INTRODUCTION: CRIME MAPPING AND CRIME PREVENTION

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Abstract: *Crime maps have only recently begun to emerge as a significant tool in crime and justice. Until a decade ago, few criminal justice agencies had any capability for creating crime maps, and few investigators had the resources or patience to examine the spatial distribution of crime. Today, however, crime mapping is experiencing what might be termed an explosion of interest among both scholars and practitioners. This introduction begins by examining some early examples of mapping of crime, focusing in particular on factors that inhibited the widespread integration of mapping into crime prevention research and practice in the past. It then turns to innovations in mapping technologies and crime prevention theory that have recently brought crime mapping to the center of trends in crime prevention. The final section introduces the contributions that follow and discusses how they illustrate the many uses of mapping in crime prevention. It examines the pitfalls and problems that researchers and practitioners are likely to encounter in developing and analyzing maps, and the potential advances in crime mapping we might expect in coming decades.*

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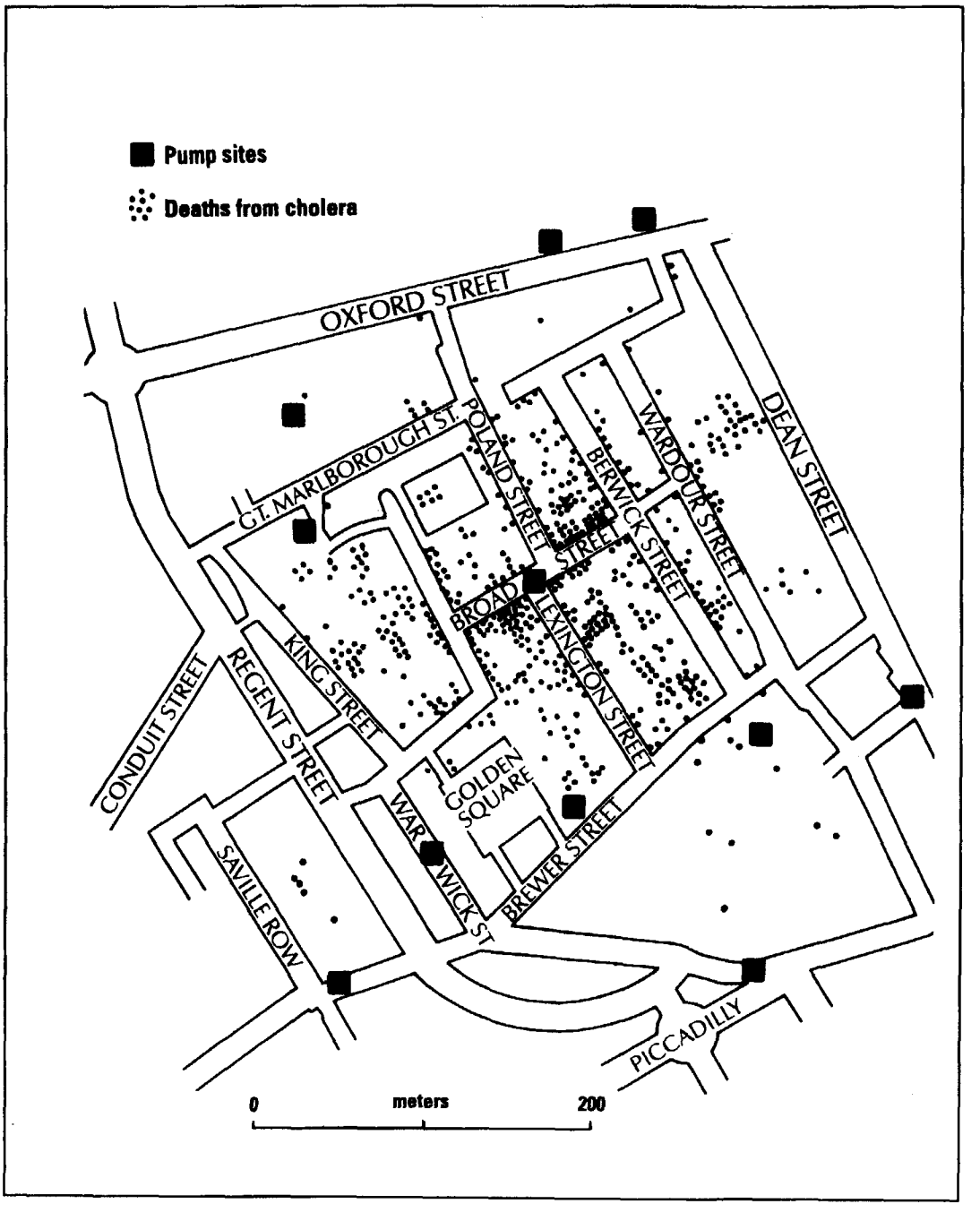
Figure 1: Map of Cholera Deaths and Locations of Water Pumps



In London in the nineteenth century, cholera was a fearful disease that raged in epidemic proportions and left death and suffering in its wake. The disease seemed to be concentrated in specific neighborhoods. In one epidemic, a physician decided to identify with precision where in the city the deadly disease left its mark, with the hope of finding some pattern to its destruction. Dr. Snow plotted the location of deaths from cholera on a map of central London in September 1854 (see Figure 1). Drawing from a theory that contaminated water causes cholera, he also marked the locations of the area's 11 water pumps. He analyzed the scatter of dots on the map and noticed that they concentrated near the pump on Broad Street. While Dr. Snow suspected the water pump was the problem, he was not entirely certain because one rectangular area near the pump showed no deaths and an area near another pump indicated a second, smaller concentration of deaths. After further inspection, he found that the rectangular space was a brewery where employees did not drink water because they were provided with free beer. Investigation of the other area determined that residents had friends and relatives near the Broad Street pump, and when visiting they often took jugs with them to fill up because the water there seemed to taste better than that from their local pump. Dr. Snow had the handle of the Broad Street pump removed, and the cholera epidemic came to an abrupt halt after having taken more than 500 lives.

Dr. Snow's efforts provide a dramatic example of the use of mapping for informing public policy. But maps themselves have a long history as a basic form of human communication. They have been used to navigate streets and oceans, to portray trends in weather or population, to illustrate political divisions or military strategies, to define boundaries or to reinforce them. For example, a Tahitian native communicated his knowledge of South Pacific geography to Captain Cook by drawing a map, thereby illustrating that the islanders were quite familiar with the idea of mapping. Real estate maps dating to 2000 B.C. found in Mesopotamia and Egypt illustrate the fact that maps are as old as human civilization.

In fiction, detectives often look to maps to untangle complex clues or to bring together seemingly disparate events. A serial murderer may be caught in part because of the clustering of kidnappings in particular types of places. The mystery of the whereabouts of booty from a bank robbery, hidden for half a century, may be unraveled by plotting the locations of cemeteries that lie close enough for a stash to be made before the criminals were caught (Grafton, 1995). Based on what we see in movies and on television, we might expect to see the

operations room of a police department laced with colored pins maps. But in practice, crime maps have only recently begun to emerge as a significant tool in crime and justice. Until a decade ago, few criminal justice agencies had any capability for creating crime maps, and few investigators had the resources or patience to examine the spatial distribution of crime. Today, however, crime mapping is experiencing what might be termed an explosion of interest among both scholars and practitioners (see, e.g., Block and Dabdoub, 1993; Eck and Weisburd, 1995; Harries, 1990). Crime mapping has suddenly emerged as a major tool in crime prevention.

In developing this volume, we sought to bring together scholars, crime analysts, and practitioners on the cutting edge of both research and practice in mapping crime. At a time when new mapping technologies are just beginning to be integrated into crime prevention, we wanted to provide examples of how maps could be used in developing policy and theory, and to illustrate the prospects and problems that crime mapping presents. Our volume includes contributions that examine mapping in real life criminal justice contexts, as well as examples of new technologies and future trends that have yet to be implemented in practice. We are concerned with crime prevention theory and crime mapping technologies. Our choice of such a wide range of topics is not accidental: successful mapping of crime demands an integration of theory and data, as well as a practical understanding of the real life context of crime and justice.

In introducing our volume, we think it important to provide historical perspective to the development of crime mapping in crime prevention. We begin by examining some early examples of mapping of crime, focusing in particular on factors that have inhibited the widespread integration of mapping into crime prevention research and practice. We then turn to innovations in mapping technologies and crime prevention theory that have recently brought crime mapping to the center of trends in crime prevention. Finally, we discuss how the contributions that follow illustrate the many uses of mapping in crime prevention, the pitfalls and problems that researchers and practitioners are likely to encounter in developing and analyzing maps, and the potential advances in crime mapping that might be expected in the coming decades.

CRIME MAPPING: EARLY APPLICATIONS

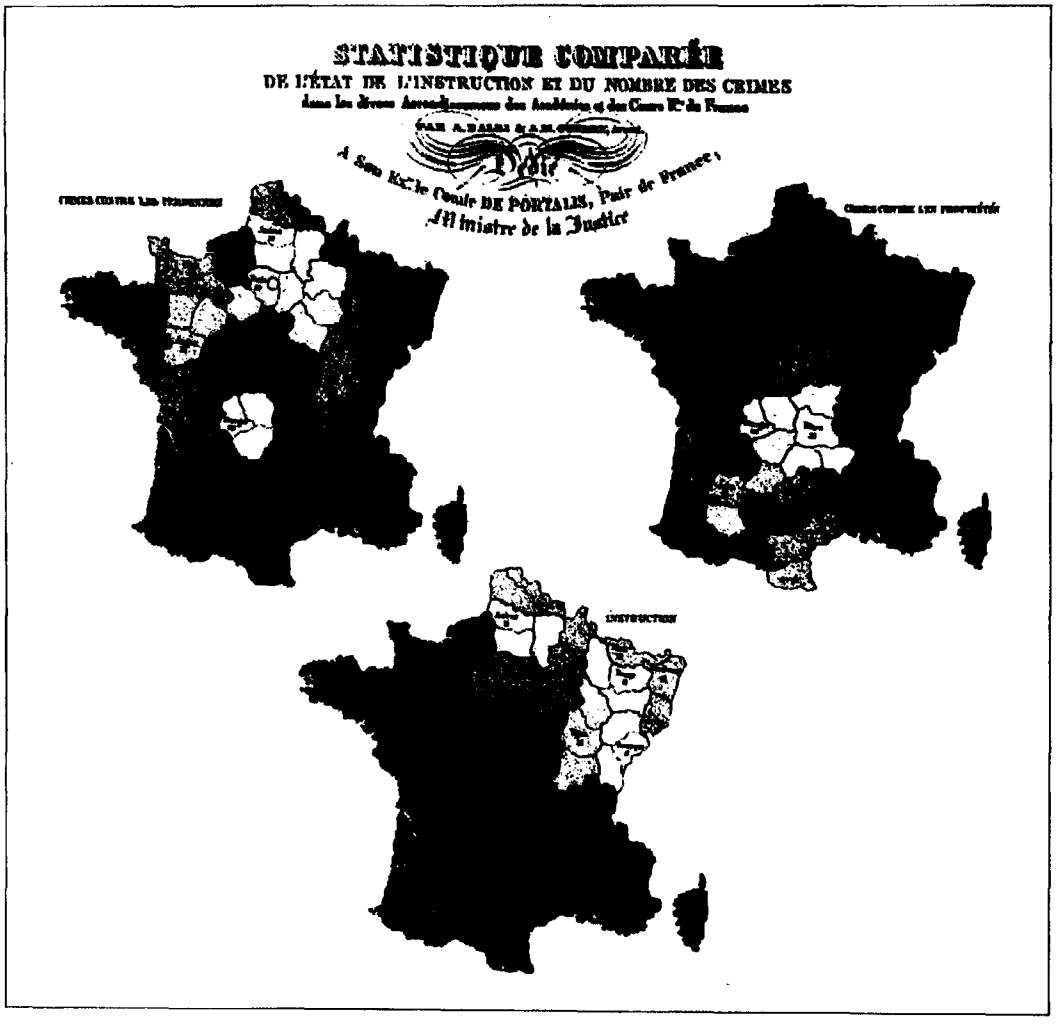
The idea of mapping crime is not new and, in fact, dates back to the early 1800s in France. A review of the historical literature from

that period to the present time shows several epochs during which interest in crime mapping was great, but then faded dramatically. In this section, we examine three such periods and discuss the reasons why what seemed like promising beginnings did not lead to sustained interest in crime mapping.

In 1829, Adriano Balbi and Andre-Michel Guerry created the first maps of crime (Kenwitz, 1987; Beirne, 1993). The collaboration itself is of interest because it combined Balbi's training in ethnography and general mapping techniques with Guerry's training as a lawyer interested in patterns of criminality. Using criminal statistics for the years 1825 to 1827 and demographic data from France's latest census, they developed maps of crimes against property, crimes against persons, and levels of education. Comparing these maps, they found that the northeastern portion of France (from Orleans to the Franche-Comte) was better educated, that areas with high levels of crimes against property had low incidences of attacks on people, and that the areas with more property crime were populated by people with higher levels of education (see Figure 2). While the results regarding geographic differences in educational levels came as no great surprise, the others ran counter to popular views at the time. Guerry, however, paid little attention to these reactions because he was not interested in developing or testing theories (Oberschall, 1989).

The Belgian astronomer and statistician Lambert-Adolphe Quetelet attempted to fill the theoretical void. In 1831 and 1832, he independently published three maps dealing with the same themes but spreading across larger areas. Quetelet saw a correlation between crime and several variables including transportation routes, education levels, and ethnic and cultural variations. Quetelet continued theoretical development through his concept of the "average man" and his quest to discover, through statistics and "social physics," the explanation of societal behavior (Quetelet, 1835). His contributions to statistics, which were very controversial at the time, suggested the application from astronomy of the normal distribution and error measurement to social phenomena (Maltz, 1991). Quetelet's use of statistical tools combined with the average man concept was founded on the belief that aggregations of data provide statistical stability, assuming there is no change in any underlying causal relationships. As he stated, "The greater the number of individuals observed, the more do individual peculiarities, whether physical or moral, become

Figure 2: Balbia and Guerry (1829) Maps Comparing Crime and Instruction



effaced, and allow the general facts to predominate, by which society exists and is preserved" (Quetelet, 1835:12, as reported in Stigler, 1986). Indeed, Quetelet found stability over time in crime, birth, and suicide rates and other social phenomena, to the extent that critics said he was questioning the very existence of free will.

Despite groundbreaking work in providing explanations for the distribution of crime, these ecological perspectives were hastily discarded with the advent of a "positivist" criminology eager to locate the

causes of crime within the biological and physiological framework of individuals (Morris, 1958; Beirne, 1993). Robinson (1982) draws the following conclusion about the development of thematic maps and Quetelet's (1835) statistical approach:

> Although thematic maps of moral statistics continued to be made [into the 1860s], especially of instruction, their developmental period had run its course. Subsequent attention seems to have been oriented more toward sociological interpretation and away from geographical variation. In a sense this reflects a greater concern with Quetelet's provocative ideas of "social physics" and a lessening of interest in the investigations of regional differences, such as by Dupin, Guerry, and Fletcher [Robinson, 1982:170].

There was also a very practical reason for moving away from the use of maps and regional variations in social and moral statistics. It required a considerable amount of time and effort to collect data, summarize by appropriate areas, and manually create the maps. Whatever the reasons for the demise of interest in mapping of crime, the lesson in our context is that the efforts during this period were based on reasonably good data (as collected by France's censuses), but were weak in other areas. Maps of interest could not be developed on any regular basis; crime theories were not adequately developed; and techniques for analysis were slow, time-consuming, and cumbersome.

The history of mapping in the U.S. stands in sharp contrast to what has just been discussed. We sometimes forget that America is a comparatively young nation. In the early 1800s, many parts of the U.S. were years away from collecting crime and demographic data on a routine basis. A search of the police literature uncovered no references even in the first part of this century to the 19th century mapping efforts in England and France. Instead, what begins to emerge are occasional references to "spot maps" in which pins are physically placed on large street maps. These spot maps were used first with traffic accident data, which predated systematic collection of crime data.[x]

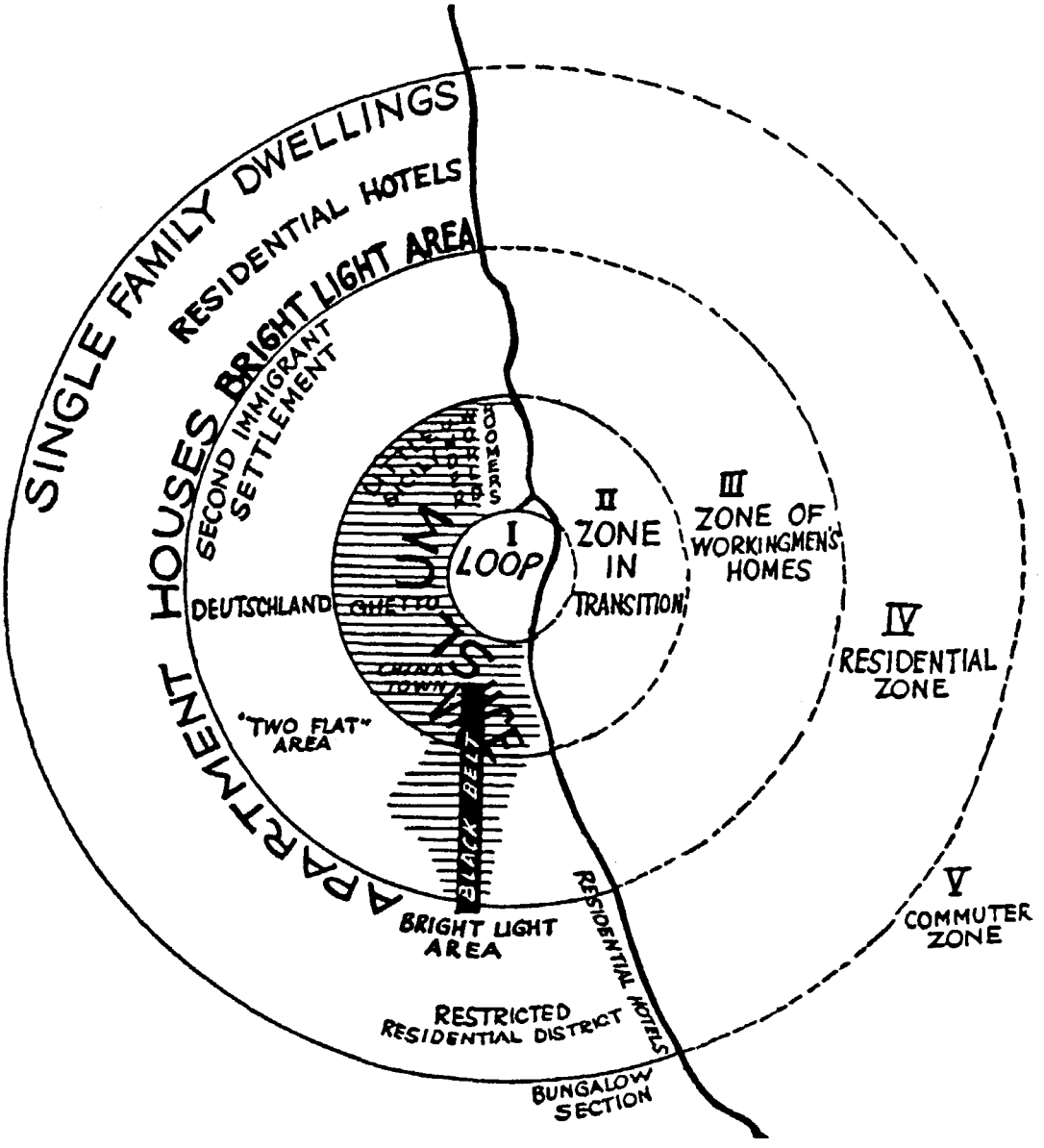
More sophisticated maps were developed by a group of scholars associated with the University of Chicago in the 1920s and 1930s. These urban sociologists, led by Robert Park, looked to characteristics of the urban environment to explain the crime problem in American cities. They mapped crime and other social characteristics in neighborhoods in the city of Chicago. Using these maps, they illus-

trated the theoretical position that crime was strongly linked to social disorganization and poverty in urban settings. For example, Frederic Thrasher (1927) superimposed the "location and distribution" of gangs in Chicago on a map of urban areas in the city (see Figure 3). He found that gangs were concentrated in areas of the city where social control was weak and social disorganization pervasive. Similar conclusions were reached by Shaw and Myers (1929) in a study of juvenile delinquency conducted for the Illinois Crime Survey. In a map that looks as if it had been generated through modern computer applications (Figure 4) rather than produced by hand, they show that the home addresses of over 9,000 delinquents are clustered in areas marked by "physical deterioration, poverty and social disorganization" (1929:652).

Interest in the ecological correlates of crime faded among American sociologists in the 1930s. The confident assertion by Shaw (1929) that the "study of such a problem as juvenile delinquency necessarily begins with a study of its geographical location" (p. 5) was not heeded by those who followed him. Once the relationship between social organization and crime in urban neighborhoods had been illustrated, a new generation of researchers shifted concern to elements of social disorganization and their impacts upon individual predisposition to criminality. The tedious and difficult process of mapping crime in the pre-computer age did not appear to offer potential for new and important insights. A new generation of sociologists concerned with crime sought to understand why certain individuals, both within these socially disorganized areas or outside them, chose to commit crimes while others did not (Merton, 1938; Sutherland, 1939). This question did not demand examination of the location of crime events, but rather led scholars to focus on the motivations of offenders.

The idea of automated crime mapping emerged in the late 1960s. Early applications (Pauly et al., 1967; Carnaghi and McEwen, 1970) showed the potential for visual representations of crime patterns through computer-generated maps. For example, Figure 5 uses such a map to show the distribution of larcenies from automobiles in 1967 in the ninth district in St. Louis, MO. Maps were seen as offering the potential for focusing police resources in more efficient and more effective ways. Similarly, publications on crime analysis strongly advocated automated analysis of crime (Chang et al., 1979; Buck et al., 1973) and illustrated the use of geographic analysis (Brantingham and Brantingham, 1981; Harries, 1974; Pyle, 1974).

Figure 3: The Place of Chicago's Gangland in the Urban Ecology



Note: The shaded portion indicates the approximate location of the central empire of gangland.

Figure 4: Home Addresses of Alleged Male Juvenile Delinquents

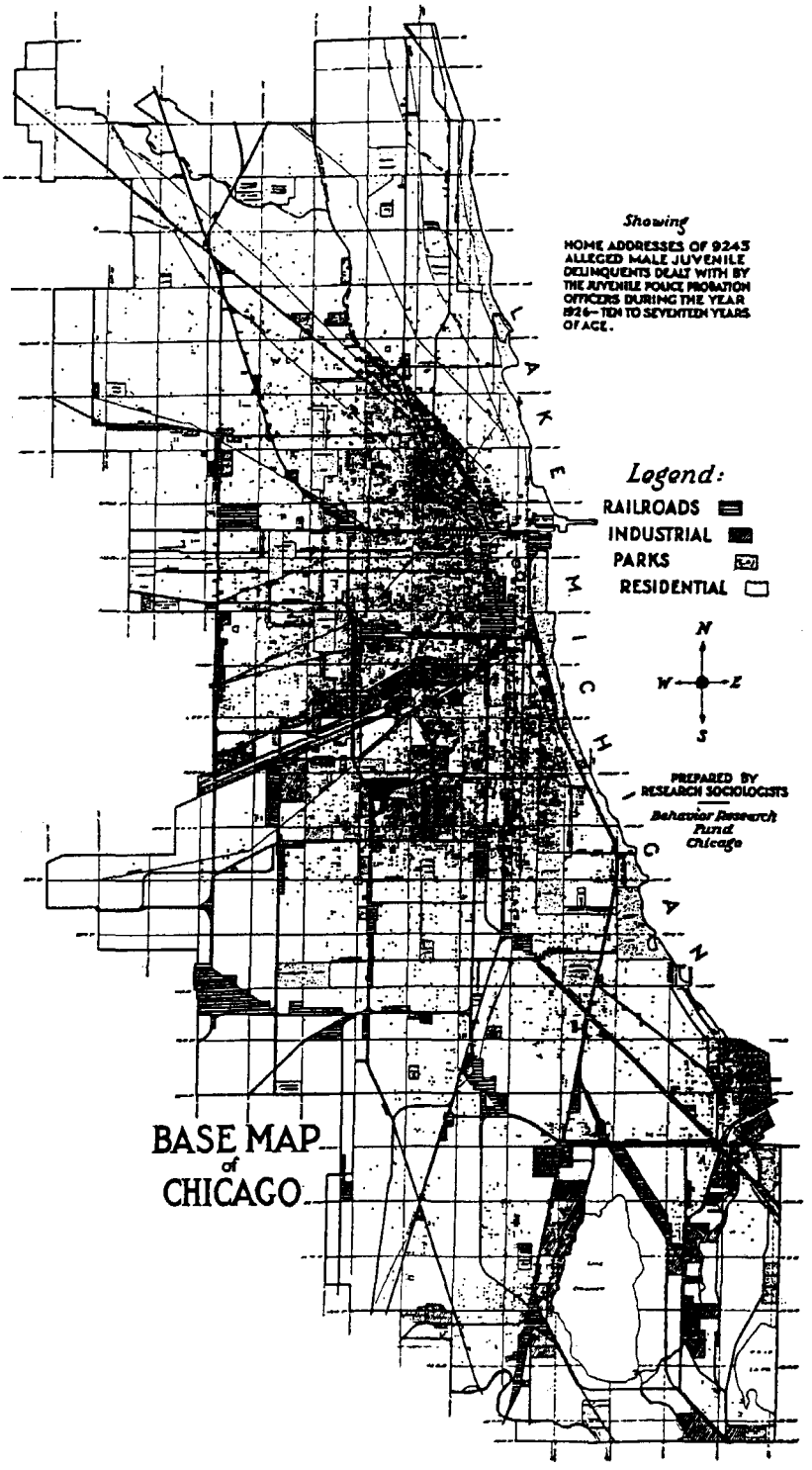
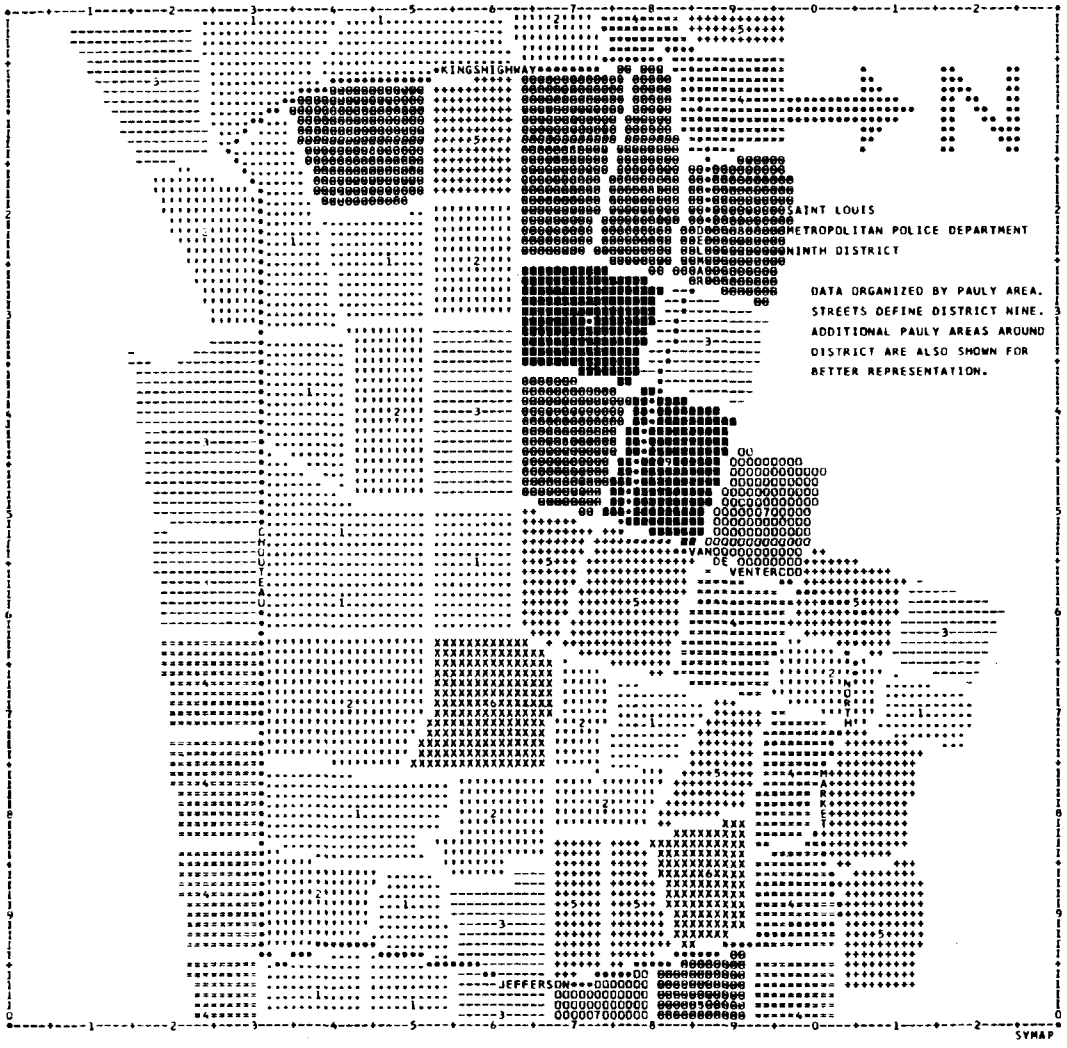


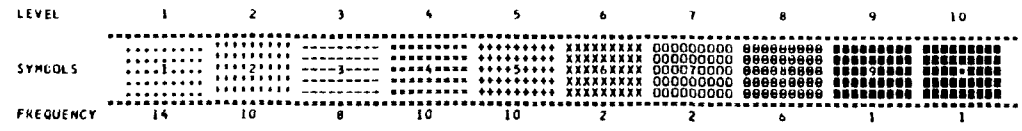
Figure 5: Larcenies from Automobiles in District 9, St. Louis

Data Mapped in 10 Levels Between Extreme Values of 0.00 and 40.00
Data Values Scaled According to Linear Scale.



District 9 **** Selected Part One Offenses
From 0001 of 03/06/67 to 2400 of 03/26/67
Crimes Within District: 486 — Total Crimes for This Map: 866

Frequency Distribution of Data Point Values in Each Level



While the potential for computer mapping generated much enthusiasm, few police departments actually integrated crime mapping into police operations. One reason for this failure is that the maps were developed with little sense of organizing theories or perspectives. Moreover, practitioners could count on little help from the academic community, which had long abandoned crime mapping and saw these efforts as representing technological policing applications that were not of their concern. The maps displayed only crime data, and were often not much more sophisticated than simple hand-generated pin maps. They remained an in-house product for police departments because the era of professional policing saw no real need for sharing crime results with either the community, scholars, or even other units of government.

Technical considerations also prevented the rapid spread of automated mapping. The maps required large mainframe computers for development and production, and these were not available to many police departments. Small and medium-sized departments were not automated and most large departments depended for support on the city's data processing section, which did not usually give priority to the needs of the police department. In addition, the computer maps required accurate and up-to-date geographic base files for converting addresses into coordinates. Even large police departments, which had the technical capabilities for creating such files, generally did not want to devote the necessary personnel to this labor-intensive and time-consuming endeavor. Even when the desire for developing maps of crime was present, it was extremely difficult given existing technologies to access crime data quickly in the form necessary for crime analysis. And as difficult as it was to prepare crime data that were under the control of police or other criminal justice agencies, it was that much more difficult to gain information from other agencies. Indeed, in this period there was little use of data across public agencies. Problems existed in both the compatibility of systems that were used and the identification of people or places tracked by specific agencies.

PRACTICAL AND THEORETICAL INNOVATIONS: PAVING THE WAY FOR WIDESPREAD MAPPING APPLICATIONS

Crime mapping has thus informed theory and policy about crime for almost two centuries. Nonetheless, its use has been sporadic. Each time that mapping has emerged as a crime analysis method or

crime prevention tool, technological or theoretical barriers have prevented its full-scale development and application. The difficulty of matching data to maps made crime mapping an extremely time-consuming and tedious activity for scholars and practitioners. The lack of good data that could be accessed in a timely fashion often relegated mapping to an interesting but not very practical tool for crime prevention. Similarly, in periods during which the major theoretical questions that informed crime prevention research and policy had little to do with the ecology of crime, a full-scale focus on crime mapping was unlikely.

A comparison of the historical situation with the present suggests that recent interest in crime mapping is likely to have a more substantial and lasting impact on crime prevention theory and applications. In large part this is because of the computer and information revolutions of the last two decades. The expensive mainframe computer, which only large municipalities or agencies could afford in the 1960s and 1970s, has been replaced by cheaper and more efficient microcomputers. Starting with the Apple computer in 1979, the capabilities of microcomputers have increased every year and the costs have decreased. Desktop computers now deliver the power of mainframe computers of the 1980s. What this means is that the hardware necessary to develop computer maps has become available to lone scholars and even the smallest criminal justice agencies. The software has also become cheaper and more efficient. There are still mapping applications that demand access to relatively more expensive mini-computers. But most programs are available for microcomputers, and the power of such applications for integrating and presenting information is continually being updated.

Information systems that accurately record crime events and the processing of offenders have become the rule rather than the exception in American criminal justice agencies. Especially for police, the linkage of such information to places, generally street addresses, has become a central concern. In general, it is the management responsibilities faced by such agencies that have led to this geographic focus. In order to respond quickly and efficiently to emergency calls to the police, accurate coding of street addresses in information systems has become a necessity for modern police departments. Other agencies that want to track the whereabouts of offenders are also concerned that there be accurate identification of where offenders live and work. Advances in information systems now allow even small-scale criminal justice agencies to accurately define street addresses and attach them to coordinates that can be linked to computer maps.

The more general concern for compatibility among systems and data sources has now made it possible for practitioners and scholars to link data about the ecology of crime to a host of other information sources (e.g., census data, hospital records, tax records, and land use information).

At the same time that advances in computer and information systems have largely overturned the technological barriers to mapping of crime, innovations in crime prevention theory have pushed the concept of place to the center of research and practice in controlling crime. For most of this century the focus of crime prevention has been on people and their involvement in criminality {Weisburd, 1997; Brantingham and Brantingham, 1990). The ecology of crime, which is at the core of crime mapping, did not fit easily into this theoretical perspective. In the 1980s, however, the focus of crime prevention began to shift. Following a series of research studies that challenged the effectiveness of offender-based approaches (see, e.g., Martinson, 1974; Visher and Weisburd, 1997), a number of scholars called for a reorientation of crime prevention practice and theory to what may be termed the *context* of crime (Weisburd, 1997). In its broadest terms, this new perspective sought to develop a greater understanding of crime and more effective crime prevention strategies through concern with the physical, organizational, and social environments that make crime possible (see Brantingham and Brantingham, 1990; Clarke, 1980, 1983, 1992, 1995; Cornish and Clarke, 1986) . From the outset, the concept of place became a central concern of scholars in this area (see Eck and Weisburd, 1995).

This shift provided an important theoretical impetus to crime mapping, and encouraged its use not only in the development of practical prevention programs but also in research about the etiology of crime (see, e.g., Brantingham and Brantingham, 1981). If place was to be seen as a focus of crime prevention efforts, then methods that emphasize the ecology of crime had to be developed. If scholars were to understand the relationship between crime and place, then data had to be collected and explored in such a way that spatial relationships became central, rather than peripheral, to their analyses. Crime prevention programs that sought to identify places where crime was common — so called "hot spots" of crime (Sherman and Weisburd, 1995) — necessitated knowledge about the clustering of crime events across addresses in the city. With concurrent advances in computer and information technologies, crime mapping emerged as an indispensable tool of research and practice in crime prevention.

CRIME MAPPING: PROSPECTS AND PROBLEMS

We begin our collection of essays with five papers that illustrate the potential of crime mapping for developing and implementing recent innovations in crime prevention. In the first, Carolyn Rebecca Block shows how computer mapping of crime can facilitate community policing and problem solving. These approaches use an action research model similar to that of situational crime prevention (Goldstein, 1990; Clarke, 1992), and rely upon detailed information about where crime events occur and the factors that facilitate them. Block introduces the concept of a GeoArchive, a geographic database that is developed with the express purpose of providing police and the community with data that can facilitate "problem-solving community policing."

Block also addresses what has become a major problem in the development of computer mapping applications, "data overload." With the development of new information technologies, vast amounts of data can be overlaid onto computer maps. Official crime information itself can include hundreds of thousands and even millions of events. If data from the census, hospitals, and other city agencies are merged, one can see that the analyst can become quickly overwhelmed with maps becoming a mass of uninterpretable points (Maltz et al., 1990). Even if the maps are focused on specific kinds of problems and include only one or two types of information, computer maps quickly begin to be difficult to interpret (see, e.g., Weisburd and Green, 1994). Block suggests methods for managing and analyzing the vast array of information that has become available for crime prevention efforts.

Following Block's contribution are two chapters that illustrate the potential role that mapping can play in building police and community partnerships. In recent years scholars have emphasized the importance of community involvement in crime prevention efforts (see Greene and Mastrofski, 1988; Rosenbaum, 1994). The community is now seen as an important resource for both identifying and solving crime problems. Faye S. Taxman and Tom McEwen suggest that criminal justice and other public agencies working together with the community in "work groups," are likely to develop more effective and long-lasting solutions to crime problems. Maps and geographic data provide work groups with information critical to identifying, understanding and responding to crime problems. Sharing such information among members of work groups provides a basis for developing consensus and cooperation among police, other public agencies, and the community.

Marc Buslik and Michael D. Maltz also illustrate the importance of bringing maps into the community. They argue that sharing information with the public will not only increase cooperation and develop trust, but will aid in analyzing and interpreting the vast amounts of data that are likely to be included in maps. People who live in a community may be able to explain clustering of points on a map through their own experiences in the neighborhood, or the special knowledge of the people who live there. Information sharing that Buslik and Maltz describe as "power to the people" may empower the community and may lead to more effective crime prevention efforts. In this same vein, Buslik and Maltz emphasize the importance of bringing computer applications to those who are closest to problem-solving efforts: just as the community may have special insight and knowledge, patrol officers also gain insight from their direct experiences in the community.

Lorraine Green Mazerolle, Charles Bellucci and Frank Gajewski also raise the issue of who will use computer maps. They focus, however, on a different concern. Too often, computer mapping is viewed as an undifferentiated technology that can be applied in similar form for a myriad of purposes. Mazerolle and her colleagues suggest that mapping systems must be built in response to the specific users and purposes for which they are developed. A mapping system appropriate for a crime analysis unit defining departmental policy is not likely to be relevant for street level officers. In turn, specialized units may need types of information that are not relevant at the departmental level. If a criminal justice agency chooses to develop systems that will be used by specialists, the system configuration will be different than one that was meant for a wider group of officers with less expertise.

Mazerolle, Bellucci and Gajewski also describe the very real problems that face criminal justice agencies in developing mapping systems given current technologies. Many scholars and practitioners have been frustrated by the disjuncture between the promises of computer mapping and the realities of developing such maps with criminal justice information. Data transfer, geocoding, data integration, system customization, and confidentiality all present problems for those who want to develop crime mapping systems. Mazerolle and her colleagues use the example of the Jersey City Drug Market Analysis Program (see Weisburd and Green, 1995) to illustrate these problems and potential solutions to them.

In the final chapter in this section, Philip R. Canter provides a series of examples of how computer maps have aided crime prevention efforts in Baltimore County, MD. This chapter provides concrete ex-

amples of how mapping crime has influenced the activities of criminal justice agencies. Mapping has fostered a broader approach to crime problems and gained significant institutional support because of its usefulness as a crime prevention tool.

In the second section of our volume, we turn from crime prevention *practice* to crime prevention *research.* In the first two essays, the importance of cognitive or perceptual maps are explored. Computer mapping has developed for the most part in the context of large, computerized data-bases supplied by criminal justice or other public agencies. The importance of qualitative assessments of crime and crime prevention has most often been ignored. George F. Rengert and William V. Pelfrey, Jr., illustrate the disjuncture between crime maps based on official data about crime and those based on perceptions of crime. Whatever the familiarity of people with a neighborhood, they are unlikely to be able to predict the relative safety of areas with any accuracy. One important, though troubling, finding in this chapter is that both minority and non-minority students and community service recruits in Philadelphia defined dangerousness in relationship to the proportion of minorities that are found in an area. Rengert and Pelfrey's essay suggests that practitioners and scholars should expand the scope of mapping beyond the quantitative data sources that have so far dominated mapping applications.

David M. Kennedy, Anthony A. Braga and Anne M. Piehl show how this approach can be applied in the context of a problem-solving program aimed at juvenile gun violence and gun markets in Boston, MA. Kennedy and his colleagues suggest that qualitative information can be integrated with quantitative data in the context of computer mapping. They argue that the "experiential assets" of practitioners provide an important resource for crime prevention efforts. They use perceptions of gang officers, probation officers, and city employed "street workers" to develop a portrait of where juvenile gangs are found, their number and size, and antagonisms and alliances. Linking these perceptual maps to criminal justice data provides the authors with a fuller picture of the relationship between gangs and gun violence, which has facilitated an innovative problem-solving approach aimed at controlling serious gang violence in Boston.

Patricia L. Brantingham and Paul J. Brantingham suggest that the future will include innovations not only in technology but also in the ways in which we analyze and integrate mapping into crime prevention research. While major advances have been made in mapping applications, similar strides are just beginning to be made in the ways in which we systematize and present information drawn from

computer maps. Traditionally, scholars have looked at simple counts of crime or rates of crime in specific areas or places. Brantingham and Brantingham suggest that additional measures are needed to develop a fuller understanding of the ecological distribution of crime problems. They present one such measure, the Location Quotient (LQC), which estimates the mix of crimes rather than the prevalence of crime events. The Location Quotient allows the researcher to define what types of crimes dominate a given area, rather than focusing upon the amount of crime that is present. The LQC emphasizes the contextual view of crime, and illustrates the importance of developing new analytical tools for describing geographic crime patterns.

The final contribution in this section shifts our focus to the use of mapping in developing a broader understanding of the distribution of crime problems. For the most part, computer mapping of crime has reinforced assumptions about the concentration of crime in specific places (see, e.g., Sherman, et al., 1989; Weisburd, et al., 1993; Weisburd and Green, 1993). James L. LeBeau and Karen L. Vincent suggest that computer mapping may also challenge current assumptions about the ecology of crime. Taking the case of repeat-address burglar alarm calls and burglaries, they caution researchers and practitioners regarding the application of hot-spot approaches to some crime problems. In their analyses, LeBeau and Vincent found that burglaries are not likely to occur at the same address multiple times. Alarm calls, in contrast, do repeat at similar addresses, though there are so many false alarms that a concentration on repeat-call locations is not likely to provide much crime prevention value.

In the final section of the volume, we include four essays that examine future prospects for integrating crime mapping into crime prevention research and practice. Our goal here is to identify technologies and issues that are just beginning to be examined, and are likely to concern scholars and practitioners over the next decade. The first two papers examine new technologies for predicting and tracking crime that are in the first stages of their development. Andreas M. Olligschlaeger describes the development of an early warning system that anticipates the emergence of criminal activity in Pittsburgh, PA. This system uses artificial neural networks to identify flare-ups of drug hot-spot areas. Olligschlaeger illustrates how neural networks can be integrated into computer mapping efforts, providing a sophisticated method for identifying where new crime events are likely to develop. While Olligschlaeger points out the barriers that confront full integration of these new technologies today, we believe neural

networks are likely to form an important part of crime prevention research and practice in the future.

Severin L. Sorensen also provides a glimpse into future trends in crime mapping technologies. Using the acronym *SMART* (Spatial Management, Analysis and Resource Tracking), he suggests that we are close to achieving real time and place mapping through linkages with Geographic Positioning Systems and Automated Vehicle Location systems. One of the major problems facing crime mapping applications today is the gap between crime events and crime analysis (see Green et al., 1997). Sorensen shows how advances in satellite tracking technologies are making it possible to develop systems in which there is almost immediate access to crime information. Following Sorensen's model for future applications of crime mapping in crime prevention, we might suspect as well that the potential for data overload we described earlier is likely to grow in the coming decade.

The final essay, by John E. Eck, emphasizes the importance of crime prevention theory in crime mapping. We think this an especially appropriate paper to conclude a section on future trends, because crime mapping in crime prevention has often been atheoretical, relying upon maps to lead the way in defining theory and practice. As Eck illustrates, crime mapping without a theoretical context is likely to lead to confusion in both research and policy. The same distribution of points on a map may lead to a number of different potential explanations. More often than not, it is difficult to make sense of the mass of data that computer maps provide without informing analyses with theories about the distribution of crime events.

CONCLUSIONS

The contributors to this book demonstrate the important role that crime maps have begun to play in crime prevention theory and applications. In their professional roles as criminologists, geographers, and crime analysts, they write about the relationships between geographic areas and crime, physical disorder, gangs, and drugs. They show how crime mapping is used in crime prevention programs, and point to future uses of crime mapping in research, theory and practice.

Technological advances in computer mapping and information systems and theoretical innovation in crime prevention have combined to bring crime mapping to the center of crime prevention practice and policy. The time when such maps were an interesting oddity has passed. Crime maps have become an essential tool in crime pre-

vention. The essays in this volume both illustrate this fact and suggest innovative directions for mapping applications.

NOTES

1. This is illustrated in a bulletin issued by the U.S. Federal Bureau of Investigation (1944):

> Spot maps have been used for a number of years by traffic bureaus in police departments throughout the country for the purpose of furnishing a clear, quick, and comprehensive picture of the accident situation and to indicate at a glance the points in the city which present the greatest hazard. Spots maps have also been used in a similar fashion to show the crime hazards of the city. For example, some departments show on a spot map one type of pin indicating the location of the theft of each automobile and a pin of a different shape or color to indicate the location of its recovery. The advantage of a spot map lies in its maintenance and interpretation [p.34].

REFERENCES

Beime, P. (1993). *Inventing Criminology.* Albany, NY: State University of New York Press.

Block, C.R. and M. Dabdoub (1993). *Workshop on Crime Analysis Through Computer Mapping Proceedings.* Chicago, IL: Illinois Criminal Justice Information Authority.

Brantingham, P.L. and P.J. Brantingham (1981). *Environmental Criminology.* Beverly Hills, CA: Sage.

——(1990). "Situational Crime Prevention in Practice." *Canadian Journal of Criminology* (Jan): 17-40.

Buck, G.A., R. Austin, G. Cooper, D. Gagnon, J. Hodges, K. Martensen and M. O'Neal (1973). *Police Crime Analysis Unit Handbook* Washington, DC: Law Enforcement Assistance Administration, U.S. Department of Justice.

Carnaghi J. and T. McEwen (1970). "Automatic Pinning." In: S.I. Cohn and W.E. McMahon (eds.), *Law Enforcement, Science and Technology,* vol. III. Chicago, IL: Illinois Institute of Technology Research.

Chang, S.K., W.H. Simms, CM. Makres, and A. Bodnar (1979). *Crime Analysis System Support: Descriptive Report of Manual and Automated Crime Analysis Functions.* Gaithersburg, MD: International Association of Chiefs of Police.

Clarke, R.V. (1980). "Situational Crime Prevention: Theory and Practice." *British Journal of Criminology* 20:136-147.

——(1983). "Situational Crime Prevention: Its Theoretical Basis and Practical Scope." In: M. Tonry and M. Morris (eds.), *Crime and Justice: An Annual Review of Research,* vol. 4. Chicago, IL: University of Chicago Press.

——(ed.) (1992). *Situational Crime Prevention: Successful Case Studies.* Albany, NY: Harrow and Heston.

——(1995). "Situational Crime Prevention: Achievements and Challenges." In: M. Tonry and D. Farrington (eds.), *Building a Safer Society: Strategic Approaches to Crime Prevention.* Crime and Justice: An Annual Review of Research, vol. 19. Chicago, IL: University of Chicago Press.

Cornish, D.B. and R.V. Clarke (eds.) (1986). *The Reasoning Criminal.* New York, NY: Springer-Verlag.

Eck, J.E. and D. Weisburd (eds.) (1995). "Crime Places in Crime Theory." In: J. Eck and D. Weisburd (eds.), *Crime and Place.* Crime Prevention Studies, vol. 4. Monsey, NY: CriminalJustice Press, pp. 1-34.

Goldstein, H. (1990). *Problem-Oriented Policing.* New York, NY: McGraw-Hill.

Grafton, S. (1995). *'V is for Lawless.* New York, NY: Henry Holt and Company.

Greene, J.R. and S. D. Mastrofski (eds.) (1988). *Community Policing: Rhetoric or Reality.* New York, NY: Praeger.

Harries, K.D. (1974). *The Geography of Crime and Justice.* New York, NY: McGraw-Hill.

——(1990). *Geographic Factors in Policing.* Washington, DC: Police Executive Research Forum.

Kenwitz, J.W. (1987). *Cartography In France: 1660-1848.* Chicago, IL: University of Chicago Press.

Maltz, M.D. (1991). "Crime Statistics: A Historical Perspective." In: E.H. Monkkonen (ed.), *Theory and Methods in Criminal Justice History, Part 2.* Ann Arbor, MI: Edwards Brothers.

——A.C. Gordon, and W. Friedman (1990). *Mapping Crime in Its Community Setting: Event Geography Analysis.* New York, NY: Springer- Verlag.

Martinson, R. (1974). "What Works? Questions and Answers about Prison Reform." *Public Interest* 35:22-54.

Merton, R. (1938). "Social Structure and Anomie." *American Sociological Review* 3:672-682.

Morris, T.M. (1958). *The Criminal Area.* London, UK: Routledge and Kegan Paul.

Oberschall, A. (1989). The Two Empirical Roots of Social Theory and the Probability Revolution." In: L. Kruger, G. Gigerenzer, and M.S. Morgan (eds.), *The Probabilistic Revolution: Ideas in the Sciences,* vol. 2. Cambridge, MA: Massachusetts Institute of Technology Press.

Pauly, G.A., T. McEwen, and S. Finch (1967). "Computer Mapping-A New Technique in Crime Analysis." In: S.A. Yefsky (ed.), *Law Enforcement Science and Technology,* vol. 1. New York, NY: Thompson Book Company.

Pyle, G.F. (1974). *The Spatial Dynamics of Crime.* Chicago, IL: Department of Geography, University of Chicago.

Quetelet, A. (1835). *Sur I'Homme et le Developpement de ses Facultes, ou Essai de Physique Sociale.* Paris, FR: Bachelier.

Robinson, A.H. (1982). *Early Thematic Mapping in the History of Cartography.* Chicago, IL: University of Chicago Press.

Rosenbaum, D. P. (ed.) (1994). *The Challenge of Community Policing: Testing the Promises.* Thousand Oaks, CA: Sage.

Shaw, C.R. (1929). *Delinquency Areas.* Chicago, IL: University of Chicago Press.

Shaw, C.R. and E.D. Myers (1929). "The Juvenile Delinquent." In: *Illinois Crime Survey.* Chicago, IL: Illinois Association for Criminal Justice.

Sherman, L.W., P.R. Gartin, and M.E. Buerger (1989). "Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place." *Criminology* 27:27-56.

Sherman, L.W. and D. Weisburd (1995). "General Deterrent Effects of Police Patrol in Crime 'Hot-Spots': A Randomized, Controlled Trial." *Justice Quarterly* 12:625-648.

Stigler, S.M. (1986). *The History of Statistics: The Measurement of Uncertainty before 1900.* Cambridge, MA: Belknap Press of Harvard University Press.

Sutherland, E.H. (1939). *Principles of Criminology.* Philadelphia, PA: Lippincott.

Thrasher, F.M. (1927). *The Gang.* Chicago, IL: University of Chicago Press.

U.S. Federal Bureau of Investigation (1944). "Spot Maps in Crime Prevention." *FBI Law Enforcement Bulletin.* Washington, DC: U.S. Department of Justice.

Visher, C. and D. Weisburd (in press). "Identifying What Works: Recent Trends in Crime Prevention Strategies." *Crime, Law and Social Change.*

Weisburd, D. (1997). "Reorienting Crime Prevention Research and Policy: From the Causes of Criminality to the Context of Crime." Washington, DC: U.S. National Institute of Justice.

——(1994). "Defining the Street Level Drug Market." In: D.L MacKenzie and CD Uchida (eds.), *Drugs and Crime: Evaluating Public Policy Initiatives.* Thousand Oaks, CA: Sage.

——(1995). "Policing Drug Hot Spots: The Jersey City Drug Market Analysis Experiment." *Justice Quarterly* 12:711-735.

Weisburd, D., L. Maher and L. Sherman (1993). "Contrasting Crime General and Crime Specific Theory: The Case of Hot Spots of Crime." In: Freda Adler and William S. Laufer (eds.), *New Directions in Criminological Theory.* Advances in Criminological Theory vol. 4, New Brunswick, NJ: Transaction.