wide Web?
2. How has Internet traffic changed since the World Wide Web was introduced? What now consumes most Internet bandwidth?
3. What was the importance of the Mosaic browser for maps? Why did Tim Berners-Lee, the inventor of the World Wide Web, disapprove of its introduction?
4. When were maps first distributed in large numbers through the Internet, and what major advance made this possible?
5. Describe some major milestones in the development of maps and the Internet.
6. How did the Internet change the way maps are used?
7. What is the fundamental difference between general reference and thematic maps?
8. Describe some areas of study that have their basis in thematic mapping.
9. How were initial interactive maps created for web pages?
10. How did MapQuest change our relationship with maps?
11. Describe the map-use problem with paper maps. Has the Internet made maps easier to use?
12. What makes mapping so expensive?

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