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MAPPING CRIME

PRINCIPLE AND PRACTICE

CMRC
CRIME MAPPING RESEARCH CENTER

Mapping Crime: Principle and Practice

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Ultimately, all these efforts to spread the blame are in vain, and the author accepts full responsibility for errors, omissions, and misinterpretations.

Foreword

In 1997, when the National Institute of Justice (NIJ) was planning to create its Crime Mapping Research Center (CMRC), we convened a 2-day strategic planning meeting to seek advice on the Center's goals, direction, and mission. Before the meeting, we had assumed that many agencies were already using mapping and that NIJ's goal would be to encourage the field to move beyond descriptive mapping (e.g., pin maps) toward analytic mapping. The meeting helped us recognize that another goal must be to assist the large number of agencies that are not using mapping.

Keith Harries, who received one of the first grants from CMRC, has prepared this comprehensive guide for agencies that are in the early stages of using geographic information systems (GIS). His words are directed to law enforcement professionals who have a little knowledge about GIS and want to learn more about its benefits and limitations.

He has collected more than 110 maps to illustrate how GIS is used. These pictures express the truth of the phrase "one picture is worth a thousand words."

Dr. Harries' guide is not designed to stand alone. Law enforcement agencies will need other curriculum materials as well—especially software manuals—but it will be a starting place. Additional materials and links to other sources of information can be found at CMRC's World Wide Web site (*http://www.ojp.usdoj.gov/cmrc*). As a clearinghouse of information about crime mapping, CMRC also sponsors a listserv (*listproc@aspensys.com*), which has more than 640 subscribers, and an annual conference, which draws more than 700 attendees.

Today about 13 percent of law enforcement agencies are using GIS regularly to analyze their crime problems, and we are certain to see this number increase significantly as more and more agencies begin using computerized crime mapping to identify and solve their crime problems. We hope this guide will help them get started. For agencies that are already using crime mapping technology, we hope this guide will spark ideas about new ways to use it.

Jeremy Travis
Director
National Institute of Justice

Preface

This guide introduces the science of crime mapping to police officers, crime analysts, and other people interested in visualizing crime data through the medium of maps. Presumably most readers will be working in law enforcement agencies, broadly interpreted to include courts, corrections, the military police, and Federal agencies such as the FBI, U.S. Bureau of Alcohol, Tobacco and Firearms, National Park Service, U.S. Customs Service, and U.S. Secret Service, as well as police departments. The material is designed primarily for those who know little or nothing about mapping crime and who are motivated to learn more.

This is *not* a guide to software. Nowhere is there more than a word or two on how to do anything technical involving a computer. A purely technical guide would quickly be out of date, and a guide that served one set of software devotees would not serve others. Technical guidance is best sought from the manuals and interest groups specific to each software package.

What *will* be found here is a broad approach addressing the kinds of questions crime mapping can answer and how, in general terms, it can answer them. Caveats are given from time to time, notably the caution against uncritically accepting all the default settings that crime mapping software so conveniently provides.

Most readers will not read this guide from cover to cover. Some will concentrate on application-oriented material. Others will have an interest in the history of crime mapping, realizing that where we have been can help us figure out where we are going.

The presentation employed in this guide leans heavily on examples. Indeed, the guide is made up of examples with the words draped around them. Crime analysts and researchers from across the United States and from Canada and the United Kingdom have contributed. Without their help, this guide would be an empty shell. I am extremely grateful to all who donated their work so graciously, and a partial listing of these kind souls is found in the acknowledgments.

Keith Harries

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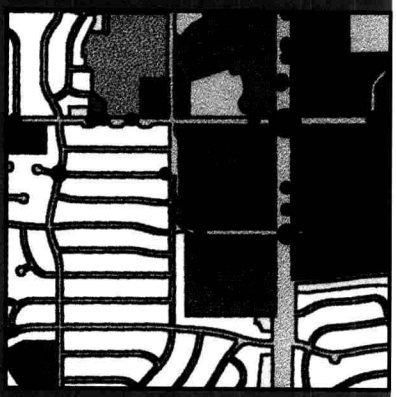
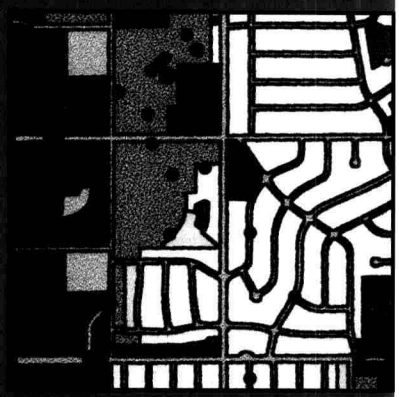
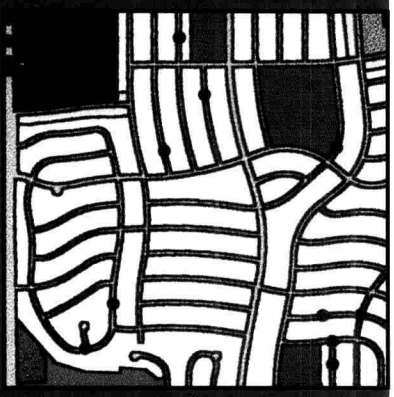


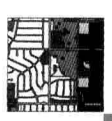
Chapter 1: Context and Concepts



From pins to computers

Crime mapping has long been an integral part of the process known today as *crime analysis*. The New York City Police Department, for example, has traced the use of maps back to at least 1900. The traditional crime map was a jumbo representation of a jurisdiction with pins stuck in it (figure 1.1). The old pin maps were useful for showing where crimes occurred, but they had serious limitations. As they were updated, the prior crime patterns were lost. While raw data could be archived, maps could not, except perhaps by photographing them.[1] The maps were static; they could not be manipulated or queried. For example, it would have been difficult to track a series of robberies that might overlap the duration (a week or month) of a pin map. Also, pin maps could be quite difficult to read when several types of crime, usually represented by pins of different colors, were mixed together. Pin maps occupied considerable wall space; Canter (1997) noted that to make a single wall map of the 610 square miles of Baltimore County, 12 maps had to be joined, covering 70 square feet. Thus pin maps had limited value—they could be used effectively but only for a short time. However, pin maps are sometimes still used today because their large scales allow patterns to be seen over an entire jurisdiction in detail. Today, "virtual" pin maps can be made on the





computer, using pins or other icons as symbols (figure 1.2).

The manual approach of pin mapping gave way during the past decade or so to computer mapping—specifically, *desktop* computer mapping. For decades before desktop computer mapping, the process was carried out on gigantic mainframe computers using an extremely labor-intensive process. First, much labor was involved in describing the boundaries of the map with numbered coordinates on punched cards. Then came the labor of keypunching the cards, followed by a similar process of coding and keypunching to put the data on the map.

Recognizing all the work needed to produce a map on the computer, many potential *cartographers*[2] (mapmakers) concluded that computer mapping was too labor intensive. They were right—it was a "royal pain." It was productive only if many maps were needed (making it worthwhile to prepare the *base map*, or boundary map, of the jurisdiction), and if the personnel necessary to do the data coding and keypunching were available. Few organizations could afford the luxury.

Since the mid-1980s, and particularly since the early 1990s, when computer processing speed increased dramatically, desktop mapping became commonplace

Figure 1.1

Pin maps.

Source: Keith Harries. University of Maryland, Baltimore County, Baltimore, Maryland.

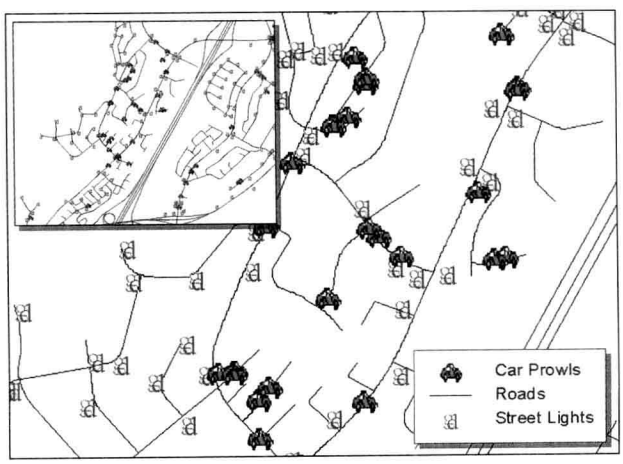


Figure 1.2

A "virtual" pin map.

Source: SanGIS and the San Diego Police Department Crime Analysis Unit.

and fast, aided and abetted by the concurrent availability of cheap color printers. What a partnership! Only a generation earlier, maps on paper (as compared with the pin maps on walls in police departments) had been drawn by hand using india ink[3] and special pens, with templates for lettering. If a mistake was made, the lettering had to be scraped off the paper with a razor blade. If shading was needed, Zipatone® patterns were cut to fit the area and burnished to stick. Those were the days? For character building, perhaps!

What does all this have to do with mapping crime today? A newfound access to desktop mapping means that more individuals than ever before have the task—or opportunity—to produce computer maps. Also the huge demand for maps means that most crime analysts, police officers, and others involved in mapping crime have received no formal training in mapmaking—the science called *cartography*. A body of accepted and useful principles and practices has evolved over the long history of mapmaking. Most cartography texts contain those principles but have no regard for the special needs of the crime analyst, police officer, manager, or community user of crime maps. The goal of this guide, therefore, is to provide a guide to cartography that is adapted to specialized needs and speaks the cartographer's language.

This guide is not intended to stand alone, isolated from evolving developments in crime mapping. Ideally, it should be used in conjunction with other materials and approaches. In 1998, for example, a group working with the support of the Crime Mapping Research Center (CMRC) at the National Institute of Justice developed a national curriculum for crime mapping. Much information contained in this guide can be found fleshed out in the curriculum and other materials disseminated by CMRC. Readers are strongly encouraged to visit the CMRC Web site at *http://www.ojp.usdoj.gov/cmrc*.

Ancient history: Cartography and crime mapping

Conclusive evidence from clay tablets found in Iraq proves that maps have been around for several thousand years—perhaps tens of millennia (Campbell, 1993). Evidently, the need to display geographic data is basic and enduring. Nowhere is the need for maps more compelling than in the field of navigation, whether for an epic around-the-world voyage or for a rookie cop's struggle to find an address in a city map book. Maps for navigation can be matters of life and death, and the inability of early navigators to locate themselves accurately on the

Maps

- Are pictures of information about areas and places.
- Help us *visualize* data.
- Are like the proverbial pictures worth a thousand words.
- Enable information to be seen at a glance.

surface of the Earth have often spelled disaster, as described vividly in Dava Sobel's book *Longitude* (1995).

Fortunately, crime mappers do not have to be concerned about such epic matters. However, mapping crime is a scientific activity—an application of the broader scientific field of cartography, which has undergone a transformation with the advent of geographic information systems (GIS). Many mapmakers now see cartography as a branch of information technology. A decade or so ago, cartography was much broader in scope than GIS with applications in fields as diverse as surveying, navigation of all kinds (including orienteering and highway mapping), geology, space exploration, environmental management, tourism, and urban planning. Today, however, the convergence of cartography and GIS is nearly complete. Both are tools in a broad range of applications, reflecting the most important use of maps—to communicate information.

Crime mapping, as noted at the beginning of this chapter, has quite a long history. Phillips (1972) pointed out that "hundreds of spatially oriented studies of crime and delinquency have been written by sociologists and criminologists since about 1830. . ." and recognized three major schools:

- The **cartographic** or **geographic** school dominated between 1830 and 1880, starting in France and spreading to England. This work was based on social data, which governments were beginning to gather. Findings tended to center on the influence of variables such as wealth and population density on levels of crime.
- The **typological** school dominated between the cartographic period and the ecological period that would follow in the 20th century. The typologists focused on the relationship between the mental and physical characteristics of people and crime.
- The **social ecology** school concentrated on geographic variations in social conditions under the assumption that they were related to patterns of crime.

The social ecologists recognized and classified areas in cities with similar social characteristics. Shaw and McKay (1942) produced a classic analysis on juvenile delinquency in Chicago. This work is generally recognized as the landmark piece of research involving crime mapping in the first half of the 20th century. Shaw and McKay mapped thousands of incidents of juvenile delinquency and analyzed relationships between delinquency and various social conditions. Work by the "Chicago school" of researchers also delineated an urban model based on concentric zones, the first attempt to develop a theory to explain the layout of cities (Burgess, 1925). Other significant contributors to the ecological school included Lander (1954), Lottier (1938), and Boggs (1966).

Most likely, the first use of computerized crime mapping in applied crime analysis occurred in the mid-1960s in St. Louis (McEwen and Research Management Associates, Inc., 1966; Pauly, McEwen, and Finch, 1967; Carnaghi and McEwen, 1970; for more discussion, see chapter 4). Ironically, professional geographers were late getting into the act. Early contributions came from Lloyd Haring (who organized a seminar on the geography

of crime at Arizona State University around 1970), David Herbert in the United Kingdom, Harries (1971, 1973, 1974), Phillips (1972), Pyle et al. (1974), Lee and Egan (1972), Rengert (1975), Capone and Nichols (1976), and others. Among the most remarkable (and little known) pieces of research emphasizing crime mapping were Schmid and Schmid's *Crime in the State of Washington* (1972) and Frisbie et al.'s *Crime in Minneapolis: Proposals for Prevention* (1997) (figures 1.3 and 1.4). The latter, in particular, was notable for bridging the gap between academic crime mapping and analysis/applications specifically aimed at crime prevention. Early computer mapping efforts used line printers as their display devices, so their resolution was limited to the physical size of the print characters. This precluded the use of computer maps for the representation of point data, at least until plotters that were able to draw finer lines and point symbols came into more general use. (For an excellent review of early map applications in crime prevention, see Weisburd and McEwen, 1997, pp. 1–26.)

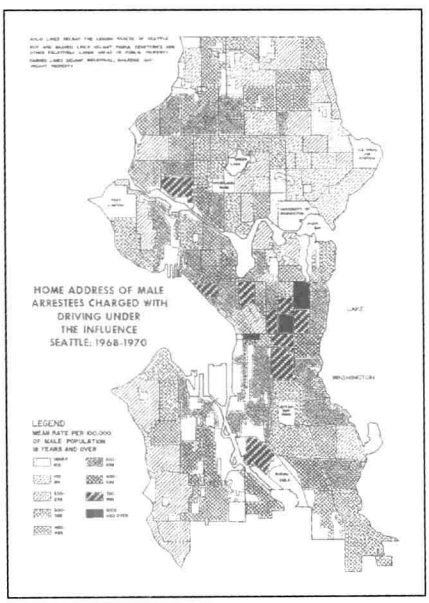


Figure 1.3

A map showing home addresses of male arrestees charged with driving under the influence, Seattle, Washington. 1968–70.

Source: Schmid and Schmid, 1972, figure 7.14, p. 311.

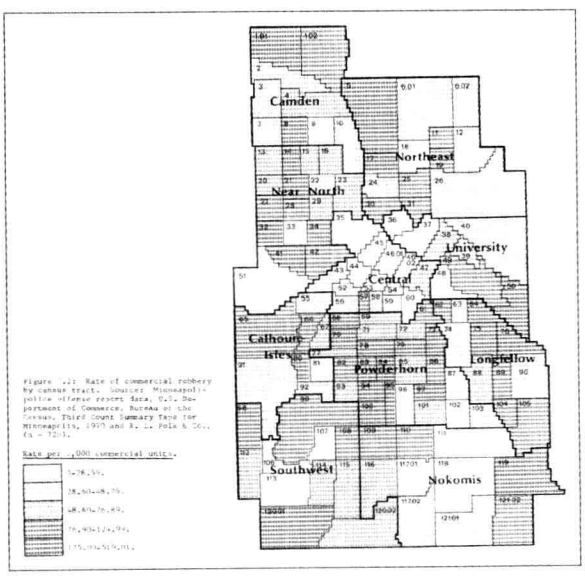


Figure 1.4

A map showing the rate of commercial robbery by census tract, Minneapolis, Minnesota. Line printer technology.

Source: Frisbie et al., 1977, figure 7.2, p. 122.

Even as late as 1980, the breakthrough into widespread GIS-style crime mapping was about a decade away. It was necessary to wait for improvements in desktop computer capacity, printer enhancements, and price reductions before desktop mapping could become an everyday, broadly accepted phenomenon.

To illustrate how matters have improved, a snippet of personal history is offered. In April 1984, the author bought his first personal computer, a Kaypro 10 manufactured by Digital Research, Inc. This wonder ran at 4 megahertz and had 64 kilobytes of random access memory (RAM) and a 10-megabyte hard drive. ("How could you ever use all that storage?" friends asked.) It also had a tiny monochrome display and ran on the CP/M operating system, the precursor of Microsoft DOS. And all this for the rock-bottom price of $2,795 in 1984 dollars. The Silver Reed daisy wheel printer purchased to complement the computer was $895 (extra daisy wheels were $22.50 each, tractor feed for paper was $160), and the 300k-baud rate modem was $535. After adding a few other knick-knacks, getting started in personal computing cost almost $5,000 (again, in 1984 dollars).

By comparison, the typical RAM in 1999 is perhaps 1,000 times larger (64 megabytes), the processor speed is 100 times faster (at least 400 megahertz), and hard drives routinely are 100 times bigger (10 gigabytes), all at a lower price. It was this type of computing environment that would facilitate the entry of GIS into law enforcement (and elsewhere) and permit cartographic principles and practices to be used on a day-to-day basis. Mapping crime has come into its own primarily because of advances in computing that, in turn, have facilitated GIS applications. Apart from all the obvious advantages, a major benefit is that computer mapping allows free rein to experiment, a luxury denied in the old days of manual mapping. Are you wondering what a certain map design would look like? Try it out. You don't like it? Start over and have a new map in minutes.

Mapping as a special case of data visualization

Desktop computing has put graphic tools within the reach of virtually everyone. Preparing a publication-quality graphic, statistical or otherwise, was an arduous process a generation ago. Today it is much easier, although the process still demands considerable care and effort. This new ease and flexibility have broadened our perspective on graphics as tools for the visualization of information. This has happened because people no longer have to devote themselves to one specialized, time-consuming methodology, such as cartography. Now, maps can be produced more easily, and the computer has in effect freed people to produce *other* kinds of graphics as needed, such as bar charts, scatter diagrams, and pie charts.

The downside to such ease of production is that it is just as easy to produce trash as it is to create technical and artistic perfection. Famous graphics authority Tufte (1983, chapter 5) referred to what he called "non-data-ink," "redundant-

data-ink," and "graphical paraphernalia"—all summed up by the term "chartjunk," a concept equally applicable to maps and charts. An exemplary map, according to Tufte, was prepared by Joseph Minard in 1861 to depict the decline of Napoleon's army in Russia in 1812–13 (figure 1.5). Tufte noted that "it may well be the best statistical graphic ever drawn" (Tufte, 1983, p. 40). What makes it so good is that it shows six variables with extraordinary clarity and without the use of color variation. The width of the bands is proportional to the number of troops, starting with 424,000, which was reduced to 100,000 by the time they reached Moscow. The map shows attrition on the return trip (with vertical rays expressing temperatures on selected dates) that left only 10,000 men still alive when the army returned to the starting point. The fact that the map illustrates the devastating loss of life further adds to its drama.

Today's simplified graphics-producing environment helps put maps in perspective. Maps are but one way of representing information, and they are not always the most appropriate mode. If information about places is being represented, maps may be the best format. However, if no geographic (place-to-place) information is present, such as when all the data for a city are combined into one table, there is nothing to map. The whole jurisdiction is represented by one number (or several numbers, each representing the city as a whole), so the map, too, could portray only one number. In this situation, a bar chart simply showing the relative levels of each crime category would be the best choice.

What does it mean to say that maps are a form of visualization? Simply that a map is data in a form that we can see all at once. Books or tabulations of data are also visualizations in the sense that we assimilate them visually, but they are labor-intensive visualizations. Maps and other graphics are essentially pictures of information, those proverbial pictures "worth a thousand words." If they are well done, they convey their message more or less at a glance.

Mapping as art and science

Like other forms of visualization, maps are the outcome of scientific activity: hypothesis formulation, data gathering,

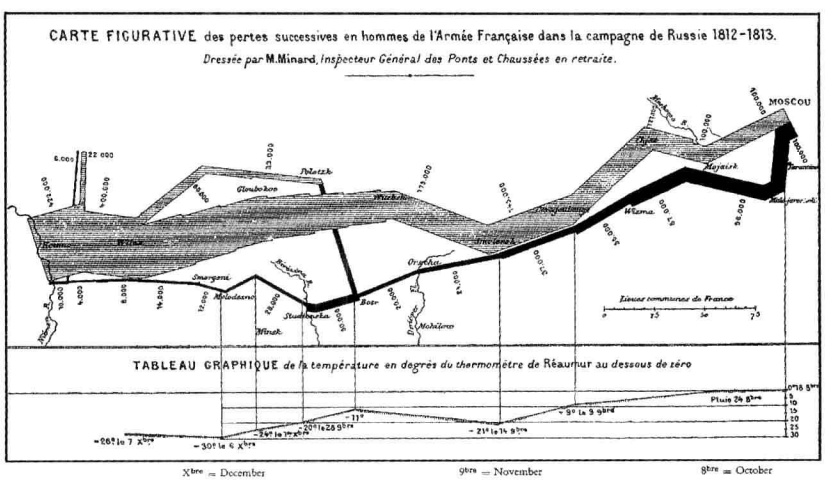


Figure 1.5

Minard's 1861 map of Napoleon's advance to and retreat from Moscow.

Source: Tufte, 1983, p. 41. Reproduced by permission.