

Lesson 1: About Crime Mapping & Analysis

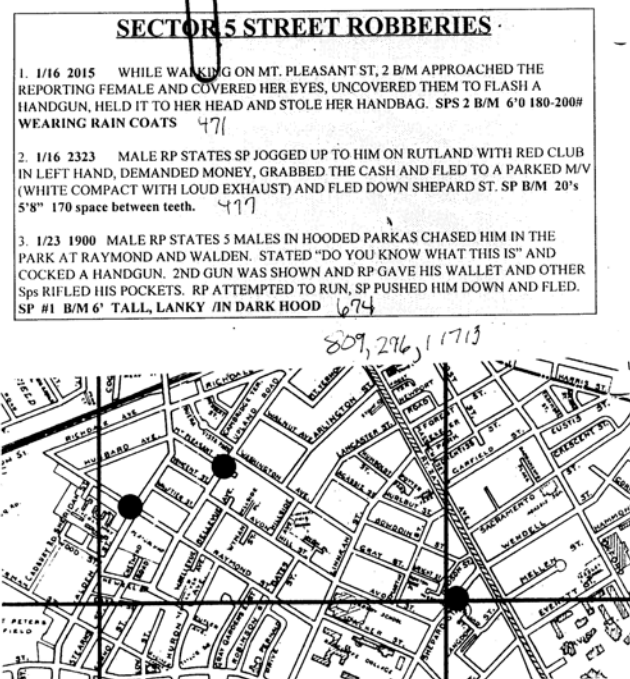
Crime mapping describes the use of geographic information to identify and analyze crime and police data. Before the 1990s, “crime mapping” referred to any method of geographic analysis, even those that involved pushpins, colored dots, and paper maps. Now, however, “crime mapping” usually means the specific use of computerized geographic information systems (GIS).

Crime mapping seeks to answer the questions of “where,” much as temporal analysis answers the question of “when” and cause analysis answers the question of “why.” Crime maps are both 1) analytical tools, allowing the analyst to ask questions about spatial patterns and relationships, and 2) products, allowing the analyst to display information to his or her audience. In the current state of the profession, crime maps are probably overused as products and underused as tools of analysis.

History

Until recently, crime mapping was an exhausting process, requiring analysts to push pins into paper wall maps in order to track and identify clusters. Multiple data sets required multiple maps and multiple sets of pins. Changing any one of several parameters, such as crime type or time period, meant many hours of removing some pins and adding others. Buffers were drawn with compasses, distances measured with rulers, and linear maps created with string tied from one pin to another. More than one “layer” required plastic transparencies. Reproduction, except for small maps, was all but impossible.

This sad state of affairs changed in the 1990s with the widespread availability of both personal computers and affordable GIS programs. Today, an analyst can create hundreds of maps, in much greater detail and analytical depth, in the same time that it used to take to create one.

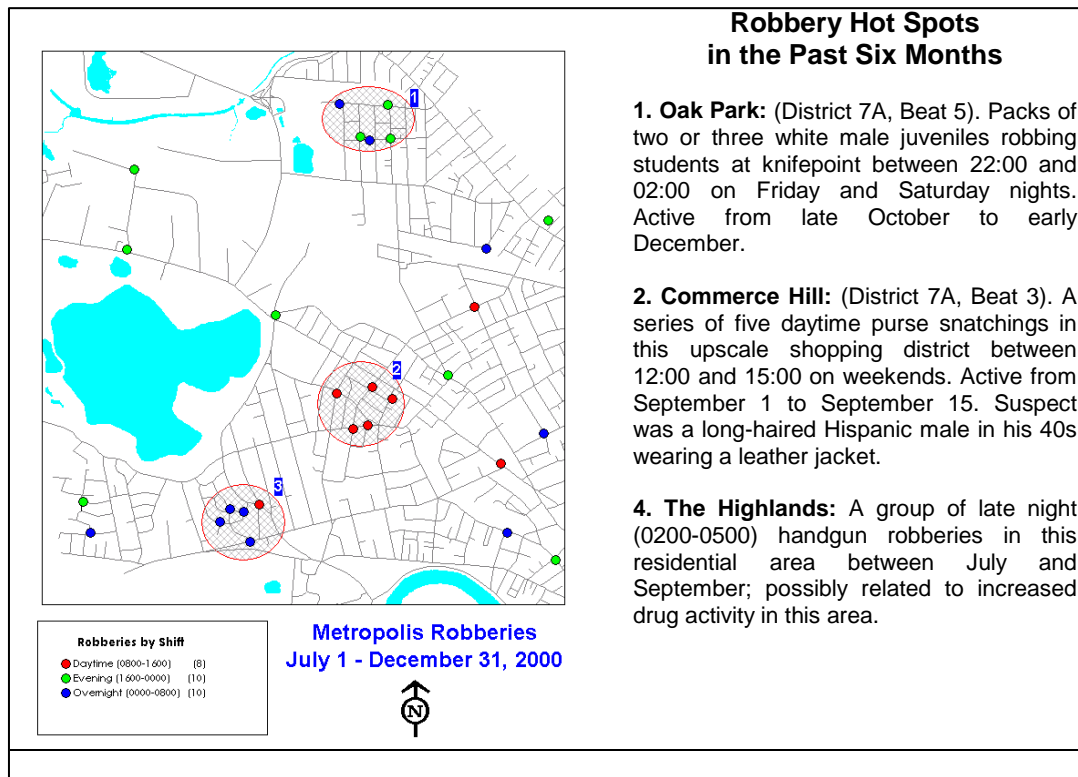


A 1980s-era crime bulletin from the Cambridge (MA) Police Department. The bulletin was created by putting black dots on a paper map and physically “cutting” a section of the map and “pasting” it (with actual paste) on a bulletin template.

Functions

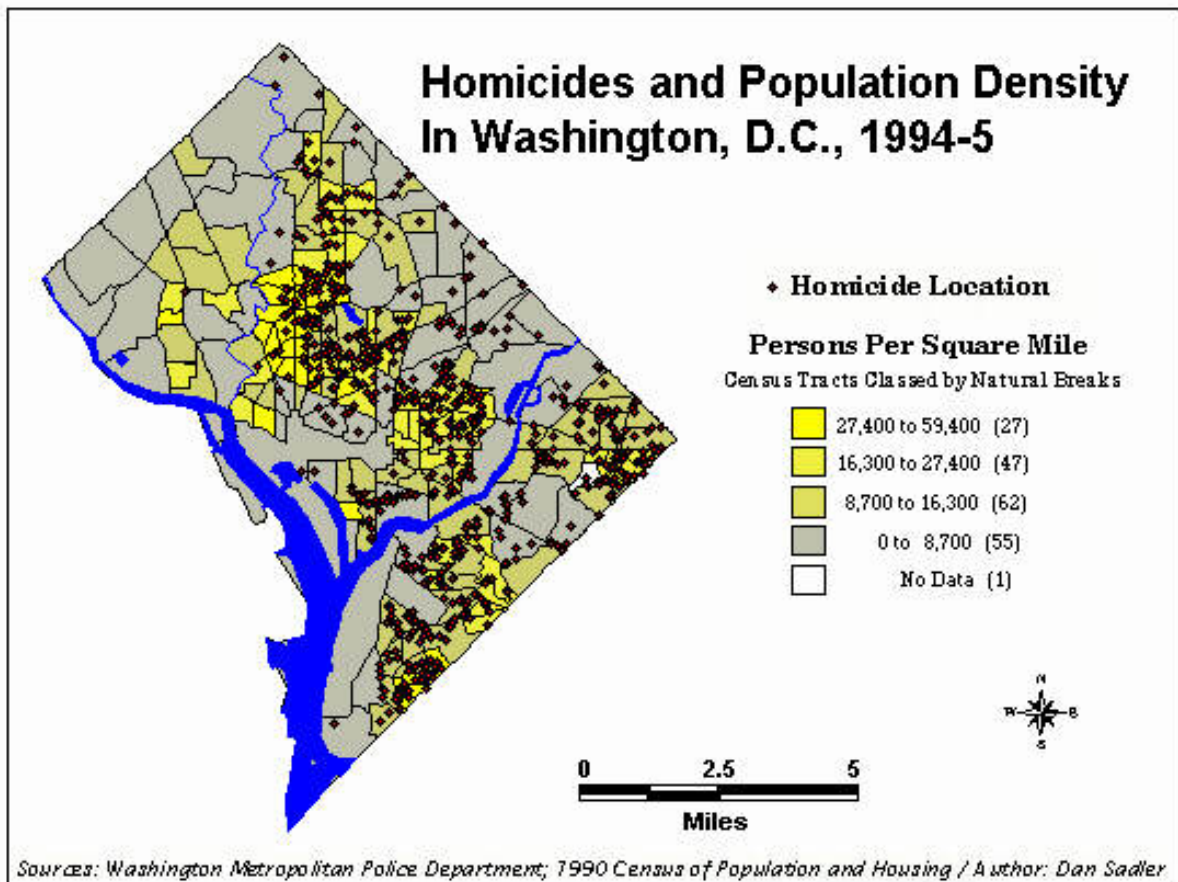
Crime mapping has a number of functions and uses, which we attempt to itemize here:

1. *To identify patterns and trends.* An analyst might display a map of burglaries over the past month, seeking to identify geographic clusters, linear patterns, or other geographic patterns that would indicate the existence of a current crime pattern or series. Similarly, he might show burglaries over the course of a year to identify geographic trends.
2. *To serve as a visual aid for information about patterns and trends.* An analyst describing a crime pattern or trend can only convey so much with phrases like, “robbery in our city is concentrated in the southeast part of town,” and “the pattern is active in the area bordered by First Street, Broadway, Fifth Street, and Park Avenue.” Even assuming that readers have a good enough grasp of geography to visualize these areas, a map provides this information in a clearer way. It may not be worth a thousand words, but it’s at least worth a dozen.



3. *To identify correlations between two or more geographic variables.* Do you want to try to understand why robberies occur where they do? Try displaying robberies on the same map as public transportation routes. No luck? Match robberies with public housing locations. Still no correlation? Try gang territories, poverty rates, locations of homeless

shelters, liquor stores, bars, street lights, police foot patrols, and owner-occupied housing. Are you trying to identify possible suspects in a recent robbery series? Display a map of known offenders' home addresses, work addresses, commuting paths, and known hangouts against the robbery series. Any two geographic data sets can be juxtaposed on the same map to seek either direct or inverse correlations. You may find these correlations by simply "eyeballing" the map, or you may use the GIS system to generate a precise mathematical correlation.

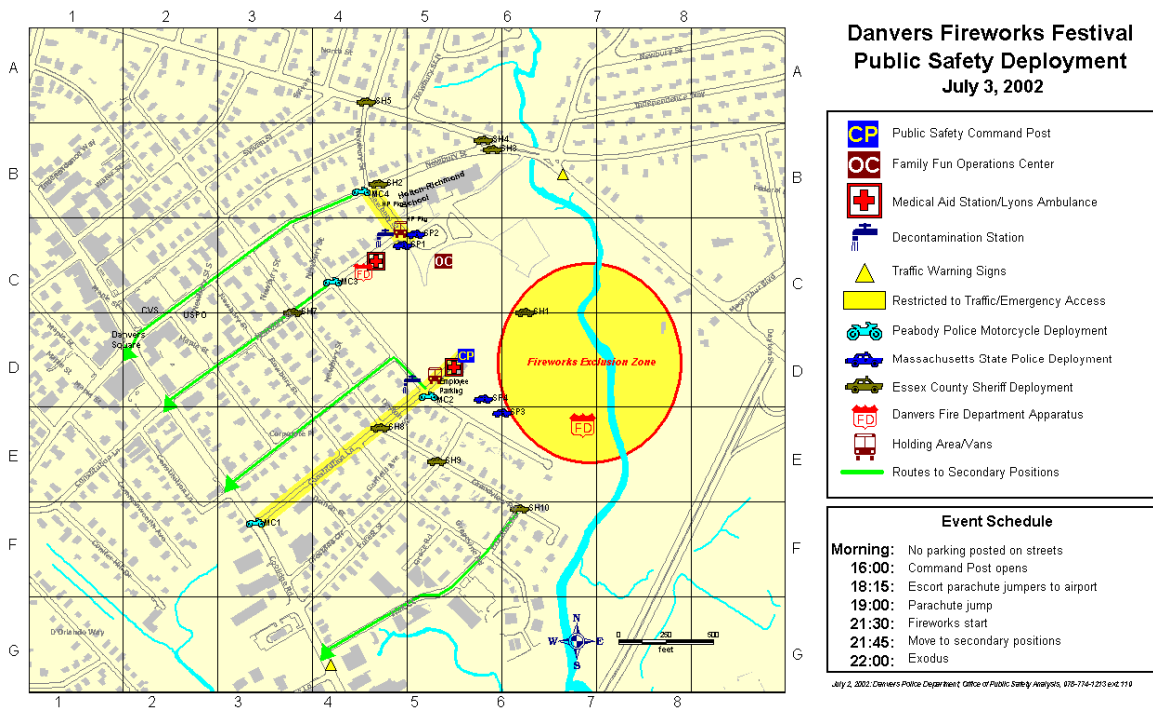


4. *To show the relationship between geography and other factors.* Certain maps, such as **point symbol maps**, can show not only geographic patterns, but also sub-patterns based on time, crime type, or other factors.
5. *To analyze spatial tendency.* Is the offender in a crime series centering his activities in a particular area? Is he progressing in a linear pattern? Is he moving in an identifiable way from one place to another? Is he spelling his name across the city?
6. *To query data by location.* Regular databases make it simple to query data by crime type, date, time, specific address, offender description, victim description, and so on. But only GIS systems make it simple (and, in most cases, feasible) to specify a geographic area

and “collect” all of the incidents within it. Crime mapping makes it possible, for instance, to find all crimes within a certain radius of liquor stores, or to identify all registered sex offenders living within a mile radius of a school, or to simply draw a random polygon and select everything within it. (The first two cases are examples of **buffering**.)

7. *To district.* Intelligent **districting** requires careful consideration of geographic and environmental factors and the ability to gather data about current or proposed districts. GIS systems can quickly calculate incident volume, geographic area, road network distance, response times, and other factors crucial to the districting process. Moreover, analysts using crime mapping for districting can quickly view multiple data sets to consider their effects on a district.

8. *To make maps.* Police department sometimes simply need maps: a citywide map to hang on the wall of the chief’s office, a beat boundary map for new officers, a route map for deployment during a special event, or a map of local shelters and services to hand out to the community. The analyst, knowing the GIS system best, will probably be asked to produce most of these maps.



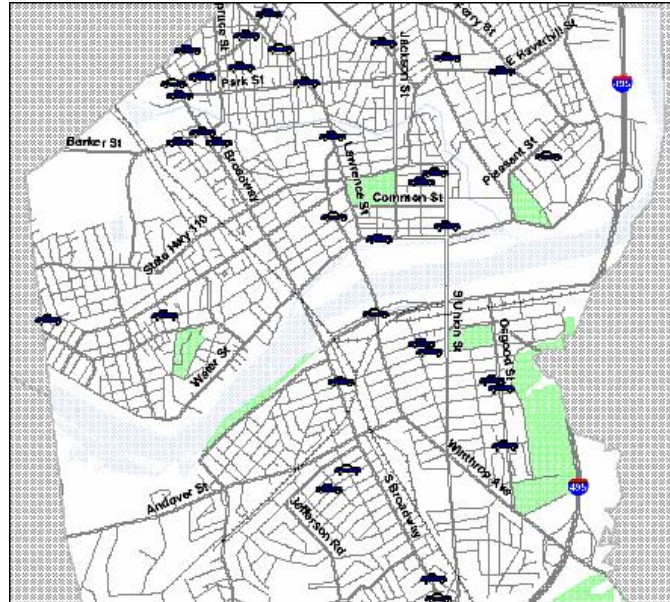
Types of Crime Maps

Pin maps (also known as spot maps) are the foundation for most other types of crime maps. They consist simply of mapped locations (for incidents, persons, or other geographic data) marked with a single symbol, such as a dot or star. A simple pin map might suffice to show the locations of incidents in a crime series, or residences of offenders near a school. But high-volume data sets usually require one of the **thematic map** (maps with a theme, or that tell a story) types listed below.

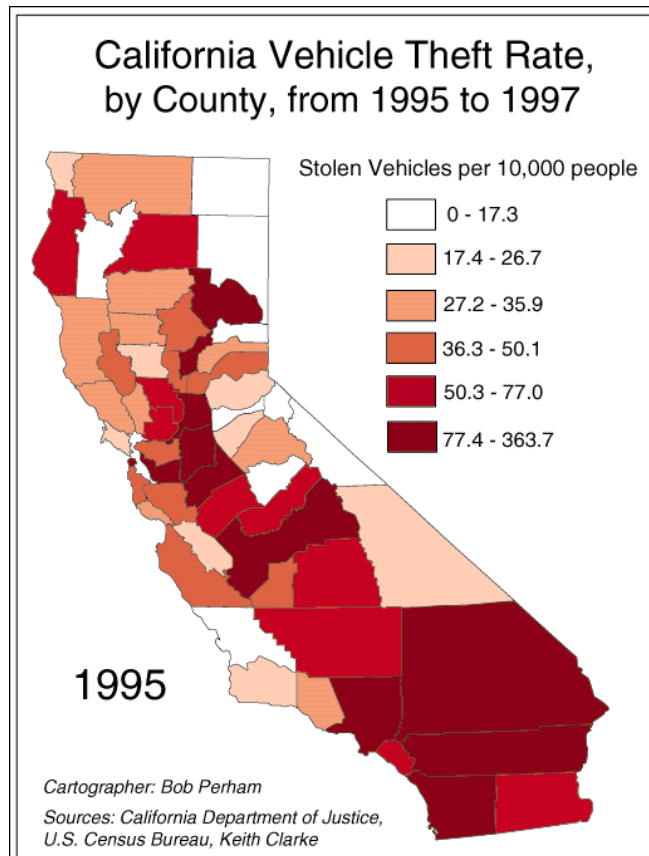
Choropleth maps aggregate information into larger geographic areas, such as census block groups, grid cells, or reporting districts. These geographic areas are color-coded or patterned to reflect either volume (e.g., red areas have a high crime volume, blue areas are a low crime volume), or some other quantitative measure, such as the value of property stolen or average income of residents.

Point symbol maps start with a pin map, but change the symbol or color to represent other factors within the data. A map of incidents in the past week in one neighborhood might use a “gun” symbol to identify robberies, a “fist” symbol to identify assaults, and so on. These symbols might be colored so that yellow symbols show daytime incidents and blue symbols show nighttime incidents.

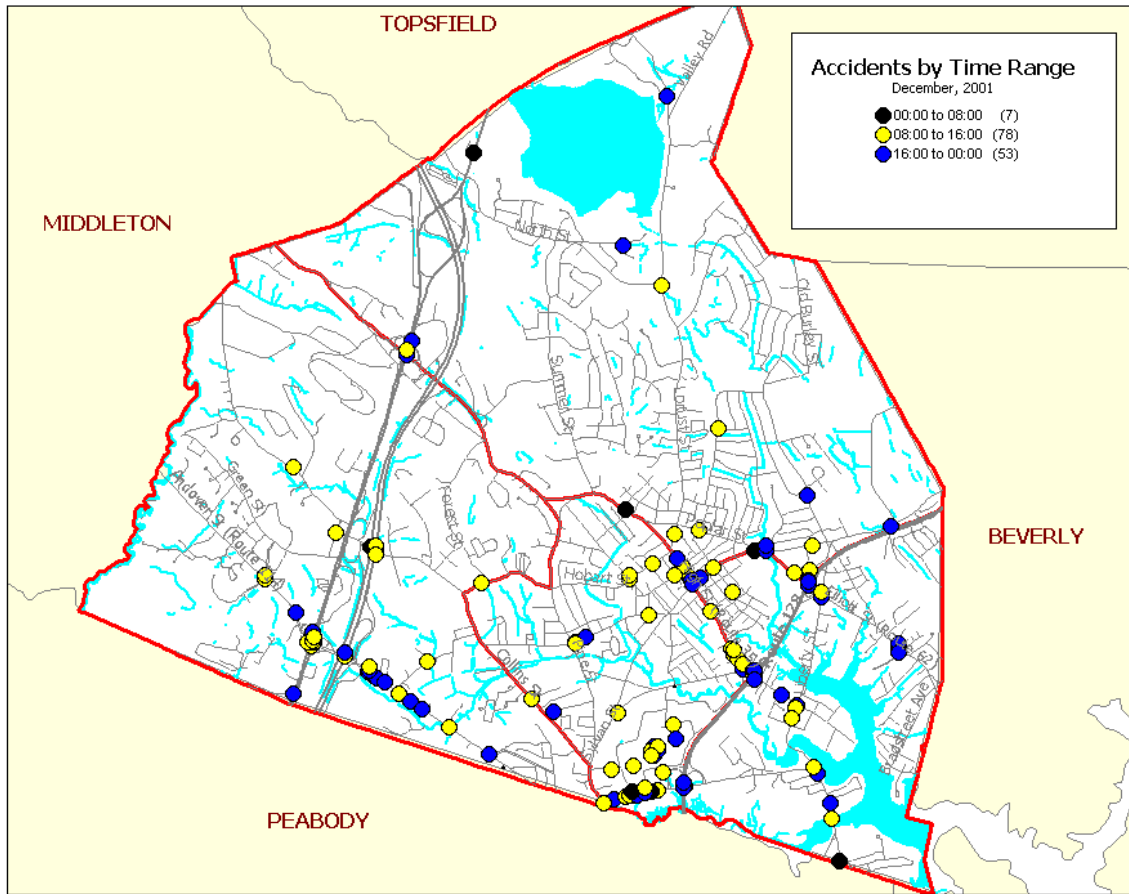
Graduated symbol maps (called proportional symbol maps in other programs) expand upon pin maps by showing bigger pins at locations with greater volume. This solves some problems inherent in pin maps.



A pin map of auto thefts in Lawrence, Massachusetts, August 2004



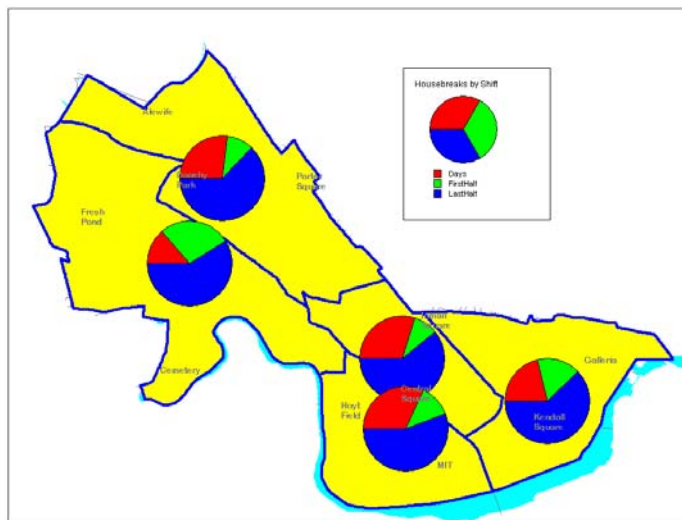
A choropleth map of vehicles stolen per capita in California counties, 1995



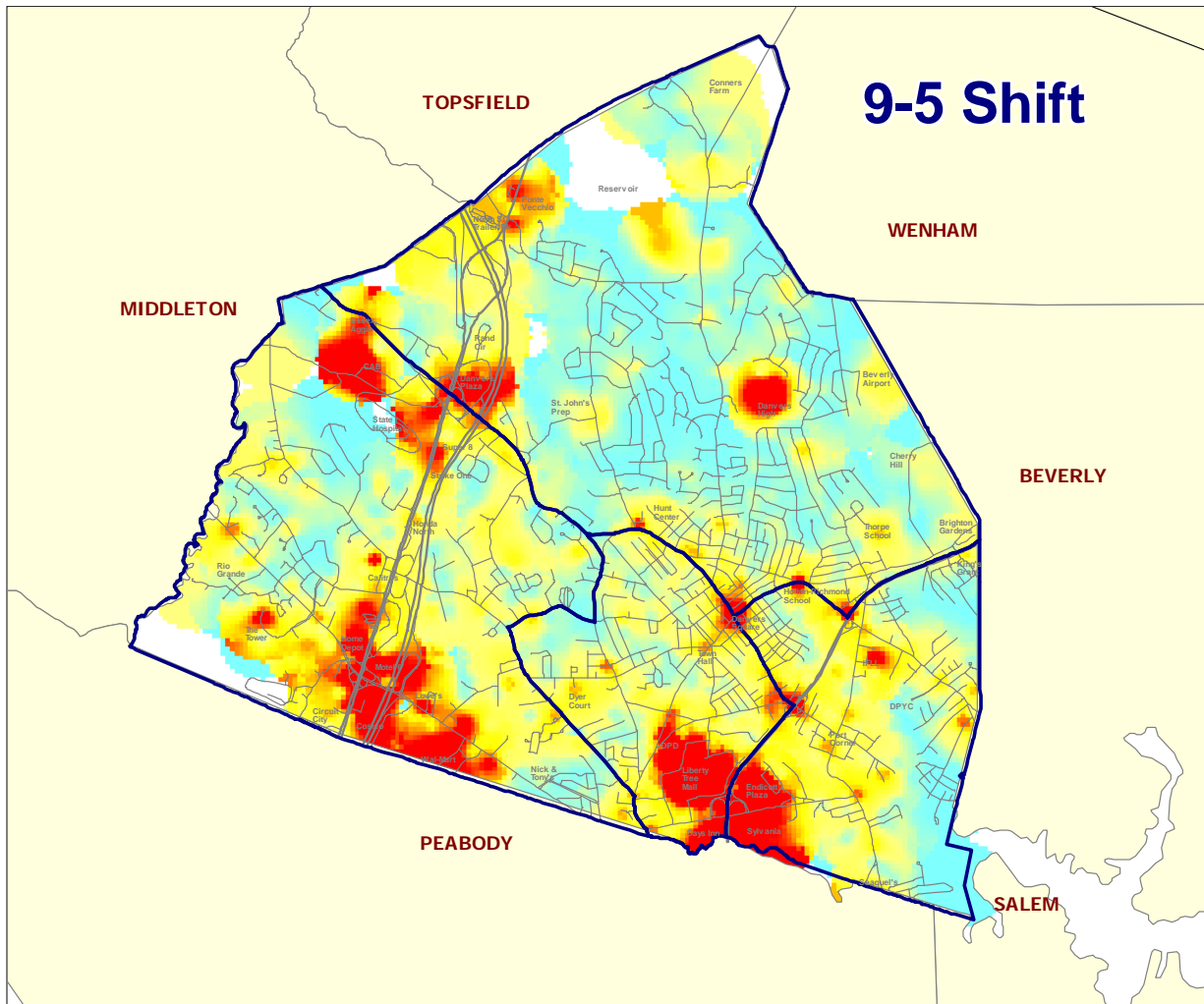
A point symbol map of accidents in Danvers in December 2001

Statistical maps superimpose charts and graphs over geographic areas to show more complex quantitative information than can be achieved with a choropleth map.

Surface density maps (also called continuous surface maps, or isopleth maps) accomplish a similar goal as choropleth maps, but with the definite (and sometimes arbitrary) boundaries on which choropleth maps rely. At the same time, though, they interpolate measurements in between areas of known value, so they must be used with care.



A statistical map showing the percentage of housebreaks on each shift for each sector in Cambridge, MA



A surface density map depicting hot spots for calls for service on the 9-to-5 Shift in Danvers, MA

GIS systems can combine multiple types of maps in the same display, making it possible, for instance, to juxtapose a surface density map of poverty levels with a graduated symbol map of domestic violence.

Tools

Most crime analysts create crime maps with one of two products: ArcView by ESRI or MapInfo Professional by the MapInfo Corporation. Of the two, ArcView (which is one of several pieces of software in ESRI's ArcGIS suite) is more widely used among law enforcement. MapInfo users profess that MapInfo is easier to use and more compatible with other Windows products; the advantages of ArcView include more availability of training, support, and customized scripts. More city and town GIS departments use ESRI software than MapInfo, but MapInfo allows quick and painless translation from other GIS formats through its Universal Translator tool.

These comparative advantages and disadvantages will change with each new release of either product.

No analyst will be crippled by his or her choice of GIS software: each product can perform similar tasks and uses similar concepts. Each product markets for a similar price (though it must be said that MapInfo contains more initial features than ArcView). Each product will also create all of the map types listed above, though some extensions may be required. Each product also allows users to write their own scripts: MapInfo features a scripting language called MapBasic, and ESRI allows users to write scripts in Avenue (in ArcView versions up to 3.3) or Visual Basic (in version 8.0 and later).

Other companies have written elaborate programs, specifically for crime mapping, that work with the MapInfo and ArcGIS engines. These programs, which cost up to \$20,000, make it easier for police personnel to create crime maps without knowledge of the underlying GIS software. Examples are the Omega Group's CrimeView (which uses ArcGIS) and Charles River Technologies' (now QED's) CrimeInfo (which uses MapInfo). Analysts, who should know how to use the GIS software, should not learn to rely on these custom programs.

Data Sources

In crime mapping, analysts are concerned with two primary sets of data: **base map** data and police records data. Base map data includes street networks, buildings, waterways, parks, railroads, and other layers that form the basic geography of the analysts' jurisdictions. Police records data contain records of crimes, disorder, calls for service, police activity, and offenders and victims. Both must be merged within the GIS program to perform "crime mapping."

Base map data can be obtained from several sources, including:

- 1) The United States Census Bureau's TIGER files
- 2) Private companies
- 3) Digitized aerial photography
- 4) Analyst-created

A much more difficult problem for analysts is often getting data out of their records management systems. Older systems may offer no obvious export function and may store data in databases inaccessible through ODBC. But for analysts with newer systems, MapInfo (and ArcView) can link to ODBC data sources.

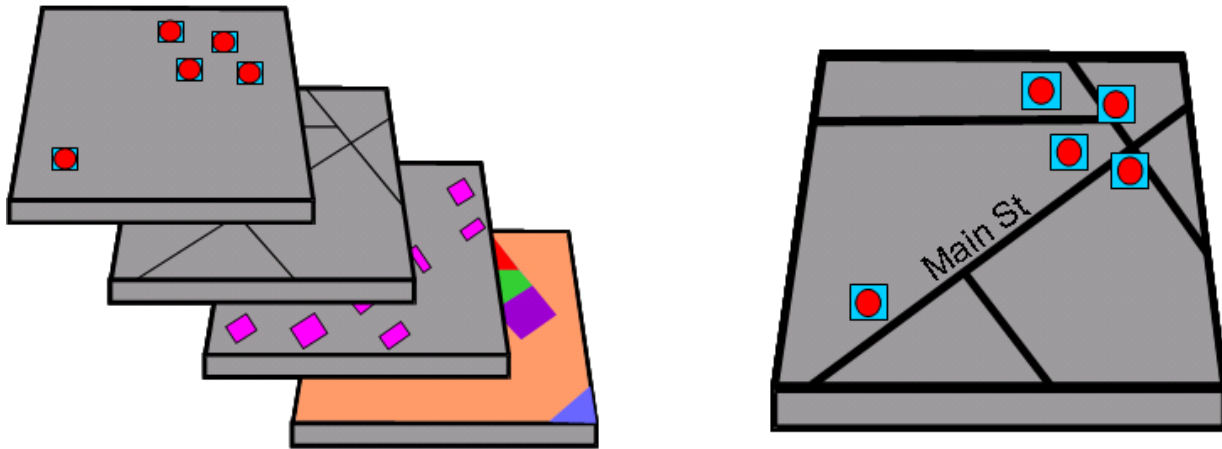
There are two basic types of map data:

1. **Raster data**—pictures or images, with data stored in pixels, such as an aerial photograph of the city. The picture may be given geographic coordinates so that other types of data

can be mapped on top of it, but there will be no underlying tabular data associated with each feature.

2. **Vector data**—data stored as one or more pairs of coordinates. The GIS program creates lines and polygons by essentially “connecting the dots” (all behind the scenes). Most data used in crime mapping is vector data. Vector data can take three forms:
 - a. **Points** or symbols, to show crimes, trees, fire hydrants, and other fixed objects and locations
 - b. **Lines**, to show streets, rivers, railroads, and other linear objects
 - c. **Polygons** or areas, to show parks, lakes, buildings, police beats, and other areas

Each map **layer** generally contains only one type of data (though MapInfo does not restrict you from putting more than one in a layer). The layers are then overlaid on top of each other, like transparent sheets, to achieve the illusion of a single unified map.



Some Important Cartographic Information

Map purists insist that every map must contain five elements:

1. A title
2. A legend
3. A scale bar
4. A north arrow
5. Information about the data sources and who created it

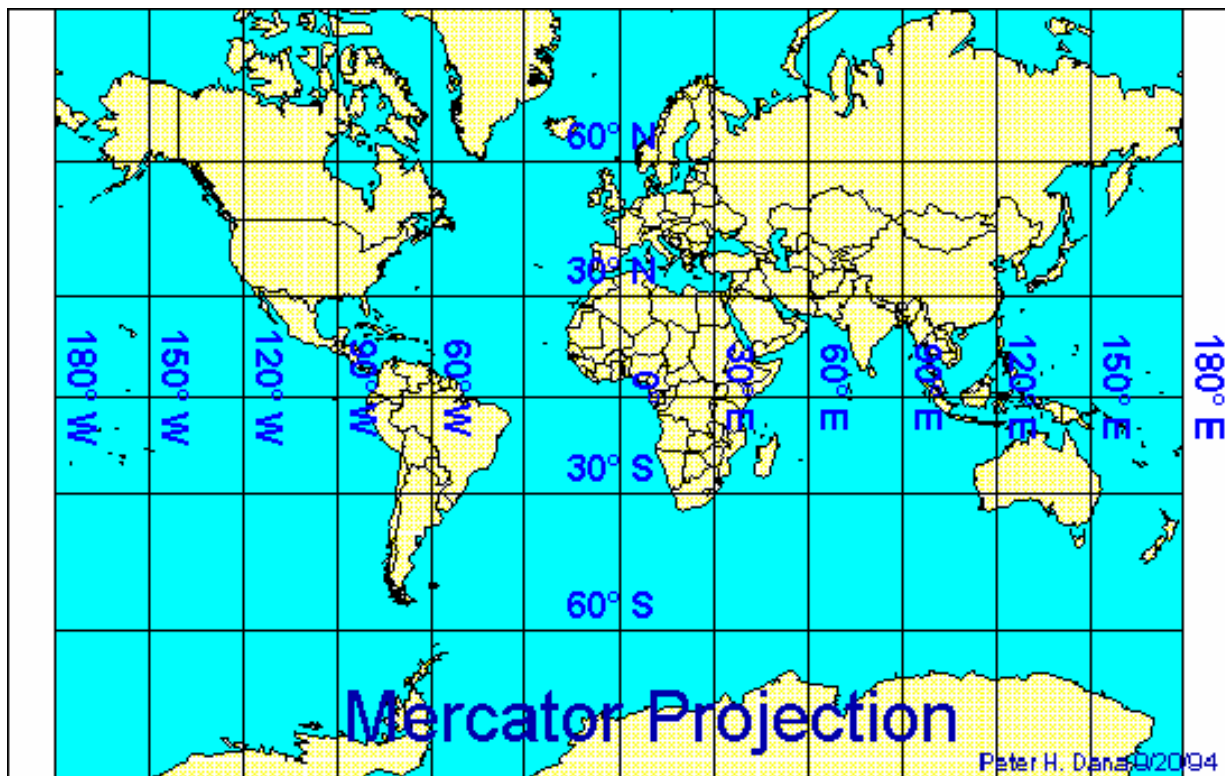
Depending on the nature of the map and the audience, however, some of these elements may be eliminated. You should always have a title.

No flat map can perfectly depict the surface of the Earth. Some type of **projection** system is required to turn the curved surface into a flat map. All projections distort geography to some degree, but geographers use the projection scheme that makes the most sense for whatever area is to be mapped. Crime analysts typically do not have to worry about projection, since they're working with small geographic areas in which the amount of distortion is minimal. However, analysts will frequently try to merge data from two sources, or convert data from one format to another, at which point knowing the projection may be important.

Any space on the Earth can be identified by its **coordinates**. A **Cartesian coordinate system** describes a pair of axes that intersect at any location and extend in all directions indefinitely. The horizontal axis is known as the "X" axis, and the vertical axis is known as the "Y" axis. Points are located by first giving the location along the X-axis and then the Y-axis (e.g., 142, 38). More useful coordinate systems for mapping include:

- Longitude and Latitude
- Universal Transverse Mercator (UTM)
- U.S. State Plane

Again, analysts rarely have to deal with coordinate systems but they may become important when merging or converting data.



About MapInfo Professional

MapInfo Professional is the flagship product of the MapInfo Corporation of Troy, New York. It is the second most widely-used software for crime mapping in the United States. In Australia and the United Kingdom, it seems to enjoy a larger market share among police departments than ESRI, though we haven't been able to compile exact statistics.

MapInfo Professional 8.0 is a Windows-compliant application designed to take advantage of all the functionality of the Windows operating system. Its files are recognized by Microsoft's Object Linking and Embedding (OLE) protocols.

Most of what you need to accomplish with crime mapping is found within the MapInfo application, without need for add-ons or extensions. The last section of this manual discusses some of MapInfo's other products.

