# THE
EVOLUTION AND DEVELOPMENT
OF
POLICE TECHNOLOGY

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SEASKATE, INC.

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A Technical Report
prepared for
The National Committee on Criminal Justice Technology
National Institute of Justice

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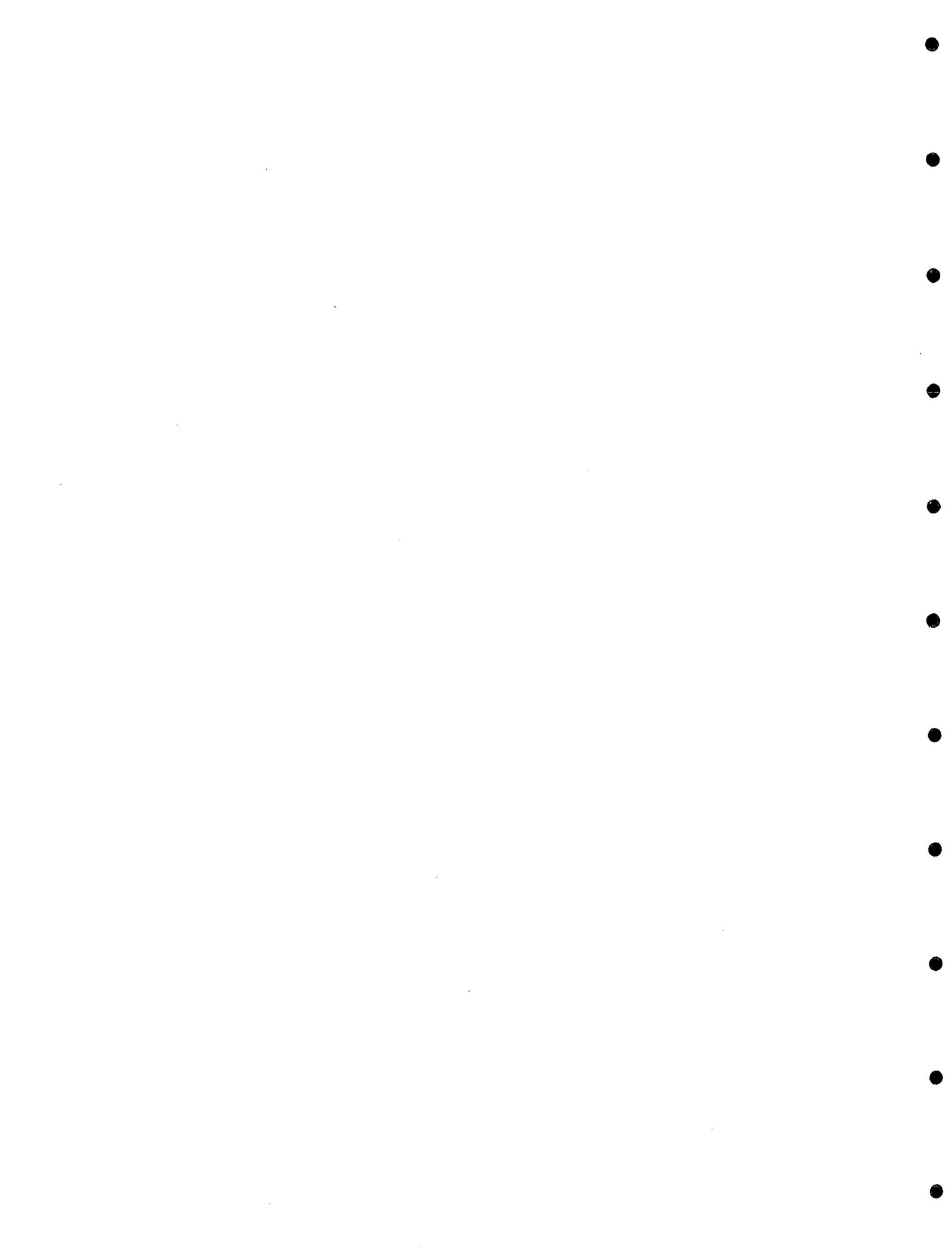
THE EVOLUTION AND DEVELOPMENT
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THIS PUBLICATION CONTAINS BOTH AN OVERVIEW AND FULL-LENGTH VERSIONS OF OUR
REPORT ON POLICE TECHNOLOGY. PUBLISHING THE TWO VERSIONS TOGETHER ACCOUNTS
FOR SOME DUPLICATION OF TEXT.

THE OVERVIEW IS DESIGNED TO BE A BRIEF SURVEY OF THE SUBJECT. THE TECHNICAL
REPORT IS MEANT FOR READERS SEEKING DETAILED INFORMATION.

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EXECUTIVE SUMMARY

THIS REPORT provides a detailed look at police technology. It is meant to help readers as they consider the evolution and future development of police technology and the role of the National Institute of Justice (NIJ) in fostering that development. It was prepared with a diverse audience in mind, all of whom have a stake in ensuring that the police are equipped to do their job safely and efficiently:
- police officers on the street and policymakers responsible for their efforts;
- citizens concerned about crime;
- the news media, and opinion leaders interested in making the police more effective;
- the private sector, the manufacturing and marketing source of current and new technologies.

The job is exacting. The police are asked to control crime, maintain order, and provide an intricate array of services, from responding to emergency 911 calls to regulating the flow of traffic. On occasion, they must perform remarkable feats of criminal investigation, quell rowdy crowds and violent offenders, and put their lives on the line. Much of the time, police resources are limited. It is estimated that the workload crime imposes on the police has increased fivefold since 1960. Their resources have not kept pace with their workload.

THE POLICE AND TECHNOLOGY

To do their job, police frequently have looked to technology for enhancing their effectiveness. The advent of fingerprinting in the 1900s and of crime laboratories in the 1920s greatly augmented the police capacity to solve crimes. The introduction of the two-way radio and the widespread use of the automobile in the 1930s multiplied police productivity in responding to incidents.

But, as noted in this report, progress in technology for the police has often been slow and uneven. A quotation from the President's Crime Commission in 1967 illustrates how the police at times have lagged behind other sectors in reaping the benefits of technology:

> The police, with crime laboratories and radio networks, made early use
> of technology, but most police departments could have been equipped
> 30 or 40 years ago as well as they are today.

The Crime Commission was established in the 1960s in response to rapidly rising crime rates and urban disorders. The Commission advocated federal government funding for state and local criminal justice agencies to support their efforts. It called for what soon became the 911 system for fielding emergency calls and recommended that agencies acquire computers to automate their functions. But even with the start-up help of hundreds of millions of dollars in early federal assistance, computerization came slowly. Only in recent years have many agencies found the use of information technologies significantly helpful. Examples include fingerprinting databases, computerized crime mapping, and records management systems doing everything from inventorying property and cataloging evidence to calculating solvability factors.

POLICE TECHNOLOGY AND THE NATIONAL INSTITUTE OF JUSTICE

Many police technologies are drawn and adapted from the commercial marketplace. Cars, radios, computers, and firearms are examples. But this report notes that the police have vital needs for special technologies for which there is no easily available source. Examples are devices to use less-than-lethal force in controlling unruly persons, to stop fleeing vehicles, and to detect concealed weapons and contraband in nonintrusive ways.

Private sector technology developers and manufacturers are reluctant to meet many special technology needs of the police. The fragmentation of the American police market, which numbers more than 17,000 agencies, makes selling to the police a time-consuming and expensive proposition. Liability issues are also a concern: Will the manufacturer be protected if its product is used in a way that injures officers or citizens?

The job of fulfilling special technology needs for state and local law enforcement belongs to the National Institute of Justice (NIJ), the criminal justice research arm of the U. S. Department of Justice. NIJ's Office of Science and Technology fosters technology research and development when it otherwise will not occur.

To determine technology requirements, the Office of Science and Technology regularly surveys the police through its Law Enforcement and Corrections Technology Advisory Council (LECTAC), which is comprised of top law enforcement officials from throughout the country. It also develops voluntary product standards, compliance and testing processes, and it disseminates a wide range of information on police technology. The vehicle for much of this activity is the NIJ-sponsored National Law Enforcement and Corrections Technology Center (NLECTC), a network of national, regional, and special purpose offices.

For the first 20 years after the federal government began supporting local criminal justice agencies, NIJ's role in technology was limited. Its most notable accomplishments were the development of soft body armor for the police and establishment and dissemination of performance standards for police equipment. Beginning in the 1990s, however, the Administration and Congress recognized increased needs for technology and began funding NIJ to meet them. A current example is a five-year project to improve the quality and availability of DNA technology to local and state law enforcement. A second example is funding to detect concealed weapons and contraband. Often in cooperation with other federal agencies such as the Departments of Defense and Energy, NIJ sponsors scores of efforts to develop new technologies.

> IT IS ESTIMATED THAT THE WORKLOAD CRIME IMPOSES ON THE POLICE HAS INCREASED FIVEFOLD SINCE 1960. BUT THEIR RESOURCES HAVE NOT KEPT PACE.

OBSERVATIONS FOR POLICYMAKERS

The purpose of this report is to inform. However, in preparing it, observations were formed that may be useful to federal policymakers. One set of observations suggests ways to coordinate federal technology development efforts for avoiding fragmentation and duplication of effort and ensuring certain systems are compatible. On the basis of its mission and partnerships with other federal agencies, NIJ seems well suited to play a coordinating role in these efforts.

A second observation is that the coordination of technology development, as well as the emphasis on its importance, would be better served by the appointment of a science and technology adviser to the Attorney General and a senior law enforcement official to the Technology Policy Board of the White House Office of Science and Technology. Here, again, it would appear that NIJ could provide excellent support in this endeavor.

Other observations address ways of encouraging industry to manufacture and market technologies developed under NIJ's aegis; of strengthening compliance with product standards; and of encouraging the federal government to help police agencies acquire new technologies through such means as buying consortiums, low-interest loans, and distribution of surplus equipment. A final observation addresses the issue of inadequate funding to support technology development for state and local police and of the necessity to provide a stable budget as a matter of highest national priority.

Through this report and these observations, we hope to accelerate the process by which the police finally become full beneficiaries of our era's continuing technological revolution, thereby enhancing their vital work in the nation's fight against crime. Our citizens deserve nothing less.

Vice Admiral E. A. Burkhalter, Jr., USN (Ret.)
Chairman, National Committee on Criminal Justice Technology
President, Seaskate, Inc., Washington, D. C.

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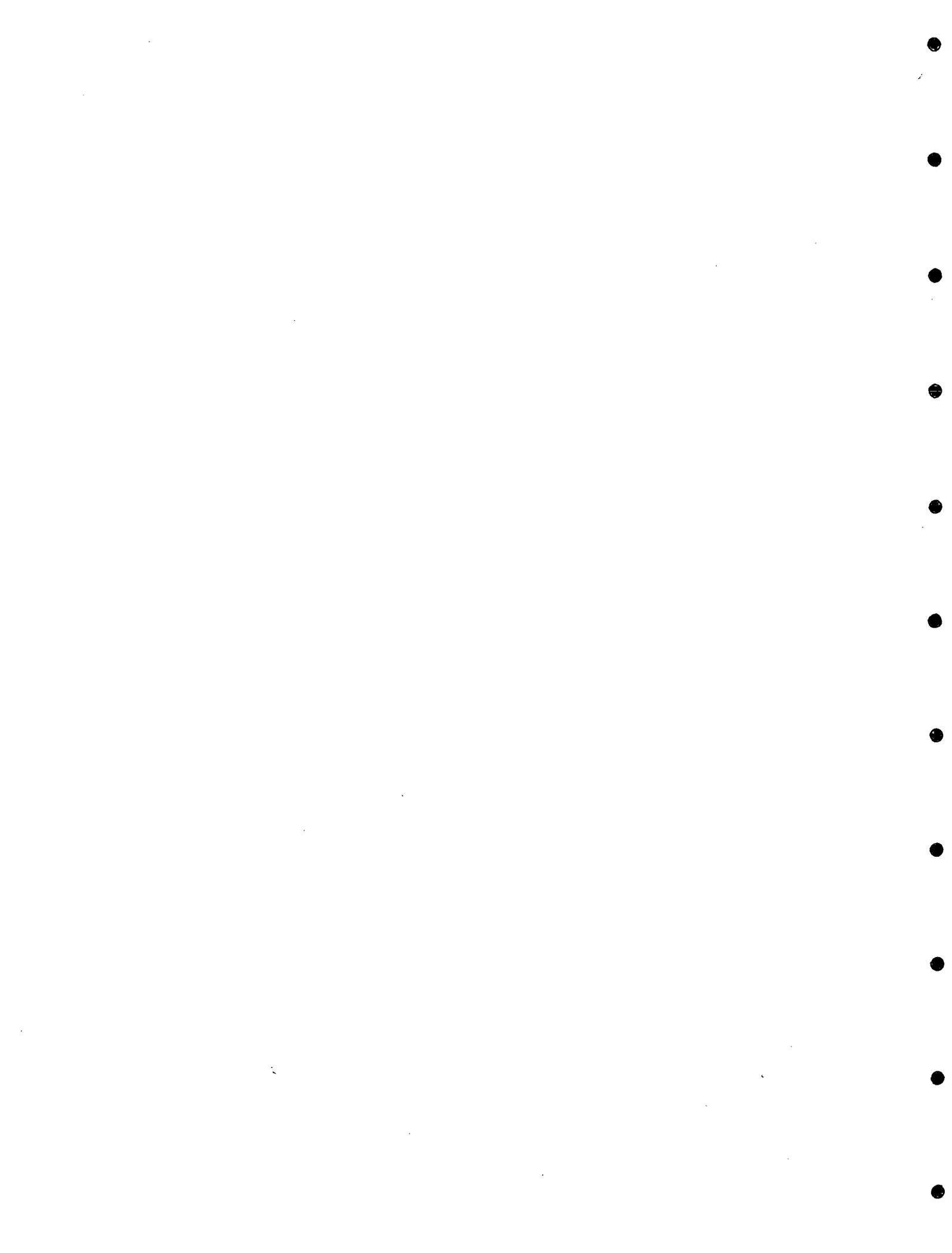
OF POLICE TECHNOLOGY

An Overview Report

"Those were desperate times for policemen in a hostile country with unpaved streets and uneven sidewalks, sometimes miles from the police station, with little prospects of assistance in case of need.... It took nerve to be a policeman in those days." So reported Chief Francis O'Neill of the Chicago Police Department in 1903. Then came technological progress with the "invention of the patrol wagon and signal service (which have) effected a revolution in police methods (O'Neill, 1976)." In 1909, Chief J.H. Haager of Louisville, Kentucky, was "proud to say that the police department of Louisville is in such a line of progress that we feel ourselves beyond the utility of the horse, and can now boast of three power-driven vehicles (Haager, 1976)."

This report is about American policing in the line of technological progress. It goes from a time in the last century when, in Chief O'Neill's words, "the introduction of electricity as a means of communication between stations was the first notable advance in the improvement of police methods" to today's high-tech frontiers.

The report is divided into four sections, and includes a time line that charts the course of police technology.

Part One reviews the history of police technology, the formation and growth of federal assistance for its development, and the early accomplishments of the National Institute of Justice.

Part Two examines in considerable detail current and prospective police technologies as they are used in performing key functions: safeguarding life, protecting citizens, solving crimes, communicating with citizens and police colleagues, traffic enforcement, and managing the police agency, particularly in terms of the growing use of information technologies.

Part Three deals with policy issues and practical matters and the National Institute of Justice's role in addressing them, and briefly looks to the future of police technology.

Part Four offers observations which federal policymakers may wish to consider in seeking to foster development and adoption of new technologies for the police.

A series of appendices is provided to document developments in police technology.

PART ONE:

HISTORY AND THE

EMERGING FEDERAL ROLE

THE POLITICAL ERA

Scholars divide the history of U. S. policing into three eras. The first, from 1840 to about 1920, is called the Political Era, so named because of the cozy, mutually beneficial ties police and politicians had in many urban areas. During this era, the police came to be armed with two forms of technology — the gun and the nightstick — that, with some modernizing, they continue to use today when called upon to use force. Whatever technological progress the police have made since the second half of the 19th century, they still rely to a considerable extent on basic tools available 100 years ago to protect innocent life and themselves.

Technological advances included the use in the late 1870s of the telegraph and telephone, installation of police callboxes, development and adoption in the 1880s of the Bertillon system of criminal identification, and the development and use at the turn of the century of fingerprinting systems to assist in criminal investigations.

THE PROFESSIONAL MODEL ERA

Historians call the period from 1920 to 1970 the Professional Model Era. Reformers sought to rid government of undesirable political influences and create what they deemed professional police departments. Technology, according to one scholar of the era, "helped emphasize discipline, equal enforcement of the law, and centralized decision making," hallmarks of the Professional Model of policing.

August Vollmer, considered the foremost champion of the Professional Model, was also a champion of police technology. Vollmer pioneered the use of the polygraph and fingerprint and handwriting classification systems. The crime laboratory he started in the Berkeley, California, Police Department was the model and training ground for the nation. In 1932, the FBI inaugurated its own laboratory which eventually became recognized as the most comprehensive and technologically advanced forensic laboratory in the world. The 1930s saw the widespread police adoption of the automobile and the introduction of two-way radios.

TECHNOLOGY AND THE NATIONALIZATION OF CRIME

There were other technological innovations reaching into the next two decades. For example, radar was introduced to traffic law enforcement in the late 1940s. In the 1960s — 120 years after the inception of the modern era of policing — the federal government for the first time launched a concerted effort to foster the development and use of new technologies for the police.

That effort had its roots in the 1964 presidential campaign when Republican candidate Barry Goldwater made crime a national political issue for the first time. Goldwater lost the election to incumbent Lyndon B. Johnson, but Johnson took two steps to assuage the nation's concerns about street disorders and crime rates, which had doubled between 1940 and 1965. First, he appointed the President's Commission on Law Enforcement and Administration of Justice to examine the problem. In 1967, the Crime Commission produced a 308-page report that offered more than 200 recommendations, 11 dealing with police technology.

Johnson's other step was to begin the flow, a trickle at first, of what eventually became billions of dollars in direct and indirect assistance to local and state law enforcement. Never before had the federal government taken on the job of providing massive assistance to state and local criminal justice agencies. The federal government became committed to addressing the problem of crime in America's streets and neighborhoods. Hundreds of millions of dollars went to fostering police use of existing and new technologies.

CRIME COMMISSION FINDINGS

The President's Crime Commission found that the nation's criminal justice system suffered from a significant science and technology gap. The commission reported:

The scientific and technological revolution that has so radically changed most of American society during the past few decades has had surprisingly little impact on the criminal justice system.
Of the police specifically, the commission observed:
The police, with crime laboratories and radio networks, made early use of technology, but most police departments could have been equipped 30 or 40 years ago as well as they are today.

and:

> Of all criminal justice agencies, the police traditionally have had the closest ties to science
> and technology, but they have called on scientific resources primarily to help in the solution
> of specific serious crimes, rather than for assistance in solving general problems of policing.

Overall, the commission's science and technology task force reported that many technological devices existed, either in prototype or on the market to help criminal justice agencies. Others deserved basic development and warranted further exploration. "But for many reasons, even available devices have only slowly been incorporated into criminal justice operations," the task force said in a statement that still has relevance today. "Procurement funds have been scarce, industry has only limited incentive to conduct basic development for an uncertain and fragmented market, and criminal justice agencies have very few technically trained people on their staffs."

Perhaps the most far-reaching recommendations dealt with computerization and what came to be known as 911.

THE ADVENT AND LESSONS OF 911

The commission called for establishment of a single telephone number, eventually available nationwide, that Americans could use to call the police. At first, AT&T personnel balked. They cited several reasons including problems involving boundaries of dialing areas and police jurisdictions, according to Dr. Alfred Blumstein, who headed the commission's science and technology task force. But then there was a change of heart, Blumstein said. AT&T decided to launch 911 as the single police and fire emergency telephone number, thus getting rid of dialing zero, the costly and personnel-intensive procedure that was then in use for summoning emergency help. "They were peddling a new product which was 911 and it was going to be automated and they were clearly ahead," Blumstein said.

AT&T announced creation of 911 in January 1968. Within a few years, 911 systems were established in many urban areas. Within ten years, police chiefs of large departments were beginning to complain that ever-increasing 911-generated calls for service were starting to distort and even overwhelm the balanced deployment of police resources. In a study of U.S. policing in the mid-1980s, two scholars wrote, "In many cities the 911 system with its promise of emergency response has become a tyrannical burden." Nevertheless, by the mid-1990s, police departments employing 95 percent of the nation's police officers had 911 systems.

The 911 experience incorporates two recurring themes in the history of police technology. The first is that when private industry can forecast an assured profit, it quickly provides the police with a technology created or adapted to their needs. The dilemma is that there are relatively few instances where industry can anticipate a fairly immediate and steady profit stream by providing a new technology to the police.

The second theme is, as in other areas of life, new technologies for the police can bring new problems. The rules of unintended consequences apply. The 911 system has become essential to summon emergency police, fire, and medical services. It also created new headaches for many administrators of large urban police departments.[1]

THE COMPUTERIZATION OF AMERICAN POLICING

The President's Crime Commission encouraged the computerization of American policing. The essential ingredient needed to spur this effort was money. Federal funding was soon on its way through a large, long-term subsidy program managed by the Law Enforcement Assistance Administration (LEAA).

The Omnibus Crime Control and Safe Streets Act of 1968 created LEAA in, as one commentator noted, "an environment of social turbulence. Crime rates were climbing, the incidence of drug abuse was on the rise, riots and disorders were becoming commonplace, and America's political leaders were targets for assassination attempts."

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1 — The Federal Communications Commission has approved the designation of a three-digit phone number for non-emergency use. Although the new 311 number is voluntary, it is expected to relieve the burden of citizens using 911 for non-emergencies. The Office of Community Oriented Policing Services, an arm of the U. S. Department of Justice, in October 1996 launched a pilot 311 program with the Baltimore Police Department. Baltimore's 911 call volume dropped more than 30 percent.

> THE DEVELOPMENT OF 911
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In this climate, LEAA sought to spur the computerization of policing. The big push started in the early 1970s. It is uncertain how much LEAA spent on police computerization, but police agencies began to acquire computers. However, many departments with access to computers in the 1970s and even into the 1980s seemed reluctant to use them for more than routine tasks. Why were many police agencies not making more effective use of computers? Leading police chiefs blamed the complexities of the new technology, the cautious, conservative nature of many police officers, and citizens' "fear of Big Brother." Lack of funds for computer training and equipment maintenance also played a part.

A leading police computer consultant of the day had another answer: Computer manufacturers lacked great interest in the police market. "Despite what they may say to the contrary, they don't really view law enforcement as an important money-maker and have been reluctant, for this reason, to invest in development of new application software or specialized hardware ...," he said, adding: "After all, there are only 17,000 law enforcement agencies in the entire country. This is paltry when you compare it to the 100,000 hospitals, 500,000 hotels, or millions of individual businesses there are."

As we will see in Part Two, perhaps the most recurring fact cited in deliberations about the difficulties of interesting private manufacturers, and in developing and marketing new police technologies, is that there are 17,000 agencies, each with its own budget and technical specifications for many products including computers. The police market, fragmented among so many agencies, is too cost-inefficient and complicated to reach; the police market, with only 17,000 scattered components, is too small to pursue when there are much larger and potentially remunerative markets to exploit.

After 13 years and the expenditure of about $7.5 billion on all of its efforts, LEAA was formally abolished in 1982. Robert F. Diegelman, who was acting director of a smaller, successor agency to LEAA, summed up the views of many when he wrote that the "LEAA program ran afoul of unrealistic expectations, wasteful use of funds, mounting red tape, and uncertain direction." But he observed that LEAA had registered significant achievements such as educating and training thousands of criminal justice personnel, implementing new and worthwhile projects, and developing new skills and capacities for criminal justice analysis, planning, and coordination.

Despite LEAA's absence, police departments continued to invest in computers and eventually apply them to more sophisticated tasks. In this they were helped by a useful LEAA legacy, software developed under a series of grants.

By the 1990s, a Bureau of Justice Statistics survey provided conclusive evidence that the use of computers was growing and police agencies were using them for increasingly diverse purposes. For example, a 1996 analysis of survey data reported:

Two thirds of local police departments were using computers in 1993, compared to half in 1990. Departments using computers employed 95 percent of all local police officers in 1993.

The more crucial point, the data showed, was that many police agencies were using computers not just for routine record keeping, but also for relatively sophisticated functions such as criminal investigations, crime analysis, budgeting, and manpower allocation.

One of the most important computer-based innovations in American policing during the past 30 years was the advent of the National Crime Information Center (NCIC), administered by the FBI. NCIC is a central computerized index of fugitives, stolen property, and missing persons. Beginning in the late 1960s, this system was in many instances the first practical application of computer technology used by American police agencies. NCIC demonstrated that the diffuse organization of American law enforcement could be tied together in a centralized system used by all agencies in a common effort to improve service and functionality.

Computers were essential in the development of Automated Fingerprint Identification Systems (AFIS). Unfortunately, AFIS has been developed in a piecemeal manner. Systems may be regional, covering several states, or they can be statewide, or they may encompass only a city and a few surrounding municipalities. The obvious disadvantage to a fragmented national AFIS network is that roving criminals can still escape detection because one state may not have access to another state's AFIS system.

The development of 911 and the computerization of policing are two instances demonstrating that the federal government can affect the development and adoption of technologies benefiting the police. The President's Crime Commission called for establishment of a program

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>
> CHIEF DENNIS NOWICKI
> CHARLOTTE-MECKLENBURG POLICE
> DEPARTMENT, NORTH CAROLINA

which quickly became the 911 system. The same commission urged the computerization of policing, and a flood of federal money in the 1970s soon flowed to police departments for that purpose. Some of the money doubtless went for police computers not used productively or not used at all. But federal cheerleading and money for computers — and the federally funded development of some useful police software — undoubtedly helped accelerate police computerization.

COMPUTERS AND COMMUNITY POLICING

The introduction of computers into policing corresponds roughly to the beginning of the third and current era in American policing, what one scholar calls the Community Policing Era beginning about 1970. Lee P. Brown, formerly the chief police executive of New York City, Houston, and Atlanta, has suggested that computers are essential to community policing. Brown has written:

> The use of high-technology equipment and applications is essential to the efficient practice of community policing. Without high technology, officers would find it difficult to provide the level and quality of services the community deserves. Computer-aided dispatching, computers in patrol cars, automated fingerprinting systems, and online offense-reporting systems are but a few examples of the pervasiveness of technology in agencies that practice community policing.

Dennis E. Nowicki, chief of the Charlotte-Mecklenburg, North Carolina, Police Department, is building a $10 million "knowledge-based community-oriented policing system" for his department. The computer system will focus "on the needs of the problem-solving officer in the streets," he has said. "We're designing our system not as a management information system but as an information system to support problem solving."

Nowicki exemplifies a class of current police chiefs with faith in computer technology as crucial to successful police work. "My vision is that when an officer comes through the academy, we give him his weapon, we give him his radio, and we give him his laptop computer."

William Bratton, the former New York City police commissioner, has said that computers have provided police with important technological advances. Computer mapping to pinpoint crime was a notable element in what a growing number of criminologists have concluded was Bratton's successful crime-fighting effort in New York City.

Dr. Alfred Blumstein, who, as noted, was director of the Crime Commission's science and technology task force, joined in agreement about the place of computers in the realm of police technology. The statement of the Crime Commission was recalled for him: "The scientific and technological revolution that has so radically changed most of American society during the past few decades has had surprisingly little impact on the criminal justice system."

Was this still true? No, said Blumstein, technology is "finally starting to take hold and the dominant transformation has been the one in computing. So much of the criminal justice system can be seen as an information-processing system — dealing with information about events, about individuals. We are starting to see, still in a surprisingly limited way, the diffusion of that (computer) technology so that even fairly small police departments today have at least their own computers."

Blumstein added, however, that police officers on the beat still require new technologies to assist them directly. He cited the need for advances in such areas as less-than-lethal technology, concealed weapons detection, and ways to stop fleeing vehicles.

THE EARLY EFFORTS OF THE NATIONAL INSTITUTE OF JUSTICE

The Law Enforcement Assistance Administration paid for big ticket technology items such as computers, software, and crime laboratories, but the National Institute of Justice (NIJ), an agency for many years under the LEAA umbrella[2], was the designated federal source of research and development in law enforcement technology. In its review of its first 25 years, the Institute made special note of two accomplishments in technology — the development of lightweight body armor and support for DNA analysis to improve evidence used in investigating crimes.

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2 — Until 1978, NIJ was called the National Institute of Law Enforcement and Criminal Justice and was essentially the same agency as NIJ.

> IN RECENT YEARS, AND WITH STRONG BIPARTISAN SUPPORT, CONGRESS HAS AWARDED NIJ SIGNIFICANTLY INCREASED FUNDING TO SPEED PROGRESS IN POLICE TECHNOLOGY. IT IS FEDERAL RECOGNITION OF THE IMPORTANT ROLE TECHNOLOGY CAN PLAY IN HELPING THE POLICE IN THEIR WORK.

But for many of those 25 years, technology research and development seemingly took a back seat to other NIJ activities. For example, a 1977 report of the National Research Council labeled NIJ's technology R&D efforts an abandoned child.

The "abandoned child" assertion may have been an overstatement. Stepchild may have been more accurate. The fact is that, for much of NIJ's first 20 years, efforts in technology research and development were to a considerable degree a one-person effort, that person being Lester Shubin, a chemist.

Shubin played a pivotal role in the serendipitous origins of soft body armor for police. A colleague at the U. S. Army Land Warfare Laboratory told Shubin that DuPont had a new fabric, Kevlar, "stronger than steel, lighter than nylon," to replace steel belting for tires. "I asked him if the fabric would do just as well to stop bullets," Shubin recalls. "He didn't know, so we folded some up and shot at it and the bullets bounced off."

The successful firing range experiment led in 1972 to an Institute-sponsored project in which the Land Warfare Laboratory used Kevlar in a new, lightweight, flexible, and protective body armor. It also led to the creation of a new industry, an instance where a federally initiated technology for law enforcement moved rapidly into the commercial marketplace. To date, the soft body armor introduced by the Institute is credited with saving the lives of more than 2,000 police officers, a savings estimated in terms of survivors' benefits and other costs to total more than $2 billion.

The Institute began its support of developing DNA technology in 1986 as the technology's potential value to crime solvers became increasingly evident. That support is much expanded in the form of a current five-year, $40 million program.

Another important NIJ contribution to policing was the establishment in 1971 of a national program of standards for police equipment. No such program existed before, Shubin noted; "Nobody knew, for example, how strong a pair of handcuffs should be." The standards were voluntary. "We had no regulatory power," he said.

By 1975, the Institute's Law Enforcement Standards Laboratory had completed performance standards for:

- Portable, mobile, and base station transmitters; mobile receivers; and batteries for portable radios;
- Walk-through and handheld metal weapons detectors;
- Portable x-ray devices for bomb disarmament;
- Communication equipment such as voice scramblers, car location systems, and radio transmitters, receivers and repeaters;
- Active and passive night vision devices;
- Magnetic, mechanical, and mercury switches for burglar alarms;
- Handcuffs, riot helmets, crash helmets, police body armor, ballistic shields, and hearing protectors

By the mid-1980s, NIJ created two mechanisms for advancement of its work in testing equipment and setting standards. It established the Technology Assessment Program Information Center to pick laboratories for testing equipment, supervising the testing process, and publishing reports of test results. It also established the Technology Assessment Program Advisory Council, a large advisory body of senior local, state, and federal law enforcement officials. Both the center and the council are predecessor operations to current programs described in Part Two.

In the almost 30 years since the Crime Commission's report, other technological advancements have also helped the police. Portable radios have been made lighter, more powerful, and easier to use. Police are now using cellular phones in many agencies.

An important technological advance benefiting the police in their daily work has been the development of pepper spray as a force alternative. Although it has proved notably useful, the police need other force alternatives. Steven Bishop, former chief of police of Kansas City, Missouri, makes the point that policing overall has been shortchanged in the slow development of technology for protecting street officers.

For all the advances in the past 30 years, there are still obstacles to the development of police technology. These obstacles and what is being done to overcome them are addressed in Part Two, which follows.

As we have seen, in the late 1960s the federal government began to assume responsibility for fostering the development, availability, and adoption of new technologies to help local and state police. Part Two of the report discusses (1) how the government is fulfilling that responsibility through the National Institute of Justice and its Office of Science and Technology (OST) and (2) the obstacles to their progress.

The mandate of the National Institute of Justice, the criminal justice research and development arm of the U.S. Department of Justice, is to improve and strengthen the nation's system of justice with primary emphasis on local and state agencies. In recent years Congress, with strong bipartisan support, has awarded NIJ significantly increased funding to speed progress in police technology. The expanded funding, through the 1994 Crime Bill and other measures, is federal recognition of the important role technology can play in helping the police in their work.

The purpose of NIJ's Office of Science and Technology is defined by its name. It is the focal point for advancing criminal justice technology. Through OST, the National Institute of Justice has developed voluntary standards, tested new equipment, and disseminated information on technologies. The newly increased funding has intensified NIJ's efforts to (1) understand policing's overall operations and its specific technological requirements; (2) encourage research and development of successful technologies; and (3) overcome obstacles slowing or derailing technological progress. The final goal is to move the best new technologies from the laboratory and from other agencies to the marketplace and the law enforcement consumer.

PART TWO:

THE NIJ'S ROLE AND

OBSTACLES TO PROGRESS

OBSTACLES TO PROGRESS

Fragmentation of local policing is the source of many of the obstacles to technological application. It is the price that many believe is required if the nation is to have local control of law enforcement. About 570,000 police officers serve in 17,000 agencies, 90 percent of which have 24 or fewer officers. Local and state police handle 95 percent of the nation's crime.

Fragmentation makes policing an often hard-to-reach, hard-to-sell, and, thereby, an unrewarding market for potential developers and manufacturers of new technologies, products, and services. Getting a product and product information to the police market can be expensive.

Fragmentation means most police departments have small budgets and make small buys of equipment. Almost all police agencies spend most of their budgets on personnel and have relatively little left over for equipment purchases. Thus, the local and state law enforcement market have scant available funds to support research and development.

Fragmentation means equipment acquisition is usually on a department-by-department basis; there is little pooled purchasing.

Fragmentation means awareness and information about valuable new technologies seep into the core expertise of police departments at markedly different rates. Some departments are state of the art in technological matters; some lag years behind.

Fragmentation means neighboring police agencies buy incompatible technologies — notably in communications equipment — which undermine their ability to serve a common area. The inability of several adjoining police departments to communicate because of incompatible radio equipment and frequencies is commonplace.

Fragmentation means almost all police agencies are too small to have on staff or on call experts who can provide objective evaluations of proffered technologies. Policing has its share of rueful tales of expensive technologies, notably computer systems, purchased in the glow of a salesman's pitch and without a thorough examination of whether the technology could deliver what was promised.

Fragmentation means no one has the authority to establish standards for law enforcement technology and equipment. The police on their own have developed no national organization for this purpose. Criminal justice has no national regulatory agency. Crime laboratories are not required to undergo accreditation.

LIABILITY CONCERNS

Another brake on progress involves liability concerns and questions of public and police acceptance associated with some existing and proposed law enforcement technologies.

"The whole issue of liability is a sobering issue," said Dr. Eric Wenaas, president and CEO of JAYCOR, a leading manufacturer of police products. "You can't underscore the importance of liability to any manufacturer of these products."

Some examples of liability concerns:

- Technologies that use graduated levels of acceptable force can spawn both lawsuits and bad press. An example is pepper spray. Police increasingly use it, and some call it one of the most useful technological innovations of the past 15 years. It is, obviously, less potentially brutal in use than a baton. On the one hand, widespread use of pepper spray has led to some lawsuits and media attention raising questions about its possibly lethality. On the other, use of pepper spray may reduce the total number of lawsuits and citizens complaints arising out of use-of-force incidents.

- Technologies to detect weapons on persons raise legal questions about relative degrees of invasion of privacy. Metal detectors, such as those stationed in airports, are less invasive — albeit notably less thorough — than prototype x-ray devices that can thoroughly scan people for weapons and explosives. However, x-ray devices can reveal anatomical details that could imply invasion of privacy.

- The specter of Big Brother can influence the development and use of some technologies. For example, some police object to the Big-Brother-over-your-shoulder aspect of Global Positioning Systems. They do not like the notion that their supervisors know where they are at every moment.

> WHILE TECHNOLOGY HOLDS GREAT PROMISE FOR POLICING, IT CANNOT MAKE UP FOR POOR JUDGMENT, INADEQUATE TRAINING, POOR OFFICER SELECTION, NOR CAN IT REPLACE COMPETENT LEADERSHIP OR USURP THE BASIC SKILLS OR STREET SMARTS OF SEASONED OFFICERS.

Wenaas is chair of the Justice/Industry Committee on Law Enforcement Technology for Law Enforcement which in late 1996 issued a report, "Impediments to Developing and Marketing New Technologies for Law Enforcement." In bullet form, the report listed these impediments. A sampling:

Impediments to Market Development. Diversity and independence of markets; split acquisition authority; lack of standards, specifications, and test procedures; high development costs in relation to sales volume; lack of funds for product acquisition.

Impediments to Product Standards and Testing. Cost and complexity of effectiveness and safety tests to assure valid results in larger populations; difficulty of performance tests on humans.

Legislative and Judicial Awareness. Liability inhibits development of nonlethal and other emerging technologies; lack of funding deters investment in rising market; potentially invasive technologies may be ruled illegal, thereby discouraging investments; partial funding by government may impair propriety rights.

OPERATING ASSUMPTIONS

In its efforts to deal with obstacles and further the development and use of new technologies, NIJ operates from several underlying assumptions. The first is that the Institute learn from and avoid earlier mistakes. The flood of federal funding for state and local law enforcement in the 1960s and 1970s was accompanied at times by unrealistic expectations and a top-down, Washington-knows-best viewpoint.

In their presentations and public statements, NIJ officials avoid unrealistic claims. They note that technological progress holds great promise for law enforcement. But they include a caveat: Technology cannot make up for poor judgment, compensate for inadequate or nonexistent training, substitute for poor officer screening and selection processes, replace competent leadership, or usurp the basic skills and street smarts of seasoned police officers.

What technology *can* do is enhance productivity in matters ranging from preventing and solving crimes to regulating traffic. It can also provide the tools which make law enforcement safer for both citizens and the police, and increase the effectiveness of police management.

To determine law enforcement's needs and to get successful new technologies out to the nation's police agencies, NIJ works closely with state and local departments, as well as a number of advisory panels whose members have expertise in everything from patrol techniques to liability issues. One purpose is to let the grassroots of American policing, and not just Washington, set priorities for the development and implementation of technologies. The goal is federal support, but local direction. Heeding the directives of local and state agencies, NIJ's priorities currently include research and development in the areas of less-than-lethal technologies, forensic science including DNA, information technology, new communications and surveillance devices, and weapons and explosives detection.

A second assumption is that NIJ does not have to develop its own research and development capacity to foster progress. NIJ believes the capacity exists in the remarkable technology infrastructure of national laboratories and government-funded nonprofit corporations which U.S. taxpayers already support. These are the technology-creating facilities which helped win the Cold War and are seedbeds of innovation for government and the private sector. For example, Aerospace Corporation, NIJ's partner in its Western regional center, provides systems engineering and integration for more than 70 U.S. space programs.

NIJ also has cooperative agreements with the Departments of Defense and Energy. The agreement with the Department of Defense (DOD) is the result of a 1994 memorandum of understanding between the Justice Department and DOD. The purpose is to share and develop jointly technologies applicable to both policing and military undertakings other than war. The interagency activity is managed on a daily basis by a Joint Program Steering Group consisting of personnel from NIJ and the Defense Advanced Research Projects Agency. Joint programs involve research and development in such matters as concealed weapons and explosives detection, biomedical and information technologies, sniper and mortar detection, and improved body armor. Funding to support this research is essential in bringing these technologies to maturity in support of law enforcement needs.

A third assumption is that the job of fostering research, development, and adoption of new technologies is unpredictable and frustration can be the norm. The job inevitably carries with it some false starts, often slow progress, and unfulfilled expectations that can test the patience of the law enforcement community as well as NIJ and collaborating organizations.

NIJ's response is to attempt, when possible, experimenting with several different approaches to a problem, whether the problem is detecting concealed weapons, stopping fleeing vehicles or subduing dangerous persons. The belief is: Keep plugging away in consultation with technology developers, providers, and police users and successful technologies as well as new equipment will emerge.

The most difficult part of this process is probably commercialization — the manufacture of products and new technological devices once they have been developed, tested, and deemed workable and useful. One police chief has formulated a checklist for police products brought to market. They must be necessary, practical, inexpensive, require a minimum of training, and be sturdy yet inexpensive to repair. Checklists like this can inhibit even the most adventuresome manufacturers.

A final assumption is that there is no single pathway through the web of impediments to technological progress for policing. NIJ has attempted to develop an agile approach, examined below, providing an array of ways to get its job done.

NIJ'S APPROACH

To achieve its ends, NIJ (1) continuously seeks to determine the technology needs of law enforcement; (2) sponsors research and development to meet those needs; (3) develops voluntary standards along with compliance and testing processes; and (4) disseminates essential information about existing and developing police equipment and technologies.

1. Determining Needs

NIJ depends on several practitioners' panels and joint government committees for advice on technology and development of new technologies. The largest is the Law Enforcement and Corrections Technology Advisory Council (LECTAC) which directly advises NIJ's system of National Law Enforcement and Corrections Technology Centers (NLECTC). The council consists of leaders, experts, and practitioners in law enforcement agencies at all levels of government and in professional associations. The council plays a significant role in setting priorities for technology development, helping to launch new technologies, cautioning against inappropriate ones, identifying serious equipment problems, and enhancing law enforcement understanding of issues and advances in technology.

THE NIJ'S APPROACH

THE NIJ OPERATES FROM SEVERAL UNDERLYING ASSUMPTIONS:

o THAT THE INSTITUTE LEARN FROM AND AVOID EARLIER MISTAKES.

o THAT THE NIJ DOES NOT HAVE TO DEVELOP ITS OWN RESEARCH AND DEVELOPMENT CAPACITY TO FOSTER PROGRESS.

o THAT THE JOB OF FOSTERING RESEARCH, DEVELOPMENT, AND THE ADOPTION OF NEW TECHNOLOGIES IS UNPREDICTABLE AND FRUSTRATION CAN BE THE NORM.

o THAT THERE IS NO SINGLE PATHWAY THROUGH THE WEB OF IMPEDIMENTS TO TECHNOLOGICAL PROGRESS FOR POLICING.

Another important advisory panel is the Less Than Lethal (LTL) Technology and Policy Assessment Executive Panel and its associated body, the Less Than Lethal Liability Task Group. The LTL panel is made up of state and local law enforcement, elected officials, and current as well as former high-ranking federal government officials. It reviews technology needs, developments, and innovations from a national perspective and makes regular recommendations to NIJ. The panel also advises the law enforcement community on ways of developing government and national support in fulfilling an aggressive technology agenda while ensuring that law enforcement needs are being fulfilled.

As noted, liability questions and civil lawsuits can play a significant role in limiting the use of certain current technologies and influencing the development of future ones. The liability task force assesses civil liability issues associated with technologies in various stages of research, development, and use. The task force has examined the liability aspects of such technologies as pepper spray, chemical darts, sticky foam, aqueous foam, smart guns, projectable nets, disabling strobe lights, projectable bean bags, microwave devices to disable automobiles, weapons detection devices, thermal imaging and forward-looking infrared devices (FLIR), and rear seat airbag restraints.

> THE NIJ SEEKS OUT NEW TECHNOLOGIES, ADVOCATES AND FUNDS THEIR DEVELOPMENT, AND ENCOURAGES THE TRANSFER OF SUCCESSFUL PROJECTS TO INDUSTRY FOR INTRODUCTION INTO THE MARKETPLACE. IT WORKS COOPERATIVELY, LEVERAGING ITS MODEST FUNDING THROUGH ADDITIONAL CONTRIBUTIONS AND THE EXPERTISE OF NATIONAL LABORATORIES AND FEDERAL AGENCIES.

2. Research and Development

In terms of research and development, NIJ seeks out law enforcement technology projects, advocates and funds their development, and encourages the transfer of successful technologies to industry for introduction into the marketplace. It also supports ways to enhance the use of established technologies, such as DNA, and assesses technologies caught in controversy, such as pepper spray. NIJ often works cooperatively, leveraging its relatively modest funding through additional contributions and expertise of national laboratories and federal agencies.

In setting its research and development agenda, NIJ is guided closely by what the Law Enforcement and Corrections Advisory Council reports to the NLECTC system. LECTAC's top police priorities, restated as recently as January 1997, include development of technologies to detect concealed weapons and contraband in a nonintrusive way; to incapacitate unruly persons through less-than-lethal means; to stop fleeing vehicles; and to enhance DNA testing.

These priorities as well as some others set by LECTAC can be met only through special research and development. Many technologies the police use were developed for general commercial purposes. Automobiles, radios, computers, and firearms are earlier noted examples. The police, or manufacturers serving the police market, adapted these and other widely available commercial technologies to police needs. But the commercial marketplace does not readily provide easy-to-adapt technologies to meet many priorities set by LECTAC. NIJ's research and development program seeks to respond to vital police technology requirements that otherwise would go unfulfilled. Additional research dollars are essential in meeting these goals.

Here is some of what NIJ is doing to meet special police needs.

Concealed Weapons Detection

Illegally concealed weapons are a threat to both law enforcement and the general public. Existing weapons detection systems, usually metal detectors, have a limited range and high false-alarm rates. They are obtrusive, hard to move, and easy to circumvent. In addition, non-metallic knives and stabbing implements, as well as handguns that have a low-metal content are very difficult to detect.

The NIJ, through its system of National Law Enforcement and Corrections Technology Centers, is exploring a number of options to develop a safe, affordable, inconspicuous system to detect metallic or non-metallic weapons at a distance of up to 30 feet.

Several types of technologies are being explored by the NLECTC in Rome, New York.

- A passive millimeter wave (MMW) technology that allows for rapid and remote detection of metallic and nonmetallic weapons, plastic explosives, drugs and other contraband concealed under multiple layers of clothing at a distance of up to 12 feet without a direct physical search. The technique relies on existing natural emissions from objects, and does

not require man-made irradiation of a person. Although the technology literally sees through clothing, it does not reveal anatomical detail. This project will include the development, fabrication and evaluation of a fixed-site camera that can be mounted on a cruiser, a monitoring console, and a proof-of-concept handheld camera with a video screen that is connected by cable to a signal analyzer box. Designs are to be developed for a totally portable, battery-powered camera and a standoff camera system suitable for use from a patrol car. This technology, although promising, is several years away from completion.

- An active approach using an electromagnetic (EM) technology, in which an EM pulse is emitted at a person standing in a portal. The difference in the EM radiation reflected back from different materials permits the identification of metallic objects. This technology has been successfully demonstrated and is now being picked up by commercial developers.

- A passive approach using fluxgate magnetometers. In this approach, anomalies in the earth's magnetic field caused by metallic objects on individuals standing in a portal, are measured by magnetometers and compared to a computerized database containing the measurements of actual weapons. This approach should significantly reduce the false alarm rate compared to the currently available technologies. The NIJ and the Idaho State Court system is jointly funding a preproduction stage of this device that is being demonstrated in an Idaho courthouse.

- An active approach using a modified off-the-shelf Compton (back) scattered x-ray imaging system. An individual is exposed to an extremely low level of radiation (about the same level as five minutes of exposure to the sun at sea level). These x-rays do not penetrate the body to any significant degree but are reflected back. A picture is then developed electronically, in less than one second, from that reflected radiation. Since different materials have different reflectivities, the operator is able to detect weapons or other contraband from images in the picture. A prototype has been successfully demonstrated in a North Carolina correctional institution and a California federal court. NIJ is also looking at enhancing the technology with real-time images of subjects, without requiring them to stop in a portal. Working with the Federal Aviation Administration, the NIJ plans to integrate other sensors to enhance the technology's ability to detect explosives and other kinds of contraband.

- A hybrid-passive approach using millimeter wave and infrared cameras in a stand-alone and sensor suite combination. The difference in the thermal energy retained and emitted by different materials causes them to appear in the pictures as distinct images. These technologies are complementary since the infrared camera has more range that the millimeter wave camera, while the millimeter wave camera has better resolution. The components of such a system have already been successfully demonstrated. The NIJ is continuing to study this technology with the goal of building a prototype.

- A sensor suite combining radar and ultrasound imaging. These work together in much the same manner as millimeter wave/infrared. The radar can detect weapons at a greater range, but does not have the resolution of ultrasound. This approach can also spot non-metallic weapons. A successful component demonstration has been conducted, and the basic acoustic technology has been successful.

NIJ is also exploring other approaches that would move these technologies further along:
- A low-cost hand-held acoustic device to detect weapons on people up to distances of 20 to 30 feet.
- A hand-held MMW device to detect weapons at an acceptable range using a unique antenna.
- Vehicle-mounted devices to detect weapons on people up to 20 feet away. Technologies would include radar, infrared, and magnetic field disturbances.
- A body-cavity search system using magnetic resonance imaging (MRI) technology. This could be used for weapons and contraband detection in corrections and other applications.

Less-Than-Lethal Incapacitation

Examples of cooperative arrangements NIJ has established to develop technologies for less-than-lethal incapacitation include the following.
- Velocity Range Correction Projectile Launcher — The Department of Energy's Lawrence Livermore lab in California is investigating methods to combat the lethality of blunt

trauma projectiles used for crowd control. If fired at too close a proximity, a round can be fatal, and authorities have expressed concern about accidental fatalities among innocent bystanders. A velocity and range correction device would determine the distance between the projectile launcher and the target, and automatically adjust the velocity to one appropriate for the range. It would allow officers to choose their distance, as opposed to standing at the outer limits of the launcher's range. It would also diminish the possibility of human error if, for example, a bystander or a child inadvertently walked in front of the launcher prior to firing.

- Physiological Responses to Energetic Stimuli — This project entails ongoing research at the Oak Ridge National Laboratory in Tennessee into various technologies to produce temporary physiological responses, such as nausea, dizziness, and disorientation. Under study is the body's susceptibility to sound, light, and ionizing and non-ionizing electromagnetic waves. The goal of the project is to learn what the body reacts to and develop a device, tool, or weapon that produces that reaction. These weapons would temporarily incapacitate an individual or group without lasting physiological damage. The lab has investigated the potential of a thermal gun, which uses radio frequency to raise the body temperature and produce disorientation; a seizure gun, which uses electromagnetic energy to induce epileptic-like seizures; and a magnetophosphene gun which produces a blow similar to one that causes a person to "see stars."

> TO DETERMINE LAW ENFORCEMENT'S NEEDS, NIJ WORKS CLOSELY WITH STATE AND LOCAL DEPARTMENTS. THE PURPOSE IS TO LET THE GRASSROOTS OF AMERICAN POLICING, NOT JUST WASHINGTON, SET PRIORITIES. THE GOAL IS FEDERAL SUPPORT, BUT LOCAL DIRECTION.

- Disabling Net and Launcher System — This project combines the efforts of private industry and the U.S. Army to produce a nonlethal, launchable net that fits a conventional weapons system, and that will safely ensnare attacking or fleeing subjects. A private company has already devised a system, which complies with the rules of military engagement, but they are less stringent than those under which law enforcement must operate. The device is being reworked to fit in a standard 37mm underslung launcher, giving an officer the option of using lethal or nonlethal force.

Technologies to Stop Fleeing Vehicles

For several years, NIJ has funded the development of technologies to stop fleeing vehicles. Here are some envisioned for development in the next three to five years.

- Retractable Barrier Strip — This is the same as the commercial spiked barrier strips, but with retractable spikes that can be operated remotely. It halts fleeing vehicles, but the spikes retract before police run over it.
- Fleeing Vehicle Tagging System — A system that attaches a small radio-frequency transmitter to fleeing vehicle via handheld or car-mounted launcher. A polymer adhesive adheres the transmitter to the vehicle. Police follow the signal instead of pursuing through city streets.
- Radio Communicator — This technology uses a low-powered transmitter in a police vehicle to override commercial radio broadcast signals. It enables police to communicate with the driver of the fleeing vehicle.
- Enhanced Police Sirens — Sirens that deliver a high level of acoustical energy toward the suspect vehicle. It can overcome the inability to hear a siren at high speeds and increasing distance, and also warn other motorists of an oncoming pursuit.
- Vehicle Barriers — This technology is of two types: fixed-in-place, which would be used where passage is not permitted; and moveable, which would be used where passage is permitted. Barriers would be adapted from these technologies to stop vehicles.
- Caltrops — This is an iron ball with four projecting spikes that are set so one spike is always pointed upward. Caltrops could be fitted with hollow spikes for a controlled air leak, and could be deployed in stringed formation from a frangible canister.
- Deployable Nets — These would be deployed from a pursuing vehicle, aircraft, or from a fixed location, and would be outfitted with mechanism to cause drag or reduce performance to stop a vehicle; a net also could use a parachute system or a net attached to a permanent barrier.
- Tire Shredders — These would be especially useful at border checkpoints to prevent high-speed pursuits. They would cause rapid loss of air and shred, not puncture, the tires.

Tire shredders could be remotely deployed with a deflator bar; the spikes would remain in the tire when the bar is retracted.

In addition, NIJ supports two other efforts related to vehicle-stopping technologies. One is a laboratory evaluation of five proposed electric or electromagnetic vehicle stopping technologies. The goal is to develop prototype stopping devices. The evaluation is being conducted jointly by the U.S. Army's Army Research Lab and NIJ.

The other project is the NIJ-funded Pursuit Management Task Force which seeks to define police practice and the role of technology in high-speed fleeing vehicle pursuits. The task force includes senior law enforcement officials from local, state, regional, and federal agencies.

DNA Testing

DNA, or deoxyribonucleic acid, is the basic hereditary material found in all living cells. It has a distinctive pattern for each individual, giving instructions for eye color, hair color, height, bone structure. DNA analysis is among the most powerful investigative tools in law enforcement today. Performed correctly, it is impartial and infallible.

> THE COMMERCIAL MARKETPLACE DOES NOT READILY PROVIDE EASY-TO-ADAPT TECHNOLOGIES TO MEET LAW ENFORCEMENT'S PRIORITIES. NIJ'S RESEARCH AND DEVELOPMENT PROGRAM SEEKS TO RESPOND TO VITAL POLICE TECHNOLOGY REQUIREMENTS THAT WOULD OTHERWISE GO UNFULFILLED.

One five-year NIJ project costing $40 million seeks to increase DNA testing through funding improvements in the laboratories of state and local law enforcement agencies. A second five-year NIJ project seeks to help secure impartial and infallible DNA analysis in a timely, cost-effective way. Project goals are to reduce dramatically the cost of DNA tests, from $700 a test to less than $10; to reduce test times from hours to minutes; to increase the reliability and legal credibility of DNA testing; and to develop standard reference materials for population database genetics.

NIJ has helped foster the early use of DNA in the criminal justice arena. For example, when DNA analysis was first used in courts, available statistics were based on a small sampling of the population. Defense attorneys demanded proof that the techniques were valid and could be applicable to all racial and ethnic groups. Under an NIJ grant, a population geneticist in Texas built a data base by collecting DNA samples from about 70 populations around the world, and developed analytical methods to test the data. The information was used to develop standards for computing match probabilities.

Another example is NIJ funding of National Academy of Science examinations of DNA testing and resulting publications. In 1996, the National Academy of Sciences announced that there is no longer any reason to question the reliability of DNA evidence.

3-4. Voluntary Standards and Dissemination

Voluntary standards and dissemination are two of several functions that come under the umbrella of the National Law Enforcement and Corrections Technology Center (NLECTC), a network of hub, regional, and specialized offices that the Office of Science and Technology uses as a national governance and management structure.

In a time of rapidly advancing technologies, NLECTC serves as a one-stop technology education, assessment, and referral source for the nation's law enforcement agencies. NLECTC consists of a national hub in Rockville, Maryland; regional centers in New York, South Carolina, Colorado, and California; and three specialized offices: the Border Research and Technology Center (BRTC) in California; the Office of Law Enforcement Technology Commercialization (OLETC) in West Virginia; the Office of Law Enforcement Standards (OLES) in Maryland; and the National Center for Forensic Science in Orlando, Florida.

NLECTC's hub is in a Maryland suburb of Washington, D.C., and has several functions.

Dissemination

The Maryland office is the nation's collection agent and repository of information about law enforcement and corrections technology. It publishes and distributes a large collection of reports on diverse matters, such as body armor, pepper spray, patrol car tire tests, metallic handcuffs, and DNA profiling. It also publishes *TechBeat*, a periodical covering the latest developments in police technology. It created and manages JUSTNET, NLECTC's site on the World Wide Web.

> R&D INEVITABLY CARRIES WITH IT SOME FALSE STARTS, SLOW PROGRESS, AND UNFULFILLED EXPECTATIONS THAT CAN TEST THE PATIENCE OF THE CRIMINAL JUSTICE COMMUNITY. THE NIJ'S RESPONSE IS TO EXPERIMENT WITH DIFFERENT APPROACHES TO A PROBLEM. THE BELIEF IS: KEEP PLUGGING AWAY IN CONSULTATION WITH TECHNOLOGY DEVELOPERS, AND SUCCESSFUL TECHNOLOGIES AS WELL AS NEW EQUIPMENT WILL EMERGE.

Voluntary Standards

The Maryland office and the Office of Law Enforcement Standards jointly perform NIJ's work of developing standards and testing police equipment. OLES develops the measurement methods and voluntary national performance standards for equipment and technology used by criminal justice practitioners. Areas of research and standard-setting include clothing, communications systems, emergency equipment, investigative aids, protective equipment, security systems, vehicles, weapons, and analytical techniques and standard reference materials used by forensic scientists. OLES is housed at the National Institute of Standards and Technology, whose resources it uses. It works closely with NLECTC's national center to conduct tests and guarantee the quality and performance of equipment used by law enforcement and corrections officers.

Coordination

The Maryland office staffs and coordinates the work of the Law Enforcement and Corrections Technology Advisory Council. Four regional NLECTC centers each serve law enforcement and corrections agencies in nine or more states. Each office (1) has a specialized technology focus; (2) may provide on a case-by-case basis expert assistance to police agencies within its region and nationwide; (3) disseminates information to the law enforcement agencies in its area; and (4) uses an advisory council of state and local law enforcement and corrections personnel and officials to ensure the center's relevance and effectiveness.

Technology Focus. Each center's technology focus makes it responsible for encouraging research and development within specific areas of law enforcement and corrections as well as providing test beds for experimentation and evaluation. An example is the Southeast regional center,which is testing at a local Navy brig an eight-kilobyte electronic "smart" card for prisoners. The card, which includes a photo identification and a bar code, contains a prisoner's criminal record and medical information, and may be used to allow or deny access to certain brig areas.

Expert Assistance. This makes available to police agencies throughout the nation expertise specific to its regional center. An example is the assistance the Western regional center, expert in forensic imagery, has provided to police departments from California to Delaware in enhancing the quality of video tapes capturing crimes in progress on security cameras and cameras installed in bank ATM machines.

Information Dissemination. Each center helps the agencies in its area to obtain information on current and emerging technologies. For example, the centers can provide manufacturer and product information to local agencies.

Advisory Councils. These regional councils provide feedback from the grassroots about law enforcement's technology needs and problems, then help disseminate information about technological responses to those needs.

The Office of Law Enforcement Technology Commercialization (OLETC) encourages the commercial development and manufacture of promising, innovative technologies. It offers support and information about the intricacies of commercialization to law enforcement agencies and criminal justice organizations, as well as the research, product development, and manufacturing communities. OLETC is a joint project sponsored by NIJ, the National Aeronautics and Space Administration, and the National Technology Transfer Center. The Border Research and Technology Center in San Diego has the special mission of fostering technologies which provide improved capabilities in border surveillance, security, and identification. The center works closely with the U.S. Customs Service, the U.S. Border Patrol, and local law enforcement agencies concerned with border problems. The National Center for Forensic Science in Orlando, Florida, focuses on research and training in the area of arson and explosives.

Discussion of the future of technology in any arena can quickly turn to specula-
tion about dramatic breakthroughs on the outer edges of high tech and the engi-
neering of dazzling devices to solve problems. Policing likely will have its share of
as-yet-unanticipated technological breakthroughs in the next century. But for now,
technology's future benefits for policing depend to a considerable degree on practi-
cal and near-term matters. One such matter is the availability of funding to pay for
current and new technologies. Another is the outcome of several current efforts by
the National Institute of Justice and the FBI. A third is the police response to the
use of high technology by some criminals.

PART THREE:
THE FUTURE OF
POLICE TECHNOLOGY

FUNDING FOR POLICE TECHNOLOGY

Technological advances are useful only if police agencies can afford them. That point is
made in the results of a survey issued in 1996 by the Police Executive Research Forum (PERF).
The PERF survey found, "In their efforts to improve the patrol function and maximize the
impact of community policing programs, police nationwide are acquiring new technology
designed to decrease response time and speed information dissemination." But the PERF survey
also found that 83 percent of survey "respondents listed the high cost of acquiring these tech-
nologies as the primary deterrent in their past efforts to become better equipped." Other factors:
"Twenty-five percent of respondents noted lack of information about available products as a sig-
nificant factor. A smaller percentage of respondents also mentioned the complexity of the tech-
nologies and the need for more support from management as obstacles to new acquisitions."

A case study included in the Forum's survey report illustrates how an agency benefits when
it can afford to upgrade information technology. The Forum survey sampled 600 police agencies
and had a 35 percent response rate. The case study summary says:

Ten years ago, the Pinellas County (Florida) Sheriff's Office was working with an antiquated
system of reporting, with four separate databases operating simultaneously and each serving
limited purposes. As in most other police departments nationwide, police officers and detectives
were bogged down with administrative detail and report writing, which cut down on their time
on the streets.
Today, the department is a model of efficiency. All four databases have been consolidated into
one major network, and average report times have been cut from 35 to 40 minutes to ten minutes,
essentially deploying officers from behind their desks to the communities where they are needed
most. The office is nearly paper-free, operating on an intra-office e-mail system and the
Augmented Criminal Investigative Support System (ACISS) database, which contains almost
all relevant case information dating back ten years.

FULFILLMENT OF CURRENT EFFORTS

Several efforts to improve the use of existing police technologies and foster the develop-
ment and availability of new ones are underway.

The National Institute of Justice has assumed several formidable tasks in attempting to
encourage police technology. The tasks include (1) surmounting impediments to progress such
as the fragmentation of American policing and liability concerns; (2) harnessing the resources of
the national laboratories and other federally funded facilities to the advancement of police tech-
nology; and (3) speeding innovation from the laboratory to the police marketplace, perhaps the
most difficult of the three tasks. To the extent that NIJ succeeds, it will help to transform the
future of police technology. The successful fulfillment of specific NIJ projects is also important.
Two examples:

• The Institute's program to improve the quality and availability of DNA technology to
   local and state law enforcement will strengthen criminal investigation and prosecution in
   the 21st Century.

• NIJ supports several projects designed to help protect police officers and citizens. The
   projects include already noted efforts to help police identify concealed weapons and to
   use less-than-lethal force in ways that protect both the police and citizens. If these pro-
   jects achieve their goals, life will be safer for everyone in the next century.

The Federal Bureau of Investigation is seeking to make two indispensable contributions to
American law enforcement. It is upgrading the National Crime Information Center in a project

called NCIC 2000 and attempting to remedy the fragmented state of the nation's Automated Fingerprint Identification Systems (AFIS) through its IAFIS project. The projects are being undertaken in conjunction with each other.

NCIC 2000 is designed to increase the speed and capacity of the current NCIC system which allows officers to check the NCIC database for wants and warrant information on detained subjects. If the officer gets a "hit," probable cause is established for further action. NCIC 2000 seeks to add sophisticated computer technology, thereby increasing the capacity of the existing system and enabling officers to transmit graphic images such as fingerprints and mug shots.

THE DEVELOPMENT OF POLICE TECHNOLOGY IN THE NEXT CENTURY WILL BE KEYED IN PART TO ATTEMPTING TO KEEP UP WITH CRIMINAL USE OF TECHNOLOGY.

While NCIC 2000 is to have a database of single fingerprints of wanted persons, the International Automated Fingerprint Identification System (IAFIS) is slated to be a huge database of tenprint cards (cards with prints of all ten fingers). As of 1996, the bureau processed anywhere from 40,000 fingerprints a day to upward of 80,000 on unusually heavy days. Plans are that IAFIS be able to process at least 60,000 per day.

The difference between the two systems is that the images in the NCIC database are not a true and total fingerprint. When printed out, the image is not identical to an inked print; the computerized version has less definition and requires filtering so it doesn't falsely identify and reject possible matches. The technology, in layman's terms known as "one-to-one" matching, is a matter of identification verification. It compares one print to one record for a simple "match" or "no match" response.

In contrast, IAFIS technology is designed to use "one-to-many" matching, which requires that the computer extract minutiae from the print and compare it to all records in the database. One of the most important uses of IAFIS is to be the ability to search unknown fingerprints, including those obtained at crime scenes, in a national database of significant offenders. This capability, when added to enhanced DNA capabilities, criminal profiling, and tracking of serial offenders through the FBI'S VICAP program, is designed to improve significantly the identification, apprehension, and prosecution of career criminals.

Law enforcement agencies will not need sophisticated computer technology to access either NCIC 2000 or IAFIS. Varying levels of participation will be available, depending on the level of technological expertise and the equipment available at the agency.

If fully realized, the two projects one day will provide a completely integrated system that can transmit textual information, single fingerprints, and mug shots and that can process ten-print cards. Law enforcement technology will be significantly advanced.

The FBI also has its Drugfire program. In place since 1992, Drugfire has kept track of cartridge casings retrieved from more than 3,700 shootings in Maryland, Virginia and the District of Columbia. Investigators can access the database to compare spent ammunition found at crime scenes and link fired cartridge casings or projectiles to other crimes.

The Bureau of Alcohol, Tobacco and Firearms (ATF) has its own program. The ATF's Integrated Ballistics Identification System does the same work as Drugfire, comparing thousands of rounds in seconds. It has been successful in linking a number of shootings to one weapon or suspect. Both programs are currently being implemented in cities throughout the country. Unlike the fragmented state of AFIS, it is hoped that investigators will be able to access either database in the near future.

In an effort to streamline the booking process, the Drug Enforcement Agency developed and implemented the Joint Automated Booking Station, which uses computer technology to reduce booking time from 75 minutes to 15.

CRIMINAL USE OF HIGH TECHNOLOGY

High technology such as computerization and wireless communications is transforming the ways of some criminals. For example, the Forum study reports that domestic and international "drug trafficking organizations routinely surpass the communications capabilities of law enforcement. Street-level dealers and kingpins have access to the best communications technologies.... E-mail, the Internet, and cellular communications have made illegal transactions more and more difficult to trace." The development of police technology in the next century will be keyed in part to attempting to keep up with criminal use of technology.

Our intention for this report is to inform. There is no list of firm recommendations for action in the report. However, we have articulated and categorized some observations for federal policy makers seeking to spur development of successful law enforcement technologies that enhance crime-fighting efforts.

PART FOUR:

FEDERAL EFFORTS

COORDINATING FEDERAL EFFORTS

Many federal agencies sponsor law enforcement technology projects. Most federal law enforcement agencies — among them, the Federal Bureau of Investigation, the Drug Enforcement Administration, the Immigration and Naturalization Service, Customs, Secret Service, the Bureau of Alcohol, Tobacco and Firearms — have technology development budgets. These budgets are generally used to meet specific agency requirements.

Additionally, other federal agencies have significant programs in security technology. Notable examples are the Department of Defense and the Department of Energy's nuclear security programs. Both agencies have produced and are working on programs with law enforcement applications. Similarly, the Federal Aviation Administration has invested in developing explosives detection technology, a law enforcement priority, and is now working with NIJ.

Amidst all these efforts, fragmentation and duplication of effort will likely occur. Systems may be developed that are incompatible with each other. Thus, federal policy makers may wish to consider designating a coordinating point for law enforcement technology programs. If a specific technology development program is required to meet multiple requirements, one agency could be tasked with leading the development effort. That agency could be required to obtain and provide an overview of all of federal government programs within a law enforcement technology area. It could encourage collaboration and help ensure that proposed technologies meet interoperability standards, thereby reducing the recurring problem of incompatible systems within law enforcement.

It is our observation that the National Institute of Justice is well suited to coordinate, when needed, federal efforts in the development of law enforcement technology . We base this observation on these factors:

Experience

As this report notes, the agency in recent years has made considerable progress in supporting federal, state, and local law enforcement in technology development. It has learned how to coordinate activities benefiting law enforcement across government and agency boundaries.

Reputation

NIJ has established a reputation as an objective source of information, assessment, and development. It champions science in projects such as those it sponsors to foster and enhance DNA technology and other forensic advances.

Single Mission

The agency has no investigative or other law enforcement role; its only products are research, development, dissemination, and coordination of efforts to improve criminal justice.

Established Partnerships

Within the federal arena, NIJ has created successful partnerships with the Departments of Defense and Energy and the National Air and Space Administration for adapting already existing technologies to meet law enforcement needs. It has worked with the Deputy Attorney General's office to establish the Justice Technology Coordination Council to encourage cooperation and reduce duplication among federal agencies.

Another means of coordinating federal efforts to develop law enforcement technology would be the appointment of a science and technology adviser by the Attorney General. The adviser would chair a coordinating council to track law enforcement technology development programs within the federal government. The adviser and council would have no fiscal or operational authority, but would help reduce duplication of effort, increase cooperation, and seek adequate resources for needed technology programs.

The Attorney General's appointment of a science and technology adviser would emphasize the importance of developing law enforcement technology. Consideration should also be given to appointing a senior law enforcement official to the Technology Policy Board of the White House Office of Science and Technology. The board currently does not address law enforcement technology matters in its deliberations.

ENCOURAGING INDUSTRY

Among the obstacles to progress in the development and adoption of new technologies are the consequences of fragmentation of local policing as well as liability concerns, particularly on the part of manufacturers. There are measures which could encourage industry to serve the police market with new products, including:

- Industries are sometimes reluctant to manufacture and market technologies developed under NIJ's aegis unless they are assured of a profit. That generally requires a period of exclusive patent rights. NIJ could be authorized to waive government patent rights or assign exclusive use of a license when necessary.

- One of industry's principal concerns in developing and manufacturing new police technologies is the lack of protection from liability suits for products meeting appropriate standards and passing required tests. Although federal agencies are generally protected from product-use liability suits, such is not the case for state and local police agencies. The result is that manufacturers may be reluctant to make and market new technologies, and the police are subject to liability suits involving innovative technologies. This is particularly true in matters involving safety and less-than-lethal technologies. Federal policy makers may wish to provide the law enforcement technology industry with the same liability protection that defense-sector industries receive.

> NIJ HAS DONE A REMARKABLE JOB IN ESTABLISHING A TECHNOLOGY DEVELOPMENT INFRASTRUCTURE.
>
> BUT AS YOUTH VIOLENCE INCREASES, ORGANIZED CRIME PROLIFERATES, CRIMINALS SHOW LESS RESPECT FOR POLICE AUTHORITY, AND CRIMINALS GET BETTER AT COMBATING POLICE WEAPONRY AND TACTICS, IT IS ESSENTIAL THAT FUNDING BE MADE MORE IMMEDIATELY AVAILABLE FOR DEVELOPING TECHNOLOGIES THAT SUPPORT POLICE AGENCIES.

STRENGTHENING STANDARDS

NIJ enforces product standards through a generally successful voluntary compliance program. Although voluntary compliance is preferred, NIJ has no means for investigation and enforcement if a technology provider is in consistent noncompliance with established standards. Because police technologies are critical tools in maintaining officer and public safety, inadequate or faulty equipment can cause injury and death. Thus, policy makers may want to consider adding an enforcement element to NIJ's standards setting authority with the objective of providing NIJ with clear, firm authority to develop and enforce a standards program.

HELPING THE POLICE ACQUIRE TECHNOLOGY

As previously noted, police spend most of their budgets on personnel and standard equipment and have little left over to buy new technologies. There are several options that policy makers could explore as a means to help state and local police acquire new equipment. These options include:

- Promoting buying consortiums which allow the police to achieve economies of scale by obtaining technologies through purchasing pools. Industry is helped with its marketing problems through obtaining bulk rather than resource-draining individual sales.
- Promoting the use of state and regional economic development agencies. These help other fragmented market communities similar to the law enforcement community.
- Expanding the availability of technology-purchasing grants to local and state police.
- Establishing a federal low interest loan program for purchasing police equipment.
- Further loosening restrictions on Department of Defense surplus property. The Department of Defense holds significant amounts of surplus property that would benefit state and local police. Under current legislation, the department has a program to expedite transfer of surplus property to the police, and this effort should be accelerated.

FUNDING AN ADEQUATE TECHNOLOGY BUDGET

Although funding for NIJ's Office of Science and Technology has increased significantly in recent years, it is still inadequate to address the level of research and technology development necessary for bringing much needed technologies to near-term fruition in supporting the requirements of our nation's law enforcement agencies. Much of the NIJ/OST budget has been ear-

marked for specific projects that are often not the high priority technologies identified by local and state law enforcement.

In spite of these restrictions, NIJ has done a remarkable job in establishing a technology development infrastructure to support its police consumers. But as youth violence increases, organized crime proliferates, criminals increasingly show less respect for police authority, and criminals become more capable in combating police weaponry and tactics, it is essential that funding be made more immediately available for developing timely technologies to support police agencies.

Through LECTAC and other forums, police officials have consistently identified vital technology needs, including (1) detecting concealed weapons; (2) stopping fleeing felons; and (3) new devices for using less-than-lethal force. A fourth critical requirement, DNA laboratory and database improvements, will require additional funding in coming years beyond the current level of effort.

In addition, each of the NIJ/OST regional technology centers have now matured and developed a list of technology initiatives that should be funded to support their regional concerns. Without adequate funding, the centers, and their important advisory councils, will not be able to realize the next level of community support and outreach so essential to continued regional law enforcement acceptance.

In conclusion, we must not forget that public safety remains the nation's NUMBER ONE priority. Providing stabilized funding for technology development to support law enforcement must be given the highest priority if the cause of public safety is to be served. Of equal high priority should be the careful consideration of the policy changes, as noted above, which can further improve the effectiveness of federal support for law enforcement.

HELPING THE POLICE ACQUIRE TECHNOLOGY

o PROMOTE BUYING CONSORTIUMS WHICH ALLOW THE POLICE TO ACHIEVE ECONOMIES OF SCALE BY OBTAINING TECHNOLOGIES THROUGH PURCHASING POOLS. INDUSTRY IS HELPED WITH ITS MARKETING PROBLEMS THROUGH OBTAINING BULK RATHER THAN RESOURCE-DRAINING INDIVIDUAL SALES.

o PROMOTE THE USE OF STATE AND REGIONAL ECONOMIC DEVELOPMENT AGENCIES. THESE HELP OTHER FRAGMENTED MARKET COMMUNITIES SIMILAR TO THE LAW ENFORCEMENT COMMUNITY.

o EXPAND THE AVAILABILITY OF TECHNOLOGY-PURCHASING GRANTS TO LOCAL AND STATE POLICE.

o ESTABLISH A FEDERAL LOW INTEREST LOAN PROGRAM FOR PURCHASING POLICE EQUIPMENT.

o FURTHER LOOSEN RESTRICTIONS ON DEPARTMENT OF DEFENSE SURPLUS PROPERTY. THE DOD HOLDS SIGNIFICANT AMOUNTS OF SURPLUS PROPERTY THAT WOULD BENEFIT STATE AND LOCAL POLICE. UNDER CURRENT LEGISLATION, THE DEPARTMENT HAS A PROGRAM TO EXPEDITE TRANSFER OF SURPLUS PROPERTY TO THE POLICE. THIS EFFORT SHOULD BE ACCELERATED.
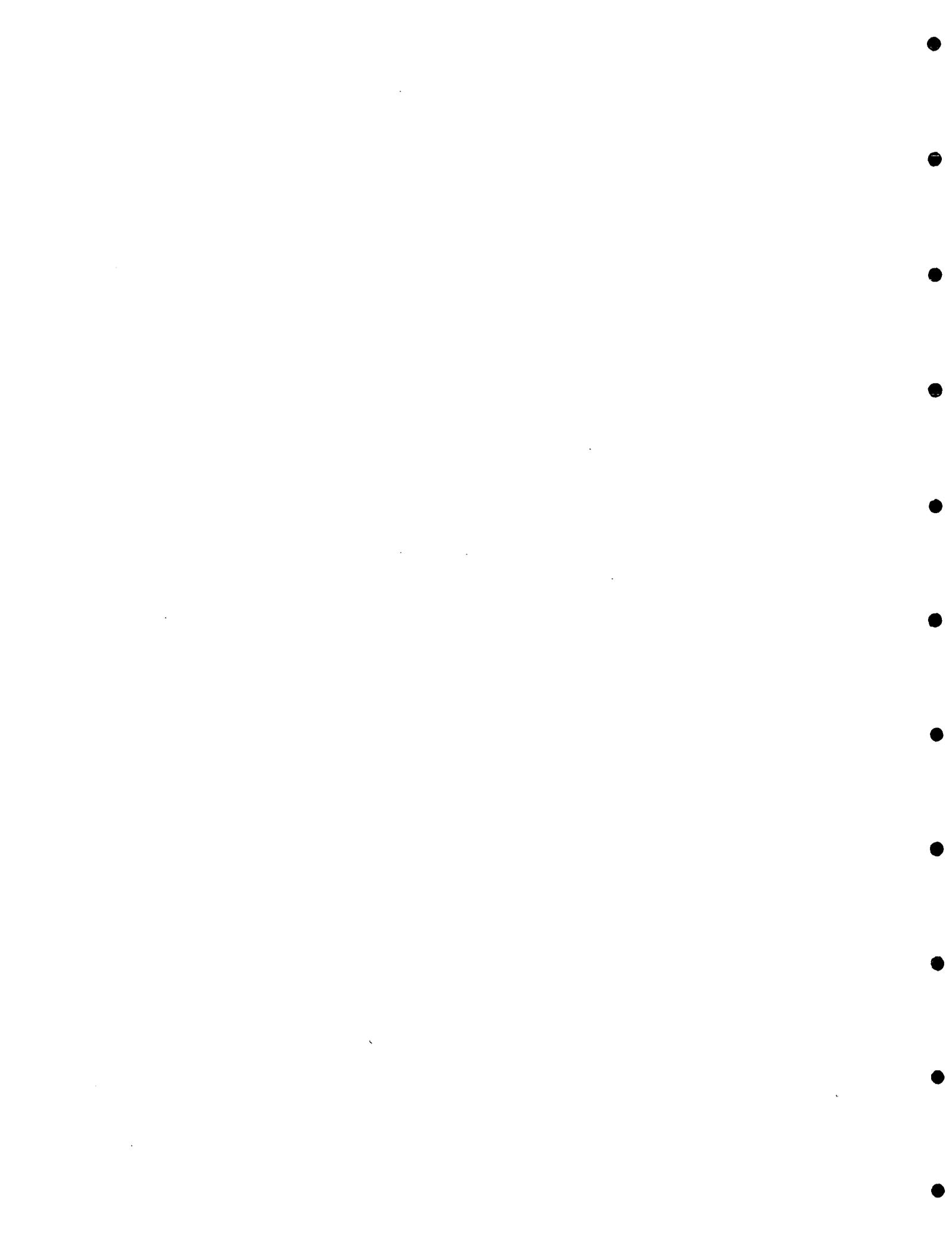
THE NATIONAL LAW ENFORCEMENT AND CORRECTIONS TECHNOLOGY
CENTER'S REGIONAL OFFICES

In October 1994, the National Institute of Justice inaugurated the National Law Enforcement and Corrections Technology Center (NLECTC) as a central information collection and dissemination operation for the nation's law enforcement agencies. A national office was opened in the Washington, D.C., suburb of Rockville, Maryland. Since then, NIJ has created five regional NLECTC offices. Four of them serve police and corrections agencies in specific states. Following is information on each office.

NORTHEAST REGION: Serves Connecticut, Delaware, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and Wisconsin.
Location: Rome, New York.
Partnership: The Rome Laboratory which is the Air Force Super Laboratory for command, control, communications, computers and intelligence research and development.
Technology emphasis: Concealed weapons detection, covert tracking and tagging, advanced database design, and voice identification.

SOUTHEAST REGION: Serves Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, Illinois, Indiana, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, West Virginia.
Location: Charleston, South Carolina.
Partnership: Navy In-Service Engineering-East, a U.S. Navy facility.
Technology emphasis: Corrections and surplus U.S. government property for redistribution to law enforcement, corrections, and other criminal justice agencies. The office seeks to facilitate identification, development, manufacture, and adoption of new products and technologies specifically meant for corrections.

ROCKY MOUNTAIN Region: Serves Colorado, Kansas, Montana, New Mexico, Nebraska, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.
Location: Denver, Colorado.
Partnership: Denver Research Institute, Denver University, and the Sandia National Laboratories.
Emphasis: Command, control, and communications, interoperability, explosives' detection and disablement, and ballistics.

WESTERN REGION: Serves Alaska, Arizona, California, Hawaii, Idaho, Nevada, Oregon, Utah, and Washington.
Location: El Segundo, California.
Partnership: Aerospace Corporation, a federally funded research and development center of the U. S. Air Force.
Technology emphasis: Forensic analysis, imaging technologies, and technologies to prevent high-speed vehicle pursuits.

THE BORDER RESEARCH AND TECHNOLOGY CENTER is located in San Diego, California. The center's special mission is to advance technologies that provide improved capabilities in border surveillance, security, and identification. It coordinates its efforts closely with the U.S. Customs Service, the U.S. Border Patrol, and local law enforcement agencies concerned with border matters.

THE OFFICE OF LAW ENFORCEMENT TECHNOLOGY COMMERCIALIZATION (OLETC) fosters commercial development and manufacture of promising, innovative technologies. It operates by providing technology commercialization and support and technology transfer information to law enforcement and other criminal justice organizations and the manufacturing and technology communities. OLETC is a joint project sponsored by NIJ, the National Aeronautics and Space Administration, and the National Technology Transfer Center, and is located at Wheeling Jesuit College in Wheeling, West Virginia.

THE NATIONAL CENTER FOR FORENSIC SCIENCE is located at the University of Central Florida in Orlando. This center focuses on research and training in the area of arson and explosives. Its goals include the development of a restricted-access electronic library for forensic and law enforcement professionals; support for the development of standard protocols for the collection and analysis of fire and explosion debris; supplemental training via the Internet, and through distance education and professional seminars; fundamental research to scientifically validate evidence collection and analysis procedures.

POLICE TECHNOLOGY TIMELINE

1850s
The first multi-shot pistol, introduced by Samuel Colt, goes into mass production. The weapon is adopted by the Texas Rangers and, thereafter, by police agencies nationwide.

1854-59
San Francisco is the site of one of the earliest uses of systematic photography for criminal identification.

1877
The use of the telegraph by police and fire departments begins in Albany, New York in 1877.

1878
The telephone comes into use in police precinct houses in Washington, D.C.

1888
Chicago is the first U.S. city to adopt the Bertillon system of identification. Alphonse Bertillon, a French criminologist, applies techniques of human body measurement used in anthropological classification to the identification of criminals. His system remains in vogue in North America and Europe until it is replaced at the turn of the century by the fingerprint method of identification.

1901
Scotland Yard adopts a fingerprint classification system devised by Sir Edward Richard Henry. Subsequent fingerprint classification systems are generally extensions of Henry's system.

1910
Edmund Locard establishes the first police crime laboratory in Lyon, France.

1923
The Los Angeles Police Department establishes the first police crime laboratory in the United States.

1923
The use of the teletype is inaugurated by the Pennsylvania State Police.

1928
Detroit police begin using the one-way radio.

1934
Boston Police begin using the two-way radio.

1930s
American police begin the widespread use of the automobile.

1930
The prototype of the present-day polygraph is developed.

1932
The FBI inaugurates its crime laboratory which, over the years, comes to be world renowned.

1948
Radar is introduced to traffic law enforcement.

1948
The American Academy of Forensic Sciences (AAFS) meets for the first time.

1955
The New Orleans Police Department installs an electronic data processing machine, possibly the first department in the country to do so. The machine is not a computer, but a vacuum-tube operated calculator with a punch-card sorter and collator. It summarizes arrests and warrants.

1958
A former marine invents the side-handle baton, a baton with a handle attached at a 90-degree angle near the gripping end. Its versatility and effectiveness eventually make the side-handle baton standard issue in many U.S. police agencies.

1960s
The first computer-assisted dispatching system is installed in the St. Louis police department.

1966
The National Law Enforcement Telecommunications System, a message-switching facility linking all state police computers except Hawaii, comes into being.

1967
The President's Commission on Law Enforcement and Administration of Justice concludes that the "police, with crime laboratories and radio networks, made early use of technology, but most police departments could have been equipped 30 or 40 years ago as well as they are today."

1967

The FBI inaugurates the National Crime Information Center (NCIC), the first national law enforcement computing center. NCIC is a computerized national filing system on wanted persons and stolen vehicles, weapons, and other items of value. One observer notes NCIC was "the first contact most smaller departments had with computers."

1968

AT&T announces it will establish a special number — 911 — for emergency calls to the police, fire and other emergency services. Within several years, 911 systems are in widespread use in large urban areas.

1960s

Beginning in the late 1960s, there are many attempts to develop riot control technologies and use-of-force alternatives to the police service revolver and baton. Tried and abandoned or not widely adopted are wooden, rubber and plastic bullets; dart guns adapted from the veterinarian's tranquilizer gun that inject a drug when fired; an electrified water jet; a baton that carries a 6,000-volt shock; chemicals that make streets extremely slippery; strobe lights that cause giddiness, fainting and nausea; and the stun gun that, when pressed to the body, delivers a 50,000-volt shock that disables its victim for several minutes. One of the few technologies to successfully emerge is the TASER which shoots two wire-controlled, tiny darts into its victim or the victim's clothes and delivers a 50,000-volt shock. By 1985, police in every state have used the TASER, but its popularity is restricted owing to its limited range and limitations in affecting the drug- and alcohol-intoxicated. Some agencies adopt bean bag rounds for crowd control purposes.

1970s

The large-scale computerization of U.S. police departments begins. Major computer-based applications in the 1970s include computer-assisted dispatch (CAD), management information systems, centralized call collection using three-digit phone numbers (911), and centralized integrated dispatching of police, fire, and medical services for large metropolitan areas.

1972

The National Institute of Justice initiates a project that leads to the development of lightweight, flexible, and comfortable protective body armor for the police. The body armor is made from Kevlar, a fabric originally developed to replace steel belting for radial tires. The soft body armor introduced by the Institute is credited with saving the lives of more than 2,000 police officers since its inception into the law enforcement community.

Mid-1970s

The National Institute of Justice funds the Newton, Massachusetts, Police Department to assess the suitability of six models of night vision devices for law enforcement use. The study leads to the widespread use of night vision gear by today's police agencies.

1975

Rockwell International installs the first fingerprint reader at the FBI. In 1979, the Royal Canadian Mounted Police implements the first actual automatic fingerprint identification system (AFIS).

1980

Police departments begin implementing "enhanced" 911, which allows dispatchers to see on their computer screens the addresses and telephone numbers from which 911 emergency calls originated.

1982

Pepper spray, widely used by the police as a force alternative, is first developed. Pepper spray is Oleoresin Capsicum (OC), which is synthesized from capsaicin, a colorless, crystalline, bitter compound present in hot peppers.

1993

More than 90 percent of U.S. police departments serving a population of 50,000 or more are using computers. Many are using them for such relatively sophisticated applications as criminal investigations, budgeting, dispatch, and manpower allocation.

1990s

Departments in New York, Chicago, and elsewhere increasingly use sophisticated computer programs to map and analyze crime patterns.

1996

The National Academy of Sciences announces that there is no longer any reason to question the reliability of DNA evidence.
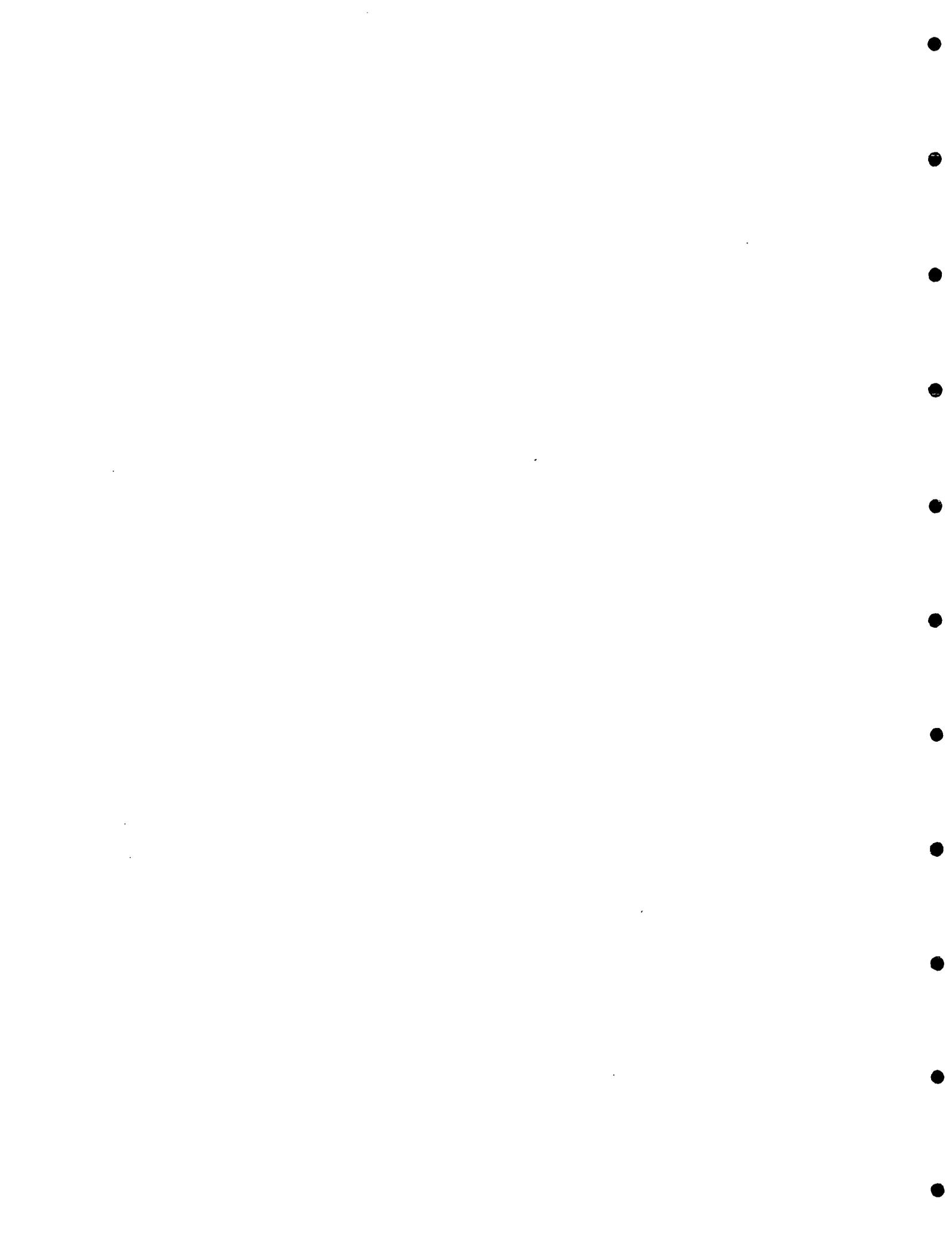
THE EVOLUTION AND DEVELOPMENT OF POLICE TECHNOLOGY

A Technical Report

PART ONE:

POLICE

TECHNOLOGY

UNTIL NOW

THE POLITICAL ERA

Scholars divide the history of U.S. policing into three eras. The first, from 1840 to about 1920, is called the Political Era. Police and politicians in many urban areas had cozy, mutually beneficial ties. Police jobs were for sale and many officers took bribes. "The officer on the beat dealt with crime, disorder, and other problems as they arose. In addition, the police carried out service functions such as caring for derelicts, operating soup kitchens, regulating public health, and handling medical and social emergencies (Cole, 1995)."

In the midst of this era, the police came to be armed with two forms of technology — the gun and the nightstick — that, with some modernizing, they continue to use today when called upon to use force. Whatever technological progress the police have made since the second half of the 19th century, to a considerable extent they still rely on basic tools available in the gaslight era for the protection of innocent life and themselves.

Technological advances for the police included first uses in the late 1870s of the telegraph and telephone, installation of police callboxes, development and adoption in the 1880s of the Bertillon system of criminal identification, and the development and use at the turn of the century of fingerprinting systems to aid in criminal investigations.

THE PROFESSIONAL MODEL ERA

Historians call the period from 1920-1970 the Professional Model Era. Influenced by the Progressive movement, reformers sought to rid government of undesirable influences and create what they deemed professional police departments. Such departments sought to stay out of politics, provide good training and tighter discipline, take advantage of technological developments, and, most important, emphasize the crime-fighting role of the police. Technology, according to criminal justice scholar George F. Cole, "helped emphasize discipline, equal enforcement of the law, and centralized decision making," hallmarks of the Professional Model of policing.

Indeed, the police reformers demonstrated great faith in technology. "The American urban police have long hoped that technology would enhance their status as professionals and ease the growing burdens of policing urban areas," according to Peter K. Manning, a professor of criminal justice. "The most influential early twentieth century police reformers, August Vollmer, Bruce Smith, Harry Fosdick, and O.W. Wilson, held high hopes for police work and police management becoming more scientific. Since the first major technological innovation — the use of a telegraph by police and fire departments in Albany, New York, in 1877 — each major innovation ... has been envisioned as a solution to chronic, vexing policing problems (Manning, 1992)."

It should not be unexpected, then, that the name of August Vollmer, the leading advocate of police professionalism, is tied to pioneering in police technology. "Vollmer introduced the first 'lie detector' to be put to practical use... As early as 1922 he inaugurated a single fingerprint classification system and a simple but effective method of classifying handwriting specimens.... In the 1920s and early 1930s, the Berkeley police laboratory became the model and training ground for police laboratory technicians throughout the country (Bailey, 1995)."

Vollmer was police chief in Berkeley, California, from 1909-1932. "We cannot ignore the value of a fully equipped, scientific police laboratory as an aid in the detection and apprehension of criminals and the prevention of crime," Vollmer wrote in 1922 (Vollmer, 1997).

In 1932, the FBI inaugurated its laboratory which has come to be "recognized as the most comprehensive and objective forensic laboratory in the world." The lab started "with a microscope, some ultra-violet light equipment, a drawing board for firearms identification, and a Packard sedan called 'Old Beulah' for going to crime scenes (Kessler, 1993)."

TECHNOLOGY AND THE NATIONALIZATION OF CRIME

There were some other technological innovations reaching into the next two

decades. For example, radar was introduced to traffic law enforcement in the late 1940s. But it was not until the 1960s — 120 years after the inception of the modern era of policing — that a concerted national effort began to foster the development and widespread use of technology for the police.

That effort has its roots in the 1964 presidential campaign when Republican candidate Barry Goldwater made crime for the first time a national political issue. Goldwater lost the election by a wide margin to incumbent Lyndon B. Johnson, but Americans were becoming concerned about crime. "The news that the nation's crime rate doubled between 1940 and 1965, and increased five times faster than the population from 1958 to 1965, was both alarming and well-publicized. The rate of increase in 1964 alone was 13 percent." So while "Senator Barry Goldwater and the Republican strategists of the 1964 presidential campaign may properly claim recognition for raising the crime issue to national prominence, ... the burden of fashioning a crime control agenda for the nation fell on Lyndon Johnson (Caplan, 1973)."

Johnson took two steps. First, as political leaders are wont to do when confronted with a problem, Johnson appointed a commission to study the problem. In this case, he appointed the President's Commission on Law Enforcement and Administration of Justice. In 1967, the Crime Commission produced a 308-page report, *The Challenge of Crime in a Free Society*, that offered more than 200 recommendations, 11 dealing with police technology. The report had nine back-up task force volumes, including a 227-page task force report on criminal justice science and technology. "Viewed as a unit, these writings represented the most comprehensive description and analysis of the crime problem ever undertaken (Caplan, 1973)."

Johnson's other step was to begin the flow, a trickle at first, of what eventually became billions of dollars in direct and indirect assistance to state and local law enforcement. Never before had the federal government taken on the job of providing massive assistance to state and local criminal justice agencies. The federal government became committed to "doing something" about crime in America's streets and neighborhoods. Hundreds of millions of dollars went to fostering police use of existing and new technologies.

> WHATEVER TECHNOLOGICAL PROGRESS THE POLICE HAVE MADE SINCE THE SECOND HALF OF THE 19TH CENTURY, TO A CONSIDERABLE EXTENT THEY STILL RELY ON BASIC TOOLS AVAILABLE IN THE GASLIGHT ERA FOR THE PROTECTION OF INNOCENT LIFE AND THEMSELVES.

CRIME COMMISSION FINDINGS

The President's Crime Commission found that the nation's criminal justice system suffered from a startling science and technology gap. The commission reported:

The scientific and technological revolution that has so radically changed most of American society during the past few decades has had surprisingly little impact on the criminal justice system. In an age when many executives in government and industry, faced with decision making problems, ask the scientific and technical community for independent suggestions and possible alternatives and for objective analyses of possible consequences of their actions, the public officials responsible for establishing and administering the criminal law — the legislators, police, prosecutors, lawyers, judges, and corrections officials — have almost no communications with the scientific and technical community.

Of the police specifically, the commission observed:

The police, with crime laboratories and radio networks, made early use of technology, but most police departments could have been equipped 30 or 40 years ago as well as they are today.

and:

Of all criminal justice agencies, the police traditionally have had the closest ties to science and technology, but they have called on scientific resources primarily to help in the solution of specific serious crimes, rather than for assistance in solving general problems of policing (President's Commission, 1967).

The commission's Science and Technology Task Force reported that many technological devices existed, either in prototype or on the market, to help criminal justice agencies. Others deserved basic development and warranted further exploration. "But for many reasons, even available devices have only slowly been incorporated into criminal justice operations," the task force said in observations that still have relevance today. "Procurement funds have been scare, industry has only limited incentive to con-

duct basic development for an uncertain and fragmented market, and criminal justice agencies have very few technically trained people on their staffs."

Five of the commission's formal recommendations in the area of police technology dealt in one way or another with police radio communications. (See Appendix Four for a complete list of recommendations.) Others addressed such matters as finger-prints, manpower allocation, police callboxes, and comparative studies of crimes, arrests, and field investigations. But what have turned out to be the most far-reaching recommendations dealt with what came to be known as 911 and computerization.

The Rapid Advent and Lessons of 911

> THE 911 EXPERIENCE IS EVIDENCE OF TWO RECURRING THEMES: THAT IF PRIVATE INDUSTRY CAN FORE-CAST AN ASSURED PROFIT, IT IS QUICK TO PROVIDE THE POLICE WITH A TECHNOLOGY CREATED OR ADAPTED TO THEIR NEEDS. THE SECOND IS THAT NEW TECHNOLO-GIES CAN ALSO BRING WITH THEM NEW PROBLEMS.

The commission called for establishment of a single telephone number, eventually available nationwide, that Americans could use to call the police. In the commission's words:

Wherever practical, a single police telephone number should be established, at least with-in a metropolitan area and eventually over the entire United States, comparable to the telephone company's long-distance number.

At first, personnel of the subsidiary of AT&T with which commission officials conferred balked, recalled Dr. Alfred Blumstein who was executive director of the commission's Science and Technology Task Force (interview). (AT&T at the time held a monopoly position in the nation's telephone business.) They cited several rea-sons, including problems involving boundaries of dialing areas and police jurisdictions and, possibly, similar requests for a single nationwide telephone number from big com-mercial clients, according to Blumstein who is a professor in the Heinz School of Pub-lic Policy and Management at Carnegie-Mellon University. But then there was a change of heart. AT&T decided to launch 911 as the single police and fire emergency telephone number. "It was clear that they would be delighted to get rid of 0," which then was the emergency number and a relatively costly, personnel-intensive operation, Blumstein said. "They were peddling a new product which was 911 and it was going to be automated and they were clearly ahead." AT&T decided to do 911 "as a commer-cial venture."

AT&T announced creation of 911 in January 1968. Within a relatively few years, 911 systems were established in many urban areas. Within ten years, police chiefs of large departments were beginning to complain that ever-increasing 911-generated calls for service were starting to distort and even overwhelm the balanced deployment of police resources. "What patrol officers do in a modern police department is almost wholly determined by incoming calls for service (Sparrow, Moore and Kennedy, 1990)." *The New York Times* came to editorialize about what it called the tyranny of 911. In a study of U.S. policing in the mid-1980s, two scholars wrote:

In many cities the 911 system with its promise of emergency response has become a tyrannical burden. Departments know that if they fail to respond speedily to every call, no matter how trivial, the public will become angry and complain to police, politicians, and the media. The pressure for 911 calls is often so great that few officers are available for proactive community involvement. Moreover, patrol personnel can exhaust them-selves speeding from one call to another, using up the time they needed for understanding the human situations into which they are injected (Skolnick and Bayley, 1986).

Whatever the new problems 911 caused, "centralized call collection using three-digit phone numbers and centralized integrated dispatching of police, fire, and medical services for large metropolitan areas" are cited as two of the relevant police technolo-gies of the 1970s (Manning, 1992). "Around 1980, some departments, among them Tampa-St. Petersburg, Florida, and Wichita, Kansas, developed the capacity to display on a screen the address of the phone from which a caller was calling," Peter Manning reported. This capacity was termed an "enhanced 911" system. "An enhanced system will allow checks of address and simplified data gathered from distressed callers who are often confused or anxious."

A data analysis that became available in 1996 shows the remarkable growth of both basic and enhanced 911 systems. The analysis, published by the Bureau of Justice Statistics (BJS), was of a wide range of data collected in 1993 through its Law Enforce-

ment Management and Administrative Statistics (LEMAS) program. The LEMAS survey is a nationally representative sample of more than 17,000 state and local law enforcement agencies. "The 1992 LEMAS survey questionnaire was mailed to all 854 state and local law enforcement agencies with 100 or more sworn officers and a representative sample of 2,416 agencies employing fewer than 100 officers," BJS said. The response rate was 92.6 percent. About the 911 system, the BJS analysis reported:

> In 1993 about two-thirds of all local police departments participated in an emergency telephone system whereby one of their units could be dispatched in a response to a citizen call to 911 or its equivalent. This was a significant increase from 1990 when about half of all departments had a 911 system, and twice the proportion of agencies reporting 911 participation in 1987. Local police departments with a 911 system employed 89 percent of all officers in 1993, compared with 65 percent in 1990.
>
> A majority of the local police departments in each population category were participating in a 911 system in 1993, ranging from 100 percent of those serving 250,000 to 499,999 residents to 59 percent of those serving a population of under 2,500.
>
> In contrast to 1990, a majority of departments with a 911 system in 1993 reported their system was an enhanced system, capable of pinpointing the location of the caller automatically. In 1993, enhanced 911 systems were operating in 41 percent of all local police departments, while 27 percent reported they had a basic 911 system. In 1990, 18 percent had an enhanced system and 30 percent a basic system.
>
> Increases in the use of 911 were seen in all population categories from 1990 to 1993, and a majority of the departments serving a population of 10,000 or more had an enhanced system in 1993. This included 80 percent of those serving a population of 250,000 or more (compared to 72 percent in 1990), 77 percent of those serving a population of 50,000 to 249,999 (54 percent in 1990), and 60 percent of those serving a population of 10,000 to 49,999 (34 percent in 1990). Among departments serving a population under 100,000, the percentage with enhanced 911 tripled from 11 percent in 1990 to 34 percent in 1993 (Bureau of Justice Statistics, 1993).

> "THE HEART OF THE PROBLEM IS THAT MANY POLICE EXECUTIVES ARE INTIMIDATED BY COMPUTERS, AND THAT OTHERS HAVE MADE NO EFFORT TO INTEGRATE DATA PROCESSING INTO DAY-TO-DAY POLICE WORK."
>
> POLICE MAGAZINE, 1982

The 911 experience incorporates two themes that recur in the history of police technology. The first is that if private industry can forecast an assured profit, it is quick to provide the police with a technology created or adapted to their needs. The dilemma is that there are relatively few instances where industry can anticipate a fairly immediate and steady profit stream by providing a new technology to the police. The 911 system was able to overcome police agency jurisdictional boundaries and provide a potentially universal service endorsed by a high-powered, presidential commission. It may have helped that AT&T was a monopoly at the time 911 was inaugurated. Typically, industry must try to sell its technologies one agency at a time to the nation's 17,000 police departments. In this fragmented marketplace, no sales are assured, and there are seldom, if ever, high-powered imprimaturs of the kind the Crime Commission could bestow.

The second theme is that, as in other areas of life, new technologies for the police can bring new problems with them. Rules of unintended consequences apply. The 911 system has become essential to summon emergency police, fire, and medical services. It also has created new headaches for many administrators of large urban police departments.

THE SLOW COMPUTERIZATION OF AMERICAN POLICING

The President's Crime Commission urged on the computerization of American policing. A formal recommendation said, "An experimental program to develop a computer-assisted command-and-control system should be established with Federal support." The commission's Police Task Force was more specific: "A greatly expanded development of computer-based information system is one concrete step that would make a dramatic impact on the police service." The task force said these systems would aid the police in such functions as patrol, criminal investigations, manpower deployment, the arrest process, and budgeting.

An essential ingredient needed to spur the computerization of policing was money. Federal funding was soon on its way. The first trickle of federal money for state

and local criminal justice agencies was funneled through a small research and demonstration program located in the Department of Justice. The program, managed by the Office of Law Enforcement Assistance, grew within a few years into a large, long-term subsidy program called the Law Enforcement Assistance Administration (LEAA) (Caplan, 1973).

The Omnibus Crime Control and Safe Streets Act of 1968 created LEAA in, as one commentator has noted, "an environment of social turbulence. Crime rates were climbing, the incidence of drug abuse was on the rise, riots and disorders were becoming commonplace, and America's political leaders were targets for assassination attempts (Diegelman, 1982)."

In this climate and among many other things, LEAA attempted to help launch the computerization of policing. The big push to computerization "started in the early 1970s, when lots of (LEAA) money was being spent," Donald Hollingsworth, a senior computer analyst with the International Association of Chiefs of Police, was quoted as saying ten years later. No one knows for certain how much LEAA spent on police computerization, but police agencies began to acquire computers. The FBI further influenced that decision. The FBI's National Crime Information Center (NCIC) "was the first contact most smaller departments had with computers," Hollingsworth said. "After NCIC came on line, computers really began to spread throughout law enforcement (Rosen, 1982)."

A 1981 Police Foundation survey of agencies serving 50,000 or more people reported that all 122 respondents claimed some sort of computer capability. Allan Lammers, an official of SEARCH, a nonprofit law enforcement consortium, reported in 1982, "My guess is that there are about 1,500 state and local law enforcement agencies — serving most American communities with populations of 25,000 or more — with some sort of computer service." Lammers added that "almost all law enforcement agencies serving populations of a million or more have some sort of computer facility that was paid for, to a considerable extent, with LEAA money (Rosen, 1982)."

Not all police departments which obtained computers used them. G. Thomas Steele, a civilian computer consultant to the Washington, DC, police department in the early 1980s and a frequent visitor to other departments, recounted, "A lot of computers were bought with LEAA money. Many were still in their packing crates, not even installed, when I saw them."

Many police agencies that had access to computers in the 1970s and even into the 1980s seemed reluctant to use them for more than routine tasks. "While almost all large police departments and many smaller ones either have their own computers or access to municipal or countywide systems, experts say that police in most jurisdictions have made little attempt to make effective use of them, using them instead as expensive, elaborate adding and filing machines," *Police Magazine* reported in 1982. It continued:

> Some departments have spent millions buying and installing elaborate data processing machinery, but have spent years trying unsuccessfully to get their systems programmed and "online" — in operating order. Others bought the systems with federal funds and never attempted to make efficient use of them. The heart of the problem, say the experts, is that many police executives are intimidated by computers, and that others have made no effort to integrate data processing into day-to-day police work.

Why else were police agencies so seemingly unable to make more effective use of computers? Leading police chiefs blamed the complexities of the new technology, the cautious, conservative nature of many police officers, and citizens' "fear of Big Brother." (Appendix Five quotes several leading police chiefs of the early 1980s on police computerization.)

Computer consultant Steele had another answer: Computer manufacturers lacked great interest in the police market. "Despite what they may say to the contrary, they don't really view law enforcement as an important money-maker and have been reluctant, for this reason, to invest in development of new application software or specialized hardware ...," Steele said, adding: "After all, there are only 17,000 law enforcement agencies in the entire country. This is paltry when you compare it to the 100,000

> THE POLICE MARKET, FRAGMENTED AMONG 17,000 AGENCIES, IS TOO COST-INEFFICIENT AND COMPLICATED TO REACH. WITH ONLY 17,000 SCATTERED COMPONENTS, IT IS TOO SMALL TO PURSUE WHEN THERE ARE MUCH LARGER AND POTENTIALLY REMUNERATIVE MARKETS TO EXPLOIT.

hospitals, 500,000 hotels, or millions of individual businesses there are (Rosen, 1982)."

As will be seen in Part Three, perhaps the most recurring fact cited in deliberations over the difficulties of interesting private manufacturers in developing and marketing new police technologies is that there are 17,000 agencies. The police market, fragmented among 17,000 agencies, is too cost-inefficient and complicated to reach; the police market, with only 17,000 scattered components, is too small to pursue when there are much larger and potentially remunerative markets to exploit.

After 13 years and the expenditure of about $7.5 billion on all of its efforts, LEAA was formally abolished in 1982. According to Robert F. Diegelman who was acting director of a smaller, successor agency to LEAA,

.. the LEAA program ran afoul of unrealistic expectations, wasteful use of funds, mounting red tape, and uncertain direction. In the face of growing criticism, the program had difficulty demonstrating that it was having any measurable impact on crime or the administration of justice.

Diegelman, writing in 1982 when he ran the newly established Office of Justice Assistance, Research, and Statistics, noted that LEAA had registered some achievements:

It educated and trained thousands of criminal justice personnel, implemented new and worthwhile projects, and developed new skills and capacities for criminal justice analysis, planning, and coordination (Diegelman).

Despite the absence of LEAA's support, police departments continued to invest in computers and apply them to more sophisticated tasks. In this they were helped by a useful LEAA legacy, software developed under a series of grants.

Some of the software was designed to run on small, desktop systems. For example, POSSE was record-keeping software that contains files for evidence and warrants, calls for service, and eight other types of routine data. CASS was an incident report analysis system for resource allocation, crime analysis, and forecasting. There was another program to help small agencies keep track of the details of large, complicated investigations. On a much larger scale, LEAA funded the development of ARJIS (Automated Regional Justice Information System) which served all law enforcement agencies in San Diego County, and is discussed in detail in Part Two.

By the 1990s, there was firm evidence that the use of computers was growing and police agencies were using them for increasingly diverse purposes. The pace of growth was captured in the BJS analysis of its 1993 LEMAS figures. The results of a 1993 LEMAS survey showed:

Two thirds of local police departments were using computers in 1993, compared to half in 1990. Departments using computers employed 95 percent of all local police officers in 1993. Departments that used laptop computers or mobile terminals employed twice as many officers (60 percent) as in 1980 (30 percent).

The more crucial point was not the availability of computers, but the purposes to which police agencies put them. The belief in 1982 was that most police agencies with access to computers were using them as "expensive, elaborate adding and filing machines." The 1993 LEMAS figures show that police agencies use computers for record keeping, but that an increasing number, particularly those serving larger populations, also use computers in such relatively sophisticated functions as criminal investigations, crime analysis, and budgeting. The BJS analysis reported:

An estimated 53 percent of all local police departments, employing 88 percent of all officers, were using computers for record keeping in 1993. This included over 90 percent of the departments serving a population of 50,000 or more. More than a fourth of all local police departments, including a majority of those serving a population of 25,000 or more, also used computers for criminal investigations (41 percent), budgeting (31 percent), crime analysis (29 percent), or dispatch (29 percent). A majority of departments serving a population of 100,000 or more also used computers for fleet management, manpower allocation, and research purposes during 1993....

Local police were also more likely to be maintaining computerized information files in 1993 than they were in 1990. For example, 55 percent of all local police departments were maintaining computerized files on arrests compared to 39 percent in 1990, and

> THE USE OF HIGH-TECHNOLOGY EQUIPMENT AND APPLICATIONS IS ESSENTIAL TO THE EFFICIENT PRACTICE OF COMMUNITY POLICING. WITHOUT HIGH TECHNOLOGY, OFFICERS WOULD FIND IT DIFFICULT TO PROVIDE THE LEVEL AND QUALITY OF SERVICES THE COMMUNITY DESERVES.
>
> MAYOR LEE P. BROWN
> HOUSTON, TEXAS

nearly half of all departments were maintaining files on traffic citations (46 percent) and calls for service (45 percent) compared to about a third for each in 1990....

COMPUTERS AND COMMUNITY POLICING

The introduction of the computer into policing corresponds roughly to the beginning of a third and current era in American policing. Scholar George F. Cole calls it the Community Policing Era and dates its start at 1970. (Others offer different starting dates and titles; all note a move away from the so-called professional style of policing and toward greater police contact and involvement with communities.)

"The central premise of community policing is that the public should play a more active and coordinated part in enhancing safety ... A full-fledged program incorporates: (1) community-based crime prevention; (2) a reorientation of patrol activities to emphasize nonemergency services; (3) increased accountability to local communities; and (4) decentralized command (Bailey, 1995)."

Some observers emphasize a problem-solving approach as an important element of community policing. The approach calls on the police to "be prepared to handle the broad range of troublesome situations — for example, battered wives, runaway children, noisy teenagers, accidents and persons in distress — that promote citizens to turn to them. Under this approach to citizen needs, the police should define the problem and look for its underlying causes (Cole, 1995)."

However community policing is described, computers seem clearly necessary to its practice. As one observer puts it, "The cornerstone of community policing technology is about information which implies computer systems."

Lee P. Brown, formerly the chief police executive of New York City, Houston, and Atlanta, has suggested that computers are essential to community policing. In response to the question, "Is Community Policing Anti-technology?" Brown wrote:

> The use of high-technology equipment and applications is essential to the efficient practice of community policing. Without high technology, officers would find it difficult to provide the level and quality of services the community deserves. Computer-aided dispatching, computers in patrol cars, automated fingerprinting systems, and online offense-reporting systems are but a few examples of the pervasiveness of technology in agencies that practice community policing (Brown, 1989).

Dennis E. Nowicki, chief of the Charlotte-Mecklenburg, North Carolina, Police Department, is building a $10 million "knowledge-based community-oriented policing system" for his department (interview). The computer system will focus "on the needs of the problem-solving officer in the streets. We're designing our system not as a management information system but as an information system to support problem solving," he said. The system will incorporate information not only gathered and maintained by the police department but from an array of other city agencies which have data that street officers need to do their work.

Nowicki exemplifies a class of current police chiefs with faith in computer technology as crucial to successful police work. "My vision is that when an officer comes through the academy, we give him his weapon, we give him his radio, and we give him his laptop computer."

Some leading police executives believe that the computer represents the most consequential technological advance for policing during the past 30 years. Darrell W. Stephens, formerly chief of the St. Petersburg, Florida, Police Department and now the city's administrator and the former executive director of the Police Executive Research Forum, holds this view.

"The most important, most significant, change in technology has been the whole development and use of computers that can store and search and analyze vast amounts of data. It increases our effectiveness and our ability to manage people and resources.... It makes the people we have more efficient (interview)."

William Bratton, the former New York City police commissioner, also has said computers have provided police with their most important technological advance. Computer maps to pinpoint crime were a notable element in what a growing number

THE CRIME LAB MAY HAVE BEEN THE STRONGEST LINK BETWEEN SCIENCE AND TECHNOLOGY AND CRIMINAL JUSTICE, BUT AS LATE AS 1968, THE U.S. ONLY HAD ABOUT 100 CRIME LABORATORIES. SEVENTEEN STATES HAD NONE AT ALL.

of criminologists have concluded were Bratton's successful crime-fighting efforts in New York City.

Dr. Alfred Blumstein, who, as noted, was director of the Crime Commission's Science and Technology Task Force, joins in agreement about the place of computers in the realm of police technology. The statement of the Crime Commission was recalled for him: "The scientific and technological revolution that has so radically changed most of American society during the past few decades has had surprisingly little impact on the criminal justice system."

Was this still true? No, said Blumstein, technology is "finally starting to take hold and the dominant transformation has been the one in computing. So much of the criminal justice system can be seen as an information-processing system — dealing with information about events, about individuals. We are starting to see, still in a surprisingly limited way, the diffusion of that (computer) technology so that even fairly small police departments today have at least their own computers (interview)."

Throughout the nation, some departments are demonstrating far-reaching and sophisticated uses of computer technology. Others still lag behind. Part Two explores further the uses of computers in policing.

THE GROWTH OF CRIME LABORATORIES

The 1967 Crime Commission observed that the "crime laboratory has been the oldest and strongest link between science and technology and criminal justice." That may have been so, but as late as 1968 the nation had only about 100 crime laboratories to serve its police agencies. Seventeen states had no laboratories; they had to depend on the FBI laboratory in Washington, D.C. Not only that, but there was a sense that the police vastly underutilized forensic science. "For the majority of felony crimes, there is little or no attempt to collect or analyze physical evidence," *Police Magazine* reported in 1979. "According to a study done several years ago by the Forensic Sciences Foundation in Washington, fewer than two percent of investigation of FBI Part 1 crimes involve physical evidence (Serrill, 1979)."

But then LEAA funding and some other factors commenced. By 1979, the number of laboratories more than doubled to about 240. LEAA funding was seen as the most important cause in the sudden, rapid expansion of crime laboratories. In the ten-year period since its creation in 1968, LEAA contributed $60 million to the establishment or expansion of laboratories in almost every state. "It has also funded the first real research in the field — research designed to define the forensic sciences' role in the criminal justice system, to foster new scientific and technological developments, and to assess the proficiency of the labs' equipment and personnel," *Police Magazine* reported.

The second reason cited for the growth of crime laboratories was the demand for scientific examination created by the tremendous upsurge in drugs and drug-related crime beginning in the mid-1960s.

The third reason had to do with increased police interest in the forensic sciences. According to *Police* magazine:

> Some say the increased contact with the labs in the course of processing drug cases made the police more aware of the services the labs could provide. Some say the increasing education and sophistication of police executives made them more inclined to approach law enforcement as the "science" it is sometimes purported to be. Others say that the increased use of the laboratories is merely the consequence of the Miranda, Escobedo, and other Supreme Court cases that placed heavy restrictions on the ability of police to solve cases by extracting confessions from defendants during interrogations.

By 1990, the nation had well over 300 crime laboratories. Eighty percent of them were housed within law enforcement agencies, most at the state and local level (Bashinksi and Peterson, 1991). Nonetheless, the FBI laboratory is still important to the police. Today the FBI lab handles 20,000 cases annually, "about two-thirds for the FBI and the rest for state and local law enforcement. In handling those cases, the lab receives as many as 170,000 pieces of evidence and performs about 900,000 examinations (Kessler)."

THE LEAA PAID FOR BIG TICKET TECHNOLOGY ITEMS, SUCH AS COMPUTERS, SOFTWARE, AND CRIME LABORATORIES, BUT THE NATIONAL INSTITUTE OF JUSTICE, UNDER THE LEAA UMBRELLA FOR MANY YEARS, WAS THE DESIGNATED FEDERAL SOURCE OF RESEARCH AND DEVELOPMENT FOR LAW ENFORCEMENT TECHNOLOGY.

THE NATIONAL INSTITUTE OF JUSTICE

The Law Enforcement Assistance Administration paid for big ticket technology items such as computers, software, and crime laboratories, but the National Institute of Justice (NIJ), an agency for many years under the LEAA umbrella[1], was the designated federal source of research and development in law enforcement technology. In its review of its first 25 years, the Institute makes special note of two significant accomplishments in technology:

> Two areas in which NIJ's role has been prominent are in the development of lightweight body armor, which has saved lives of countless police officers over the years; and in DNA "fingerprinting" to improve evidence used in investigating crimes (National Institute of Justice, 1994).

But for many of those 25 years, technology research and development seemingly took a back seat to other NIJ activities. For example, a 1977 report of the National Research Council labeled NIJ's technology R&D efforts an "abandoned child." The report, *Understanding Crime: An Evaluation of the National Institute of Law Enforcement and Criminal Justice*, found no evidence that NIJ chose to integrate so-called technological R&D for crime problem-solving with research activities that are based in the social and behavioral sciences. Therefore, technology R&D is planned and conducted separately from research programming for police, courts, corrections, prisons, etc.

The report also said:

> The Institute has maintained between a fifth and a quarter of its budget for technology, but the nontechnology divisions neither significantly contribute to ATD's (Advanced Technology Division) work nor help disseminate its product. It is clear that the inability to structure a technology research and development program as part of a broader strategy to solve problems in criminal justice — whether deliberate or not — created a kind of abandoned child (White and Krislov, 1977)[2].

The "abandoned child" assertion may have been an overstatement. "Stepchild" may have been more accurate. The fact is, for much of NIJ's first 20 years, efforts in technology research and development were to a considerable degree a one-person effort, that person being Lester Shubin, a chemist. Shubin recalls he was one of four persons working in the Advanced Technology Division (ATD) after he joined NIJ in 1971. But after ATD was reorganized out of existence in the mid-1970s, he said he "was pretty much alone (interview)."

SOFT BODY ARMOR

Shubin played a key role in the serendipitous origins of soft body armor. Nicholas Montanarelli, an U.S. Army Land Warfare Laboratory specialist, told Shubin that DuPont had a new fabric, Kevlar, "stronger than steel, lighter than nylon, to replace steel belting for tires. "I asked him if the fabric would do just as well to stop bullets," Shubin recalls. "He didn't know, so we folded some up and shot at it and the bullets bounced off."

The successful firing range experiment led in 1972 to an Institute-sponsored project in which the Land Warfare Laboratory used Kevlar in a new lightweight, flexible, comfortable, and protective body armor. It also led to the creation of a new industry, an instance where a federally initiated technology for law enforcement moved rapidly into the commercial marketplace.

Of particular concern to NIJ was whether a bullet's force through Kevlar could

TWO AREAS IN WHICH NIJ'S ROLE HAS BEEN PROMINENT ARE THE DEVELOPMENT OF BODY ARMOR, WHICH HAS SAVED THE LIVES OF COUNTLESS POLICE OFFICERS, AND DNA ANALYSIS. A THIRD IMPORTANT CONTRIBUTION WAS THE ESTABLISHMENT IN 1971 OF A NATIONAL PROGRAM OF STANDARDS FOR POLICE EQUIPMENT. NO SUCH PROGRAM EXISTED BEFORE. NOBODY KNEW, FOR EXAMPLE, HOW STRONG A PAIR OF HANDCUFFS SHOULD BE.

1 — Until 1978, NIJ was called the National Institute of Law Enforcement and Criminal Justice and was essentially the same agency as NIJ.
2 — The 260-page report is generally critical of the NIJ of the 1970s. Its authors, drawn from the council's Assembly of Behavioral and Social Sciences, reported that the "quality of Institute-funded research is not high, and much has been mediocre." They were not infallible, for example, questioning the staying power of interest in soft body armor. Their report said it "remains to be seen whether bullet-proof vests will be more than a passing fad ... and hence whether they will remain solid market items."

cause serious blunt trauma injuries. In 1975, 15 large urban police departments field tested a total of 5,000 body armor garments. "The tests showed that the armor could be worn without restricting the officers' ability to do their jobs, and more importantly, the vests worked....." Tests found that Kevlar "could protect against 80 to 85 percent of the then available handguns ..." and further "testing showed it was effective against blunt trauma (National Institute of Justice, 1994)." By 1998 the soft body armor introduced by the Institute was credited with saving 2,000 police officers' lives, a savings estimated in terms of survivors' benefits and other costs to total $1.5 billion.

DNA ANALYSIS

The Institute began its support of developing DNA technology in 1986 as the technology's potential value to crime solvers became increasingly evident. That support is much expanded in the form of a current five-year, $40 million program.

NIJ's first grant was to the developers of Polymerase Chain Reaction (PCR), a new method. "This method promised improvement over the existing, acceptable Restriction Fragment Length Polymorphism (RFLP) method, which used dangerous radioactive materials to produce an image of DNA on an x-ray film. Instead, PCR technology amplified DNA samples through molecular photocopying, thus allowing the resulting data to be digitized manually or by computer (National Institute of Justice, 1994)."

A discussion of DNA technology, including an explanation of the principal terminologies, appears in Part Two. NIJ's current program is discussed in Part Three.

TESTING AND EVALUATION

A third important NIJ contribution to law enforcement was the establishment in 1971 of a national program of standards for police equipment. No such program existed before, Shubin noted; "Nobody knew, for example, how strong a pair of handcuffs should be." The standards were voluntary. "We had no regulatory power," he said.

By 1975, the Institute's Law Enforcement Standards Laboratory had completed performance standards for:

- Portable, mobile, and base station transmitters; mobile receivers; and batteries for portable radios;
- Walk-through and hand-held metal weapons detectors;
- Portable x-ray devices for bomb disarmament;
- Communication equipment such as voice scramblers, car location systems, and radio transmitters, receivers, and repeaters;
- Active and passive night vision devices;
- Magnetic, mechanical, and mercury switches for burglar alarms;
- Handcuffs, riot helmets, crash helmets, police body armor, ballistic shields, and hearing protectors.

By the mid-1980s, NIJ created two mechanisms to advance its work in equipment testing and standards setting. It established the Technology Assessment Program Information Center to pick laboratories to test equipment, supervise the testing process, and publish reports of test results. It also established the Technology Assessment Program Advisory Council, a large advisory body of senior local, state, and federal law enforcement officials. Both the center and the council are predecessor operations to current programs described in Part Three.

Over a 20-year period, NIJ had other success in technology. For example, it funded the U. S. Army and the New York City Police Department in successful field tests of the ability of dogs to sniff out hidden drugs and explosives. In technological terms, dogs are "self-propelled computers with gas chromatograph noses," according to Shubin. (A chromatograph selectively separates components of a sample.) The Institute also made several contributions to the development of forensic science and sponsored studies and tests of various technologies. These contributions are discussed in Part Two.

It was not until the 1990s that NIJ began to approach research and development in technology with a comprehensive game plan. That plan is described in Part Three.

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SAFEGUARDING LIFE

PART TWO:

HOW THE

LESS THAN LETHAL TECHNOLOGIES

The need for less-than-lethal weapons is significant. Recent incidents in all parts of the nation have pointed to the need for more options on the use-of-force continuum. The trial of police officers charged with using excessive force in arresting Rodney King resulted in riots that tore apart South Central Los Angeles. The storming of the Branch Davidian headquarters in Waco, Texas, and the group's subsequent fiery end unleashed criticism about law enforcement tactics. The Ruby Ridge incident decimated a family and left the FBI determined to review its deadly force policy.

On a smaller scale, incidents involving police use of force are repeated daily in towns and cities throughout the country. Whether officers are facing an inebriated or mentally ill individual, or one who is simply unable or unwilling to cooperate, they need a variety of options to handle the situation safely. Those options come in different forms, from verbal responses and commands, to physical, hands-on tactics, to the use of batons, chemical sprays, or firearms.

In the purview of use-of-force, an officer's behavior is determined to a great degree by federal law. In 1989, the Supreme Court ruled in *Graham vs. Connor* (109 S.Ct. 1986 [1989]) that the officer's decision regarding the level of force must be judged from the "perspective of the reasonable officer on the scene..." within circumstances that are "tense, uncertain, and rapidly evolving." The court recognized that a police-citizen encounter can escalate out of control within a matter of seconds. More important, however, it recognized that the subject determines the appropriate level of force, not the officer. The officer's job is to respond. If the subject is cooperative, the officer continues to be calm and professional. If the subject becomes resistant or combative, the officer is trained to respond with tactics and techniques to defuse the situation and gain control of the subject. If at any time the subject reverts to a level of passivity, the officer de-escalates his behavior to match the subject's.

Guiding officers in determining the appropriate level of force is the use-of-force continuum, taught at academies throughout the country and by the Federal Law Enforcement Training Center in Glynco, Georgia. This five-tiered structure outlines the levels of aggression shown by the subject and the proper response by law enforcement officers.

- Level I: At the base of the use-of-force continuum is compliance, which describes the majority of police-citizen encounters as positive and cooperative.
- Level II: The second level is termed "passive resistance," in which the subject offers no physical threat toward the officers but is unresponsive to their demands.
- Level III: The third level describes a person who is actively resistant toward the officers and is indifferent to their attempts at control; in short, the subject is physically defiant and is threatening to assault or has already assaulted the officers.
- Level IV: The fourth level constitutes a threat of bodily harm toward the officers. The subject shows active hostile resistance.
- Level V: The fifth, and most serious level, is assaultive, in which the officer can draw a reasonable conclusion that the subject intends to kill him or inflict great bodily harm.

POLICE USE

TECHNOLOGY

Part One of this report has focused on the development of police technology and two technological advances in particular — 911 systems and computerization. Through 911, citizens summon the police in emergencies. Through computers, police departments increasingly are able to manage and analyze vast amounts of information, deploy their resources productively, pinpoint "hot spots" of crime, and enhance efforts in community policing. But automated technologies do not patrol the streets and investigate crimes; police officers do. Part Two of this report explores current and emerging technologies for police officers in their everyday work.

USE OF FORCE CONTINUUM		
	Subject	**Officer**
Level I	Compliant/Cooperative	Verbal commands
Level II	Passive resistance	Contact controls
Level III	Active resistance	Compliance techniques
Level IV	Assaultive/bodily harm	Defensive tactics
Level V	Assaultive/serious bodily harm or death	Deadly force

The use-of-force continuum guides law enforcement officers in responding appropriately to these various levels of non-compliance.

- Level I: Officers handling cooperative subjects continue to interact in a calm, professional manner.
- Level II: Officers faced with subjects who are passively resistant gain control by using tactics that are primarily psychologically manipulative, and use a minimum of physical contact that does not involve pain.
- Level III: The officer responds to active resistance with compliance techniques, using a baton and/or physical contact for leverage and control. Depending on the situation and agency policy, this level of response may involve pain, the use of chemical sprays, and the deployment of additional officers.
- Level IV: Here the officer uses more forceful tactical procedures that include options from Level III, as well as techniques to disarm or counter the subject's attack and to maintain control.
- Level V: The fifth level is that of deadly force, in which all tactical options are directed toward officer survival and self-preservation. This level of force makes available every option on the use-of-force continuum.

Legal limitations also direct the use of deadly force. Although department policy and state law are clear guideposts, they are rooted in the decision reached by the Supreme Court in the 1985 case of *Tennessee vs. Garner* (471 US 1 [1985]), which altered the law on the use of deadly force. Up to that time, it was legal in most states to use deadly force for two reasons: when a suspect posed a serious threat to an officer or a citizen; or to stop a fleeing felon. The Court's decision left intact the officer's right to safeguard life, but made the use of deadly force against a fleeing suspect unconstitutional. (Appendix Six provides background on deadly force.)

FORCE OPTIONS: TACTICS, TOOLS AND TECHNIQUES

Tools to counter non-compliance have come and gone over the years, depending not so much on their effectiveness as much as the public's reaction to them. Tactics have been equally important, and in some cases, equally subject to police and public disfavor. Certainly, the public's expectation that it be protected from its aggressors must be met, as should its expectation that all people, including those who would act against society, be treated humanely. Yet the tools the police employ, while effective, have been the cause of much criticism, which is not always undeserved.

Tactics

One tactic that has become increasing controversial is the practice of "hog-tying," a long-standing control tactic commonly used to restrain prisoners who are assaultive and kicking at officers. The subject is placed face down on the ground and handcuffed. His feet are drawn up, toward his hands, and with a tie or belt made especially for this purpose, secured so that his feet are positioned near his hands. The prisoner is then placed in the backseat of a patrol car for transport.

Although hog-tying is an effective technique, people have died when it was employed, some while being tied and others while in the backseat of a patrol car. For many years, these were termed "accidental deaths." They were not attributed to police procedure until recently, when the National Institute of Justice and the International Association of Chiefs of Police undertook the first nationwide study of in-custody deaths.

Research showed that a contributing factor may have been a phenomenon known as "positional asphyxia," which can occur under circumstances that have several common factors: drug or alcohol use by the subject, or some type of corresponding mental instability that caused psychotic behavior; a violent struggle in which the subject's heart and respiratory rate escalate dramatically; compression of the lungs due to an officer's weight during restraint, or the subject's own weight while lying face down during transport. In essence, the subject asphyxiates as a result of physical distress caused by a combination of these factors.

Most departments have either banned the practice of hog-tying or limited its use.

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Agencies that continue it are training officers to recognize the predisposing factors of positional asphyxia, signs of prisoner distress, and how to respond.

Another control tactic that was used repeatedly for many years by the Los Angeles Police Department was the carotid chokehold. The goal was to place the subject's neck in the crook of the officer's arm and put pressure on the carotid artery, thereby restricting the blood flow to the brain and causing the subject to "pass out." The LAPD taught officers that this was a pain compliance technique, one that could be used on unruly subjects or those who were beyond control due to incapacitation from mental illness, drugs or alcohol. But people died as a result of the technique, and in the 1980s, the department eliminated its use. The LAPD's Board of Police Commissioners determined that it was the equivalent of deadly force and was no longer appropriate. It ordered the department to find an alternative. After a study of various nonlethal devices, the commissioners recommended that the department adopt the baton as a first-response tool.

Opinions vary on the chokehold. According to one researcher, it was effectively used on the more than 800 people arrested every day (Meyer, 1991). But Skolnik and Fyfe, authors of *Above the Law*, maintain that the practice was "a prime and disastrous example of a misguided policy that tacitly encouraged vigilante justice and fostered public hostility toward police."

The chokehold and hog-tying are control tactics that are distinguished by the fact that the officer carries no implement or weapon — their use typically warranted by behaviors near Level V of the use-of-force continuum. Even though they proved effective, incidents that ended in injury or death created a backlash against their use.

Tools and Techniques

Since the earliest days of policing, law enforcement has sought appropriate tools to control the behavior of the lawless. One of the first was the "billy club," also known as a "truncheon." Originating in Britain, it was issued to London's bobbies in the late 1820s. Authorities wanted a weapon that was not immediately intimidating to citizens, and this small wooden baton fit the bill. Although the British authorities are experimenting with some of the newer composite batons, the traditional wooden truncheon still is the primary tool for responding to resistant subjects. This is especially true in light of the fact that some British officers are still unarmed.

American law enforcement, however, has carried firearms since the early days of its inception, along with various versions of the billy club. The first batons were made of wood and measured anywhere from 22 to 26 inches in length and 3 inches in diameter. Some departments still issue the wooden baton, but many more have made the transition to one made of a durable plastic, a style invented in 1958. The latest design came about in the early 1970s, when a former Marine created the side-handle baton — a standard baton with a handle attached at a 90-degree angle 5-1/2 inches from the gripping end. Because of its versatility and effectiveness, the side-handle baton has become standard issue in many of the law enforcement agencies around the country (Truncale, 1996).

The early 1960s saw a technological explosion, with new devices created as a response to the era's protests and riots. The problem with some of these was that the manufacturers were more interested in profits than in whether the device actually worked. Safety and liability issues were not always addressed; the push was simply to get a new device to the market.

Still, technology moved forward. CN gas (Chloroacetaphenone), or tear gas, was introduced for police use in the mid-1960s. Tear gas produces burning in the eyes, nose and throat. CS gas (Ortho/Chlorobenzal-Malononitrile), another disabling gas, also came into use. Considered more potent than CN gas, CS gas causes pain in the nose, throat and chest, nausea and vomiting. Both gases were used in response to the disorders and protests that accompanied the Civil Rights and anti-war upheavals of the 1960s and early 1970s. At about the same time, a third gas, CR gas, became available. Proponents said it was six times more potent than CN gas and 20 times more potent than CS. Problems associated with the use of these gases led some officials to claim their use incited increased violence, while others asked for additional research to ensure their safety.

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OFFICERS CIRCLED A SUBJECT, WITH
ONE OFFICER DISTRACTING HIM BY
POKING HIM WITH A LONG POLE,
A SECOND SPRAYING HIM WITH
A FIRE EXTINGUISHER, WHILE
THE OTHER TWO OFFICERS
TOSSED A NET OVER HIS HEAD.

In the late 60s, manufacturers began to develop alternatives to bullets, which ini-
tially appeared as if they might solve many of the problems associated with street disor-
ders. Wooden bullets, originally from Hong Kong, were designed to be "skip fired," or
ricocheted off the ground to strike the combatants in the legs. The problem was that
direct fire broke bones or was fatal. If the projectile inadvertently bounced the wrong
way, it harmed innocent bystanders.

Rubber bullets were designed so police could outdistance the rock throwers. These
rounds delivered a blow like a hard punch and caused severe bruising.

Water cannons were popular in Europe, but were not adopted in the United States.
These devices fired jets of water at demonstrators, and, in some cases, included a non-
toxic dye to mark offenders. Their reputation for usefulness suffered when protesters
discovered they could defeat a cannon's spray by hiding behind barriers.

Other technologies have been tried and, for a variety of reasons, not widely adopt-
ed. The "Photic Driver" was a strobe gun that operated at five flashes per second and
ostensibly caused nausea, giddiness and fainting. The "Squawk Box" had sound genera-
tors that operated at different frequencies and caused nausea and giddiness. The "Sound
Curdler" used speakers attached to helicopters or vehicles and emitted earsplitting
shrieks at irregular intervals. Its purpose was to drive protesters out of a specific area
(Bailey, 1995).

Most of these devices suffered from the "it-was-a-good-idea-at-the-time" outcome,
as did several others: a chemical that when sprayed on the streets created an extremely
slippery surface; shotgun shells filled with plastic pellets; an adhesive substance that
when sprayed over crowds made people stick together; and an expandable baton that
had a 6-inch steel whip and, when opened to its full length, had three steel coils that
resembled the Medieval cat-o-nine tails. Perhaps the most manpower intensive innova-
tion was a group effort described by one writer as resembling a classic Keystone Cops
scenario. Four officers circled the subject, with one officer distracting the subject by
poking him with a long pole while a second sprayed him with a fire extinguisher. The
other two officers tossed a net over the suspect, while the first officer used the long pole
to knock any weapons out of his hands. (Appendix Seven reports on a study of various
less-than-lethal weapons used by the police.)

Impact Tools

The baton is still one of the most widely used police tools in the use-of-force con-
tinuum, but it has the potential to contribute to public relations nightmares for the
police.

Probably no recent incident sparked greater public dismay than the Rodney King
arrest, in which a group of officers from the Los Angeles Police Department beat King
after he led police on a high-speed pursuit and then resisted being taken into custody.
Had the incident not been captured by a bystander's video camera, it would certainly
have gone on record as the pursuit and arrest of a highly resistant subject. The case
would have drawn little department attention, primarily because some of the tactics
used by the officers were department-sanctioned and academy-taught defensive tactics
that were deemed appropriate when responding to subjects displaying Level III and
Level IV behavior. Still, when the smoke cleared — after the officers' acquittal of crim-
inal charges and the subsequent riots in South Central Los Angeles — nearly 60 people
were dead, 2,000 injured, and 10,000 businesses destroyed.

Even with all of its potential for creating controversy, the baton, used appropriate-
ly, is an effective first-response tool. It can be made of wood, plastic, polycarbonate, or a
combination of aircraft aluminum and nylon.

Expandable batons are relatively new to policing, and consist of metal tubes that,
with a snap of the wrist, lock into place. Although as effective as any other style, their
disadvantage lies in the fact that they may collapse with a hard strike to an immovable
surface, and that they lack the durability of a rigid baton. The newest style of expand-
ables are made from a combination of polycarbonate and metal, and use a screw that
automatically locks the device in place to prevent its collapse.

The baton is a dual purpose device: It can be used with leverage techniques as a

tool for pain compliance, or as an impact weapon. The advantages to the baton are that it is lightweight and inexpensive; it is versatile because it can be used to disarm or immobilize, or as a blocking tool; training is readily available from a number of public and private sources; and it is a tool the public is accustomed to seeing officers carry.

The disadvantages of the baton are, in part, responsible for its public image. Even with intensive training, it is still difficult or impossible to avoid head strikes, particularly in a combat situation. Injuries from facial strikes reflect badly on a department when the subject is shown on television news programs or in the next day's newspapers. Another problem, at least with the side-handle and non-collapsible batons, is that they are cumbersome to carry; as such, they are often left in the patrol car. Because they hang down nearly two feet from the officer's gunbelt, they can get in the way when the officer is running. (Americans for Effective Law Enforcement, 1988).

Other impact and compliance devices that are similar in nature include miniature batons. These go by a number of different names, and generally measure about six inches in length, with some expandable models. These are not impact weapons, but are used with leverage and pain-compliance techniques.

The flashlight is not technically categorized as an impact device, but some departments train officers to use it as such. The advantages to the flashlight are that it is readily available and considered standard equipment; it can be used with minimal reaction time if held in the hand; and it can deliver a heavy blow. The disadvantages are that it has a short reach; it has sharp edges that can cut; a blow to the head can be fatal or cause permanent paralysis; and most manufacturers have not warranted or endorsed their flashlights as impact weapons.

Some departments have banned the use of flashlights in response to incidents in which citizens or officers were injured. There are those who say such action is a mistake, that banning heavy flashlights, adopting those that are too small to be used as defensive weapons, or mandating that officers carry only plastic flashlights are not solutions. Critics say that solid policies and job-related training are the only way to reduce liability. They maintain that if an officer is attacked, he will use whatever he can to defend himself, including his flashlight (Brave, 1993).

Nunchakus come from the martial arts arena and are used by officers who combine these skills with their training in defensive tactics. The nunchaku looks like two short batons joined together with a cord running from the end of one baton to the end of the other. Although this device is not well-accepted by the public or most departments, those that do allow them have found they can be effective in come-along holds, and have tremendous force when used as an impact tool. There are devices that are similar in design and which have been created especially for police work, but still have not become widely accepted as impact and/or leverage tools.

One of the most unusual impact/leverage devices looks like a bent shepherd's crook and measures a bit over 15 inches in length. The device is intended for use primarily as a leverage device, with the officer using the crook in a back armlock or a take-down. It has never really caught on in policing.

Electronic Devices

Electronic devices suffer from a controversial reputation. One reason is because they are often associated with cattle prods, which put out a harmful level of electric current. Another reason is because they are not consistently effective; one was used several times on Rodney King before he was physically approached by officers.

Electronic devices have the advantage of being lightweight, easy to use, and, for the most part, affordable. They often work on people who do not respond to chemical sprays, and may be especially effective on the mentally ill or those who are under the influence of mind-altering drugs. But like any other type of control device, they can be misused. The electrical sparks can cause burns or start fires, and if the department is involved in a lawsuit, the manufacturer may not carry any product liability, and may not be willing to provide testimony or litigation support services (Americans for Effective Law Enforcement, 1988).

The TASER is probably the most well-known of electronic devices. An acronym

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> CS AND CN GAS HAD THEIR ADVANTAGES. THEY SUFFICIENTLY INCAPACITATED MOST PEOPLE. CANISTERS WERE CHEAP, LIGHTWEIGHT AND EASILY CARRIED. THEIR USE DID NOT REQUIRE EXTENSIVE TRAINING, AND NO PHYSICAL CONTACT WITH THE SUBJECT WAS NEEDED. IN THE 1960s, WHEN THEIR USE WAS POPULARIZED, THEY OFTEN WERE THE MOST APPROPRIATE TOOL WHEN RIOT-PLAGUED DEPARTMENTS NEEDED A RESPONSE ON THE LOWER LEVEL OF THE USE-OF-FORCE CONTINUUM.

for Thomas A. Swift's Electric Rifle, the TASER is a low-powered (five watt) device that runs on a 7.2-volt battery and shoots a pair of tiny barbs attached to 15 feet of wire. As the barbs travel (180 feet per second), the lower one drops about 1 foot for every 5 feet of range, with both ultimately lodging in the subject's clothing. Electrons flow from the battery, along the lower wire and leap across the gap between the subject's clothes and skin. The human nervous system forms a closed circuit for the TASER, with the current running along the subject's nerves, to the top wire and back to the battery. Short pulses delivered eight to 22 times per second cause a series of spasms which feel like a muscle cramp and cause the subject to involuntarily lose control of all movement.

TASERs have fallen somewhat out of favor as a result of the King incident, and also because they do not always work, especially on individuals wearing baggy clothes, which are currently in vogue, especially among teenage gang members.

Stun guns operate under the same principle, yet without firing long barbed wires. The officer must be within arm's reach of the subject and place the gun directly against the subject's body. Although stun guns are appropriate for some situations, they may not be the right choice when use at close proximity would be dangerous. There are modern versions of the stun gun that are mounted on extending poles and give officers a reach of up to 7 feet.

Some stun guns boast a hefty 150,000 volts, while others claim as little as 40,000. What is important to understand is that amperage is dangerous, not voltage, which is why 50,000 volts or more will not harm a person when the power source is relatively small. According to Ohm's Law (Georg Simon Ohm, 1927), as voltage increases, amperage decreases. Therefore, weapons that claim higher voltage may not have enough knock-down power because the amps have been decreased in proportion to the increase in volts.

Chemical Sprays

CN (Chloroacetaphenone) and CS (Ortho/ Chlorobenzal-Malononitrile) sprays have been available for many years. Even though they were once widely used by the police, they caused problems. Officers transporting prisoners whose clothing was saturated from the sprays often complained that they also were affected. There were times the sprays did not work on the mentally disturbed, intoxicated and drugged. There were reports that some people, when sprayed, became more combative. If they were armed with a knife or blunt instrument, they might lash out blindly at officers. Other subjects suffered temporary respiratory problems or eye irritations if left untreated.

This is not to say that CS and CN gas did not have their advantages. They sufficiently incapacitated most people. Canisters were cheap, lightweight and easily carried. Their use did not require extensive training, and no physical contact with the subject was needed. In the 1960s, when their use was popularized, they were helpful to riot-plagued departments, and were often the most appropriate tool when a situation called for a response on the lower level of the use-of-force continuum.

Their use has been nearly eclipsed, however, by oleoresin capsicum, or OC spray, also known as pepper spray. While CS and CN are irritants, OC is an inflammatory. Irritants, which can cause pain, are less effective when alcohol and drugs block the body's neural transmitters. Pain also can be deadened by heightened levels of endorphins or adrenaline in the drugged or mentally disturbed.

OC is a substance found naturally in cayenne or hot peppers. Because it is an inflammatory, the eyes do not tear as they do with CS/CN. They swell and involuntarily slam shut. The airway swells and causes choking, coughing, gagging, gasping for breath, and in some cases, nausea. Some people also experience a burning sensation on their skin. Because of its chemical properties, cross contamination of the officer is generally not a problem.

Decontamination consists of exposing the subject to fresh air, and flushing the eyes, face and affected areas with cool water. In FBI tests, the most severe symptoms were gone within two to three minutes after decontamination. Within 10 to 15 minutes all symptoms had disappeared, including bloodshot eyes and redness of the skin.

A two-year study by the FBI's Firearms Training Unit, in cooperation with the U.S. Army's Chemical Research and Development Center, found that of the 899 subjects exposed to OC, no ill effects or adverse reactions were experienced (Weaver, 1989). Another study on people with pre-existing respiratory conditions found the spray to be safe (Fuller). But one done by a private research facility and funded by a Midwest police department, found that the use of OC on subjects with respiratory problems could, in rare instances, cause death. It concluded, however, that such an occurrence was statistically improbable.

Pepper spray has been lauded by almost all who use it, and it has found its use-of-force continuum niche just above hands-on pain compliance and immediately below the use of impact weapons. Steve Bishop, former police chief of Kansas City, Missouri, cites the development of pepper spray as perhaps the most important advance in the past 20 years in helping police officers on the streets. Bishop says, however, that overall policing has been shortchanged in the slow development of technology to protect street officers.

In the early 90s, there were claims that pepper spray was the cause of some in-custody deaths. In response, the International Association of Chiefs of Police and the National Institute of Justice commissioned an in-depth study of the uses of pepper spray and the cases of in-custody deaths in which the spray was used. The study revealed that positional asphyxia may have been a contributing factor, and that pepper spray was not.

Pepper spray is not regulated by the Food and Drug Administration, the Environmental Protection Agency, or the Consumer Product Safety Council, nor are there any technical standards determining its composition. Manufacturers' claims also differ, with some claiming their pepper spray is "hotter" than their competitors' or has a stronger concentration of OC in the solution.

The traditional method of determining effectiveness has been to study the rating of Scoville Heat Units (SCUs). These were created by a pharmacist who was producing lineaments for treating painful muscle problems. He started using hot peppers in the mix and needed a way to measure the amount of "fire." His scale rated a sweet bell pepper at 0, a jalapeno at 5, cayenne at 8, and the hottest peppers, the habenero and Bahamian, at 10. Chemists quantify the degree by measuring the SCUs in the mix.

In the early days of pepper spray, there were questions and concerns about the solution in which it was mixed. Choices included isopropyl alcohol, Dymel, methylene chloride, and before the Clean Air Act banned its use, Freon. The controversy heightened after an officer used the TASER on a subject on whom pepper spray was ineffective. Because the spray contained a flammable carrier, the subject caught fire when hit by the TASER's electric current. This incident and the subsequent lawsuit filed against the manufacturer and the department alerted officers to keep flammable OC sprays out of situations where there is the possibility of fire.

In recent years, manufacturers have found new combinations for pepper spray. Some mix it with CS gas. Some mix it with dyes to mark offenders. Some mix it with talc or smoke for use in SWAT incidents.

Many believe that pepper spray is the most effective recent nonlethal tool to find its way into policing. Members of an NIJ-supported Less Than Lethal Liability Task Group examining less-than-lethal technologies concluded in the fall of 1997 that they knew "of no reason why law enforcement authorities should not continue using OC spray in an appropriate manner and under appropriate circumstances." (Appendix Eight is the full text of the group's statement. Appendix Nine reports on a Florida study of pepper spray.)

Chemical agents are widely used and effective nonlethal crowd control devices. Whether officers use CS/CN (Mace) or OC spray, they can disperse crowds, deny access to a given area, or help outnumbered police squads rout looters from stores. A simple smoke grenade can be used to cover officers' movements, or can be used as a warning that law enforcement will be using more serious weapons, like a chemical irritant or spray. Smoke can also be used in conjunction with tear gas or OC spray to carry it further into the crowd. For safety's sake, some departments have used powdered gas, which is nonflammable and has a tendency to linger. If the area is later revisited by

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rioters, it is kicked up by their footsteps and recontaminates the area. (Appendix Ten describes how two police departments have learned to respond to civil disturbances.)

Bean Bags

Another nonlethal technology — the bean bag shot from a .12-gauge shotgun — is gaining use. The bean bag round is designed to be fired directly at an unruly subject, which reduces problems associated with ricochet. It is fired from a shotgun, which most police departments have in their inventory. Most important, the subject is still alive when the incident is resolved, a factor that can reduce a police department's liability.

One department began using the .12-gauge bean bag round in response to a number of officer-involved shootings and subsequent negative publicity. In each case, the suspect was armed with something other than a firearm, such as a baseball bat, shovel, stick, or knife. The department evaluated many types of munitions before deciding on the bean bag round. The only real disadvantage is that its range of accuracy stops at about 60 feet. Beyond that, accuracy deteriorates substantially. To compensate, the department uses a 37mm grenade launcher that rapid fires six rounds, and has a rifled barrel and a sighting system for accuracy to 100 meters.

The bean bag round has been effective primarily because it enables officers to select and isolate their target. It has also been effective in handling those who are determined to commit "suicide by cop" — when an armed subject rushes police with the sole intent of being gunned down. The department discovered that firing a .12-gauge bean bag round incapacitates the subject so he or she can be disarmed.

Chemical Incapacitants

With the 1985 landmark decision in *Tennessee vs. Garner*, it was obvious that police needed alternatives to deadly force. The National Institute of Justice investigated several ideas and ultimately funded a feasibility study of chemical incapacitants. When the study was completed in 1989, the agency funded additional research and development, and, in 1990, added more funds to the effort.

The most promising incapacitant was Alfentanyl, a synthetic narcotic that was commonly used as a surgical anesthetic. A derivative of the Fentanyl family, Alfentanyl was considered the most promising because it is a highly potent drug that acts as a central nervous system depressant. Although its potency made it effective, it also was the reason why Alfentanyl fell out of favor as a potential incapacitant for police use. The drug carries a 4:1 dose safety margin, which means that in a hospital setting, the lethal dose is four times that of the therapeutic dose. While a 4:1 margin is appropriate for use in surgery, it is far too low to use on the street. Officers need a drug that can be administered in the same dose to a child or an adult, and have a sufficiently incapacitating, yet nonlethal effect.

Later efforts focused on Lofentanyl, another Fentanyl derivative. Lofentanyl has a higher dose safety margin, and, like Alfentanyl, passes quickly through the blood-brain barrier to go straight to the brain. It can also bypass any other drugs that may already be in the subject's system and incapacitate for up to two minutes with no side effects.

Although the initial research on Lofentanyl was promising, its use as a chemical incapacitant has made little progress. Research in this area is fraught with potential problems. Scientists have not discovered an appropriate dose, one that would be safe for adults and children, and that would not require the officer to calculate dosage in the middle of a volatile situation. Science also has not found a workable delivery system. The original plan was to administer the dose in dart form, turning the patrol officer's baton into a combination nightstick/dart gun. Another idea was to lace a paintball, like that used in law enforcement training, with DMSO and a chemical incapacitant. The paintball would splatter on the subject and the DMSO, which is absorbed immediately into the skin, would carry the drug into the body. As yet, no feasible delivery system has been produced.

Science and the legal community will also have to address the issue of public acceptance, or lack of it, and the obvious liability concerns associated with using chemicals to incapacitate people. A chemical that acts instantly and has the ability to safely

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disable for up to two minutes could be many times more effective, more humane, and therefore, more socially acceptable, than use of an officer's sidearm. The problem may be that the idea of the police using incapacitating drugs on citizens is simply unacceptable.

CURRENT EFFORTS

Police have a variety of nonlethal tools at their disposal. But these tools and their deficiencies leave gaps in the use-of-force continuum. The baton is the most widely accepted impact/leverage tool. Yet a rash of problems have been associated with it in recent years. With the exception of pepper spray, most newer technological devices have not worked well enough or consistently enough to gain widespread use within policing. As these tools are removed from the market, or fall out of favor with police and the public, the gaps in the use-of-force continuum widen. (Appendices Eleven and Twelve provide details on criteria and issues surrounding less-than-lethal technologies.)

As noted, the National Institute of Justice began to address the needs of law enforcement for nonlethal tools on the heels of the *Tennessee vs. Garner* decision. One result was the first study of chemical incapacitants. In 1992 and 1993, the NIJ initiated a series of cooperative agreements, interagency agreements and grants that focused on finding out exactly what police needed.

This less-than-lethal effort included panels of representatives from all levels of law enforcement and criminal justice as well as social scientists and legal professionals. The panels were given the job of advising NIJ on the needs of policing, possible less-than-lethal tools that could address those needs, and the related social, policy, and liability issues

With a resultant "wish list" in hand, the NIJ turned to the scientists at the Department of Energy's national laboratories and the DOE's Special Technologies programs. Four labs then took on the task of developing new technologies for law enforcement. The program accelerated in 1993 when a panel of law enforcement administrators from state, local, and federal agencies, the scientific community, military personnel, and legislators were tasked with examining military technology to find suitable devices that could be reworked to fit law enforcement's needs.

As the LTL program evolved, so did its goal. The original idea was to find an alternative to deadly force. But that effort is now geared more specifically toward finding tools and devices that can subdue subjects without harm.

Scientists and researchers have a set of parameters for less-than-lethal tools:
- It must improve on a present practice;
- It cannot overburden the officer;
- It must be inexpensive;
- It cannot require extensive training or dedicated manpower;
- It has to work.

Potential projects are divided into three categories: "off the shelf," meaning technology that is already in use in some form; "some assembly required," for technology that does not require extensive scientific development; and "scratch," for projects that require building from the ground up. At the same time, a series of panels comprised of social scientists, legal practitioners, and criminal justice professionals study the policy issues, liability issues, and potential public reaction to each device.

Examples of cooperative arrangements NIJ has established to develop technologies for less-than-lethal incapacitation include the following.

Velocity Range Correction Projectile Launcher
The Department of Energy's Lawrence Livermore Laboratory in California is investigating methods to combat the lethality of blunt trauma projectiles used for crowd control. If fired at too close a proximity, a round can be fatal, and authorities have expressed concern about accidental fatalities among innocent bystanders. A velocity and range correction device would determine the distance between the projectile launcher and the target, and automatically adjust the velocity to one appropriate for the range. It would allow officers to choose their distance, as opposed to standing at the outer limits of the launcher's range. It would also diminish the possibility of human

> THE ORIGINAL GOAL OF THE NIJ'S LESS THAN LETHAL PROGRAM WAS TO FIND AN ALTERNATIVE TO DEADLY FORCE. BUT THAT EFFORT IS NOW GEARED MORE SPECIFICALLY TOWARD FINDING TOOLS AND DEVICES THAT CAN SUBDUE SUBJECTS WITHOUT HARM.

error if, for example, a bystander or a child inadvertently walked in front of the launcher prior to firing.

Physiological Responses to Energetic Stimuli

This project entails ongoing research at the Oak Ridge National Laboratory in Tennessee into various technologies to produce temporary physiological responses, such as nausea, dizziness, and disorientation. Under study is the body's susceptibility to sound, light, and ionizing and non-ionizing electromagnetic waves. The goal of the project is to learn what the body reacts to and develop a device, tool, or weapon that produces that reaction. These weapons would temporarily incapacitate an individual or group without lasting physiological damage. The lab has investigated the potential of a thermal gun, which uses radio frequency to raise the body temperature and produce disorientation; a seizure gun, which uses electromagnetic energy to induce epileptic-like seizures; and a magnetophosphene gun which produces a blow similar to one that causes a person to "see stars."

Disabling Net and Launcher System

This project combines the efforts of private industry and the U.S. Army to produce a nonlethal, launchable net that fits a conventional weapons system, and that will safely ensnare attacking or fleeing subjects. A private company has already devised a system, which complies with the rules of military engagement, but they are less stringent than those under which law enforcement must operate. The device is being reworked to fit in a standard 37mm underslung launcher, giving an officer the option of using lethal or nonlethal force.

THE NIJ's LESS THAN LETHAL PROGRAM

SCIENTISTS AND RESEARCHERS HAVE A SET OF PARAMETERS FOR LESS-THAN-LETHAL TOOLS:

- IT MUST IMPROVE ON A PRESENT PRACTICE;
- IT CANNOT OVERBURDEN THE OFFICER;
- IT MUST BE INEXPENSIVE;
- IT CANNOT REQUIRE EXTENSIVE TRAINING OR DEDICATED MANPOWER;
- IT HAS TO WORK.

POTENTIAL PROJECTS ARE DIVIDED INTO THREE CATEGORIES: "OFF THE SHELF," MEANING TECHNOLOGY THAT IS ALREADY IN USE IN SOME FORM; "SOME ASSEMBLY REQUIRED," FOR TECHNOLOGY THAT DOES NOT REQUIRE EXTENSIVE SCIENTIFIC DEVELOPMENT; AND "SCRATCH," FOR PROJECTS THAT REQUIRE BUILDING FROM THE GROUND UP.

THE PROGRAM INCLUDES THE WORK OF A SERIES OF PANELS, MADE UP OF REPRESENTATIVES FROM ALL LEVELS OF LAW ENFORCEMENT AND CRIMINAL JUSTICE, AS WELL AS SOCIAL SCIENTISTS AND LEGAL PROFESSIONALS. THESE PANELS ADVISE THE NIJ ON THE NEEDS OF POLICING, POSSIBLE LESS-THAN-LETHAL TECHNOLOGIES THAT COULD ADDRESS THOSE NEEDS, AND THE RELATED SOCIAL, POLICY, AND LIABILITY ISSUES.

duties, particularly when responding to violent situations, is a factor in the reduction of officer deaths. Others say the use of body armor has been a significant contributor. Some contend that computer-aided dispatching gives the officers a wealth of information about each call, therefore enabling them to better prepare and, if necessary, arm themselves for each encounter. Still others attribute success on the streets to the use of a more sophisticated weapon, the semi-automatic, as opposed to the revolver.

The most reasonable assumption, of course, is that all of these elements are factors in keeping officers safe. Tactics are more sophisticated; body armor is as important to the police uniform as the firearm; computer technology has made vital information more accessible; and modern equipment allows police to keep pace with the criminals.

Firearms were the earliest form of protection employed by peace officers. But even those did not appear until the late 1860s, primarily because of a backlash against the armed and oppressive police forces of Napoleonic France. Police officers wore civilian clothes, had no formal training, and, if they did carry firearms, they were concealed. That changed with the military draft riots of that era and the onset of the Civil War. Suddenly the uniform, once the symbol of tyranny, was a badge of honor. American politicians and citizens rejected the European model of unchecked power, and made the local police accountable to civilian authority (Dowling, interview).

Guns became more commonplace as citizens began to accept the violence that periodically erupted in police-citizen encounters, and supported the officers' need to protect themselves. It was also clear that a police officer's physical isolation while on duty, and the unpredictability of citizen help or support in violent encounters, made extra protection necessary. Still, in the early days of policing, feelings about armed versus unarmed officers ran deep. Some felt officers who needed to carry guns were unfit for police duty. Others argued that attacks on lone policemen required a stronger response than a whack with a billy club.

One of the first cities to unofficially arm its officers was New York, with Boston later allowing its officers to carry weapons, but only at night. In the late 1800s, Boston fully armed every member of its police force with the Smith and Wesson .38-caliber revolver. Cincinnati armed its officers not long after, and in the late 1890s, New York City officially armed its officers with the Colt .32-caliber revolver. By the 1900s, armed officers were considered commonplace. (Bailey, 1995).

Until the 1960s, the revolver was a standard in law enforcement. But in 1966, a California police department adopted the Colt .45 ACP semi-automatic weapon, one that had been used by the U.S .military since the early 1900s. Although the weapon was quite serviceable, the general police community waited for the creation of the double-action semi-automatic before it considered straying from the dependable revolver.

The semi-automatic pistol is a self-loading weapon, using the residual energy of a fired shot to eject the spent cartridge, extract a cartridge from the magazine, insert it into the pistol's chamber, and reset itself for another shot. The trigger pull on the double-action's first shot requires a hard continuous pull. Subsequent shots are a shorter, easier trigger squeeze executed from the slide-cocked hammer position.

The police community has embraced the use of the semi-automatic 30 years after its initial adoption. Its proponents initially lauded its compact shape, increased ammunition capacity, fast reload, rapid fire and reduced recoil. In recent years, however, that view has become more focused, with many in policing arguing that semi-automatics are an effective way to respond to criminals who seem to be carrying bigger and better guns.

Police have a continuing concern with being "outgunned." Facing such automatic weapons as the AK47, the Mac 10, and the Uzi has many convinced that the only way to do battle in the streets is bullet for bullet, round for round. And the only weapon capable is the semi-automatic. These concerns deepened after a 1986 Miami shootout that left two FBI agents dead and five wounded after a firefight with two highly trained criminals armed with automatic weapons. Following the incident, the FBI looked at its tactics, and more closely, its weapons and ammunition. After extensive study and testing, it adopted a semi-automatic weapons system that gives its agents a choice of pistols.

The bureau was awash in a trend that ultimately swept the entire country. There were those who wanted to keep the serviceable and dependable revolver. They cited

> IN THE EARLY DAYS OF POLICING, FEELINGS ABOUT ARMED VERSUS UNARMED OFFICERS RAN DEEP. SOME FELT OFFICERS WHO CARRIED GUNS WERE UNFIT FOR DUTY. OTHERS ARGUED THAT ATTACKS ON LONE POLICEMEN REQUIRED A STRONGER RESPONSE THAN A WHACK WITH A BILLY CLUB.

statistics that said an officer rarely fires more than five bullets in a gunfight, therefore the revolver's six bullets ought to be enough. They said shot placement and tactics were the problem, that officers were undertrained, that training was unrealistic, and that range qualification once a year was not enough. They argued that semi-automatics were subject to mechanical problems, jammed far too often, and would ratchet training expenses up to an unmanageable level. Although the arguments, claims and assertions were true for the most part, the facts did little to assuage the fear of line officers. It was a debate of perception. Whether or not they were outgunned was not a concern. What mattered was that most officers felt better, and in some cases shot better, with increased firepower on their duty belts. Today, most police departments in the country have changed to semi-automatic weapons, even the New York Police Department, which was one of the last bastions of the revolver.

Weapons continue to undergo revision and redesign. There are new cartridges and bullet designs, new trigger mechanisms, and the recent advent of smaller semi-automatics, dubbed "pocket rockets." Some maintain this new generation of pistols is the result of President Clinton's Crime Bill and the fact that it restricts semi-automatic magazine capacity to 10 shots. Still, the pistols have been extremely well-received. Testing has shown that the smaller pistols are easy to shoot, and have recoil and accuracy similar to the full-size semi-automatics. These 9mm weapons also fit smaller hands, and are currently touted as being the latest thing in backup firearms.

Shotguns are among the most familiar of traditional police firearms. Carried in cruisers, these weapons give officers a psychological advantage merely by the easily recognizable sound of racking the action, which can be intimidating enough to stop a criminal in his tracks. It also makes the officer a more daunting force, something that is especially true for smaller officers. Shotguns are the preferred entry weapon because they work well in small spaces and at short distances, and can be loaded with various types of ammunition, including rifled slug loads and tear gas. Not only is the shotgun's shot pattern bigger, it is an effective weapon in the hands of a less-than-proficient shooter.

Rifles are used primarily for sniper or distance shooting, although some are increasingly being carried in patrol cars for backup. Although carrying such a weapon can dramatically increase ammunition capacity, the fact that it is a devastating distance weapon can also make it dangerous to innocent bystanders. Stray rounds have an extremely high penetration rate and can travel several miles before they slow down. Unlike shotguns, rifles lend themselves to job specific use. The U.S. Border Patrol, for example, regularly trains with them because of the agency's rural environment and the need to cover large distances with a well-aimed shot. The U.S. Customs Services, which performs such assaultive missions as boarding boats or forcing aircraft out of the air, has used the Steyr AUG (Army Universal Gun) 5.56-caliber rifle. Some state and local police agencies have recently begun offering rifles to patrol officers. One Florida department added rifles to its duty arsenal after a mass murderer shot and killed six people, including two police officers, at a shopping center. The rifle allows the officers to deploy at greater distances and shoot more accurately.

New-model weapons are continuously being developed as older models are refined and improved. Better holsters, new accessories, and superior ammunition are the focus of weapons manufacturers. New developments do not have to be big, flashy or spectacular — sometimes even the tiniest change can be a dramatic improvement. One firearms company has found a way to give marksmen/snipers the extreme accuracy needed for tactical shooting. At one time, the only way to ensure accuracy was to use a specialty weapon, a custom rifle capable of shooting 1/2 minute of angle or better at 100 yards, which means it can put a three-shot group in less than a 1/2 inch. The problem was that the barrel of the rifle vibrated like a tuning fork, and this vibration, or barrel whip, affected the trajectory of the bullet. For extreme accuracy, the marksman's rifle had to have a "bull barrel," one that was heavy and thick, and did not move when the weapon was fired.

The bull barrel increased the weapon's weight to anywhere from 18 to 26 pounds, but tactical operations required that officers rappel, climb and jump while carrying

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these large and unwieldy weapons. The firearms manufacturer was able to reduce the weight while maintaining accuracy by putting an adjustable muzzle break and a tuning mechanism on the end of the barrel, thereby allowing the shooter to tune the barrel to the bullet. Rifle weight dropped to about seven pounds and barrel length decreased by several inches, all while maintaining accuracy.

Like some other types of equipment available for police use, this revolutionary new system was not revolutionary at all. The manufacturer created it several years ago, but limited its use to hunting rifles. Only recently did the company modify it for the police.

As noted in Part One, soft body armor provides an important measure of protection to the police. For many years, DuPont owned the market on ballistic materials used in body armor. But in the mid 80s, the market opened up. Allied Signal introduced Spectra Shield, a material molded from layers of unidirectional fibers coated with resin. It was lighter, more flexible, and not subject to the sun's damage, as was DuPont's Kevlar. Although Spectra Shield made a strong showing, and is currently used by a large percentage of vest manufacturers, both companies continue to pursue research for something even better. DuPont is working on a new "puncture-resistant" material for vests that will be worn by corrections officers; Allied Signal is continually seeking to develop more effective ballistic technologies.

Body armor manufacturers are also working toward a better, more wearable concealable vest by tweaking old technology to create armor that is lighter, more comfortable, and still ballistically sound. Some use Spectra products, while others use the traditional Kevlar-based products. Some inventive manufacturers have come up with ways to combine them, creating a kind of hybrid technology. But they don't stop there. They try new stitching patterns, new strapping combinations, new carrier materials, and new pocket combinations.

Soft body armor is today as important as a police officer's weapon. Its ability to save lives is undisputed; DuPont keeps statistics on "saves," and gathers information on everything from shot location to the type of bullet fired. According to DuPont's Casualty Reduction Analysis, of the 74 officers feloniously killed in 1992, 56 of them were not wearing vests. Thirteen of those deaths could have been prevented had the officer been protected by body armor, according to the analysis. The company asserts that there has never been a vest that failed to stop the caliber of bullet for which it was rated. Vests have, however, been pierced — and officers killed — when the vest did not stop a higher caliber bullet for which the vest was not rated.

If body armor is so successful at protecting personnel, one would assume that patrol officers and those at risk of gunfire would be eager to wear it. But some are not. When body armor first arrived on the policing scene, the traditions and machismo of the profession were its biggest impediments. Officers scoffed at its ability to stop bullets; others, usually veteran officers, imagined that their many years on the street somehow made them impervious to bullets. There were complaints that the vests were uncomfortable, especially in hot weather. And there were those who believed that gunfights would never happen in their sleepy little towns.

Compounding the problem was a body armor battle that started when the NIJ raised the equipment standard for vests. As part of its testing and evaluation efforts, the NIJ's Technology Assessment Program Information Center routinely tested body armor, and published a list of results, detailing which models passed and which ones did not. In 1987, the NIJ modified its standard and, suddenly, vests began to fail at an alarming rate of about 60 percent. Vest manufacturers cried foul, accusing the NIJ of creating a standard that was impossible to meet and pointing to what they said were problems in the test protocol. The NIJ dug in its bureaucratic heels and the war was on. Manufacturers whose vests failed joined with the Personal Protective Armor Association and wrote their own standard, one that the NIJ said was far too flexible and could result in officer deaths. The NIJ recommended to the nation's law enforcement agencies that they buy only vests that were NIJ certified. But without the power of enforcement, that recommendation held little weight. DuPont, fearing lawsuits brought on by officer deaths, considered halting sales of Kevlar to manufacturers who refused to construct the type of vests that would comply with the new NIJ standard. It was a serious controversy,

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with all sides claiming their first priority was the safety of peace officers. And in the thick of it all were officers and police administrators, confused about what kind of armor to buy.

The disagreements were eventually resolved. The NIJ still uses its standard, believing that to draw the line any lower would result in inferior vests. Manufacturers, for the most part, have complied, and police agency procurement guidelines generally require that vests meet the standard.

Still, in mid-1996, echoes of the old debate began to reverberate throughout the police community. "Without regulatory authority, (vest manufacturers) can essentially ignore the NIJ," said one veteran administrator. But NIJ officials say they do not want regulatory authority, that they agency's focus is on product testing to meet standards set by the police profession, not a governmental entity. Its objective lab tests act like a kind of *Consumer Reports* for law enforcement, dispassionately reporting the results. The NIJ says it wants to act as an information clearinghouse and an agency that funds and supports technological development. It has set standards for police vehicles, handcuffs, weapons systems, patrol car tires, all without getting into debates about regulatory authority.

The NIJ, through its National Law Enforcement and Corrections Technology Centers, currently is updating its standard, and has turned to the National Armor Advisory Board for help. The NAAB is made up of members of the body armor industry and the law enforcement and corrections community. The relationship between the NIJ and the NAAB is evidence that the battle over the body armor standard is, for the most part, over. NIJ officials worked dilligently to build a bridge between the agency and the body armor industry, and today puts great value in the advice and input from the NAAB members.

The NIJ has other projects designed to protect police personnel. One is the development of the Smart Gun, a weapon that can only be fired by its owner or other designee. The NIJ, working with scientists and engineers at Department of Energy labs, has investigated several technologies and developed five prototypes: a remote control device; a sensor that must come in contact with a certain spot on the weapon; a small chip embedded in a ring that must be within a certain proximity to the weapon for it to fire; and devices that are fingerprint and voice activated. This weapon is currently being further developed by Colt Manufacturing.

The NIJ also funded the development of the back seat airbag to address the problem of transporting unruly prisoners in the back seat of the police vehicle. The airbag is made of a porous nylon, and is inflated by the officer. Although it fills the back seat and immobilizes the prisoner, it still lets him breathe.

Also under consideration is a personal locator transmitter. Developed by the DOE's Idaho National Engineering Laboratory with funding from the NIJ, the transmitter is designed to be worn around the collar of a police uniform to provide a constant location and communication ability between the officer and the central command station. It allows the officer hands-free communication as he deals with each incident. In the event that the officer is injured, backup would know his exact location.

The Remote Control Information System (RCIS) is a similar device that was originally developed by a coalition of private corporations for medics in the military. It is a portable communicator that provides full-color video, two-way audio, and incorporates GPS technology for officer location, as well as a system to monitor the officer's vital signs. The RCIS would allow military medics, with direction from doctors hundreds of miles away, to provide trauma treatment in the field. For police, it would allow supervisors to monitor an unfolding incident, fix on the officer's location, and monitor his vital signs in case of injury. To ensure that law enforcements' operational requirements are incorporated into the device, which some say could eventually replace the hand-held radio, private industry is working with police administrators and NIJ officials.

The NIJ also developed the Technical Information Network (TIN). Housed in the southeast office of its National Law Enforcement and Corrections Technology Center in Charleston, South Carolina, the TIN offers free, 24-hour access to all of the agency's information sources and any other service that is of value to law enforcement.

SOFT BODY ARMOR IS AS IMPORTANT AS A POLICE OFFICER'S WEAPON. ITS ABILITY TO SAVE LIVES IS UNDISPUTED. DUPONT KEEPS STATISTICS ON "SAVES," GATHERING INFORMATION ON EVERYTHING FROM SHOT LOCATION TO THE TYPE OF BULLET FIRED. ACCORDING TO DUPONT STATISTICS, THERE HAS NEVER BEEN A VEST THAT FAILED TO STOP THE CALIBER OF BULLET FOR WHICH IT WAS RATED.

Although this large database is operated out of Rockville, Maryland, the Charleston center built the infrastructure that makes it accessible to the nation's police agencies.

PROTECTING CITIZENS

Perhaps the greatest expectation of police is that they address crime. Even though serious crime, as noted earlier, constitutes only a small percentage of police calls, it engenders the greatest fear.

To help the police deal with crime, NIJ has sought to find federal dollars to support the development of new technologies and the transfer of those already existing in other industries. It has created the National Law Enforcement and Corrections Technology Centers that are finding ways to piggyback on existing research to create new technologies for law enforcement (detailed in Part Three). Each center is tasked with a certain area of technology scientific development. One center is addressing the problems of communications interoperability between jurisdictions, while another is building the network for a huge equipment and technology information database. Another center is working on sophisticated surveillance technologies, while another is trying to untangle the complex web of obstacles to procuring used military equipment and getting it into the hands of police.

As part of its work, the NIJ in 1995 launched an initiative to find a way to detect weapons, a project that is inherently important to the safety of both citizens and police. A technology that would let officers stop a car, order the suspects out, and scan them for concealed weapons without leaving the safety of their cars would save the lives of many police officers. Such a device also could be used by schools to scan for students carrying weapons and by airport security personnel to look for illegal arms and bombs. The project has taken on even greater importance with recent incidents of domestic terrorism. The bombing of the World Trade Center, the bombing of the Alfred P. Murrah federal building in Oklahoma City, and the bomb that killed one and injured more than a hundred at the Atlanta Olympic Games have made the detection of concealed weapons and contraband more important than ever.

NIJ, through NLECTC, is exploring a number of options to develop a safe, affordable, inconspicuous system to detect metallic or non-metallic weapons at a distance of up to 30 feet. Several types of technologies are currently being explored by the NLECTC center in Rome, New York:

• A passive millimeter wave (MMW) technology that allows for rapid and remote detection of metallic and nonmetallic weapons, plastic explosives, drugs and other contraband concealed under multiple layers of clothing at a distance of up to 12 feet without a direct physical search. The technique relies on existing natural emissions from objects, and does not require man-made irradiation of a person. Although the technology literally sees through clothing, it does not reveal anatomical detail. This project will include the development, fabrication and evaluation of a fixed-site camera that can be mounted on a cruiser, a monitoring console, and a proof-of-concept handheld camera with a video screen that is connected by cable to a signal analyzer box. Designs are to be developed for a totally portable, battery-powered camera and a standoff camera system suitable for use from a patrol car. This technology, although promising, is several years away from completion.

• An active approach using an electromagnetic (EM) technology, in which an EM pulse is emitted at a person standing in a portal. The difference in the EM radiation reflected back from different materials permits the identification of metallic objects. This technology has been successfully demonstrated and is now being picked up by commercial developers.

• A passive approach using fluxgate magnetometers. Anomalies in the earth's magnetic field caused by metallic objects on individuals standing in a portal are measured by magnetometers and compared to a computerized database containing the measurements of actual weapons. This approach should significantly reduce the false alarm rate compared to the currently available technologies. The NIJ and the Idaho State Court system are testing a preproduction stage of this device in an Idaho courthouse.

• An active approach using a modified off-the-shelf Compton (back) scattered x-

ray imaging system. An individual is exposed to an extremely low level of radiation (about the same level as five minutes of exposure to the sun at sea level). These x-rays do not penetrate the body to any significant degree but are reflected back. A picture is then developed electronically, in less than one second, from that reflected radiation. Since different materials have different reflectivities, the operator is able to detect weapons or other contraband from images in the picture. A prototype has been success-fully demonstrated in a North Carolina correctional institution and a California federal court. NIJ is also looking at enhancing the technology with real-time images of sub-jects, without requiring them to stop in a portal. Working with the Federal Aviation Administration, the NIJ plans to integrate other sensors to enhance the technology's ability to detect explosives and other kinds of contraband.

> • A hybrid-passive approach using millimeter wave and infrared cameras in a stand-alone and sensor suite combination. The difference in the thermal energy retained and emitted by different materials causes them to appear in the pictures as dis-tinct images. These technologies are complementary since the infrared camera has more range than the millimeter wave camera, while the millimeter wave camera has better resolution. The components have been successfully demonstrated. The NIJ is continuing to study this technology with the goal of building a prototype.

> • A sensor suite combining radar and ultrasound imaging. These work together in much the same manner as millimeter wave/infrared. The radar can detect weapons at a greater range, but does not have the resolution of ultrasound. This approach can also spot non-metallic weapons. A successful component demonstration has been conduct-ed, and the basic acoustic technology has been successful.

NIJ is also exploring other approaches to move these technologies further along.

> • A low-cost handheld acoustic device to detect weapons on people up to dis-tances of 20 to 30 feet.

> • A handheld MMW device to detect weapons at an acceptable range using a unique antenna.

> • Vehicle-mounted devices to detect weapons on people up to 20 feet away. Tech-nologies would include radar, infrared, and magnetic field disturbances.

> • A body-cavity search system using magnetic resonance imaging (MRI) technol-ogy. This could be used for weapons and contraband detection in corrections and other applications.

NIJ earlier was successful in supporting development of the use of a canine tech-nology to detect explosives. In the 1970s, when terrorist bombs were increasing in cities and on campuses, the NIJ funded two grants. One was to the U.S. Army to train dogs to enter buildings and find explosives, and another to the New York Police Department to field test the trained dogs' detection ability. The result was the discovery that almost any dog could sniff out explosives, from a German shepherd to a Chihuahua. Any resid-ual skepticism about the animals' abilities was erased when a dog began tearing at a wall at the 1972 Democratic National Convention in Miami. Police found a spent car-tridge from a rivet gun. In New York a dog discovered a bomb aboard an American Air-lines plane, and another found $100 million in heroin for federal drug investigators.

The NIJ has also worked with private industry to develop other technologies for citizen protection. Alliant Techsystems, Inc., created SECURES (Systems for the Effec-tive Control of Urban Environment Security), which uses acoustic sensing to pinpoint the location of gunfire. By placing sonar detection modules in a grid through a gun-plagued area of a city, the SECURES system can recognize and pinpoint gunfire, which will allow police and emergency services to respond 85 percent faster than usual.

In 1996, the company tested the system for the first time by placing the cigarette pack-sized detectors on street lamps, traffic lights and the sides of buildings in a 10-block area of Washington, D.C., which has had a high homicide rate for several years. When the system detects a gunshot, it sends a signal to a computer, which alerts a dis-patcher of the location. It can monitor an entire city block from one location, while fil-tering out similar sounds, like that of a car backfiring. If placed on top of a traffic signal, it can monitor all four intersecting streets at one time.

Although civil libertarians worry that the use of gunshot detectors and video cam-

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eras, like those installed in a 16-block stretch of downtown Baltimore that monitor the area 24 hours a day, will eventually encroach on personal privacy, citizens living in these tough neighborhoods welcome the intervention. Said one Washington, D.C., woman, "If they build a robo-cop, he can stand guard in my yard." (Bowles, 1996).

Illegal drug use and drug trafficking endanger citizens and are a potent source of fear of crime. In the early 1980s, the NIJ began helping cities respond to escalating drug problems with its Drug Use Forecasting program. The forerunner of the program was its early research that studied the results of urine tests given to arrestees in New York City and Washington, D.C. The study found that more than half had been using drugs, like cocaine, PCP or heroin, during the 48 hours prior to the test, and that at least one third of them used more than one drug. Even earlier NIJ research had shown that multiple drug use was one of the most salient characteristics of serious, habitual offenders, and that high-risk individuals, such as heroin addicts, committed four to six times more crime when they were on drugs than when they were relatively drug free. In Washington, D.C., a pretrial services agency used this data to develop urinalysis tests for arrestees to give judges a way of determining who could be released before trial and under what conditions.

In the late 1980s, the NIJ found another way to use this information. The drug-using habits of the offender population could be used to warn local law enforcement about drugs that might soon become widespread. Since that time, the Drug Use Forecasting program has given local officials the information they need to allocate drug control resources and to gain an understanding of the extent and nature of drug use in its offender populations. It has also helped advocates of treatment and prevention gain support for their programs, and has been a source of information for those exploring specific areas of drug use.

On another technological front, there now exist machines that detect drugs or explosives on nearly any surface. These machines, which are desktop or handheld, are able to spot even the most minute particles of a contraband substance. All they require is that the user wipe an area with a treated swab and insert the swab in the machine. In seconds, it detects the molecular composition of the substance the device is calibrated to find. One company even offers a home test kit for parents who are worried about their children using drugs.

Cartels in South America and Mexico are continually finding ways to get drugs into the country. In attempts to combat drug smuggling:

- A $3 million x-ray machine installed by U.S. Customs to detect contraband in 18-wheeler trucks crossing the border has been remarkably successful, finding load after load of contraband drugs, guns, and even fruits and vegetables. The technology originally was built to detect Soviet missile warheads in trucks. What it cannot do is find contraband that is in densely packed areas of the trailers. Drug agents say Mexican smugglers know this and have adjusted.
- A billion-dollar U.S. nuclear attack submarine in the Pacific electronically shadows trawlers and container ships suspected of drug smuggling. In the Caribbean, the Coast Guard scans the horizon with state-of-the-art radar that was originally designed to detect Soviet submarine periscopes. Both patrols search for drug shipments headed from Mexico to the U.S. The problem is that Mexico has 28 poorly regulated major commercial ports, and the U.S. has 13 that have been classified as "high threat" by the Customs Department. Federal agencies do not have the equipment to go through the thousands of vessels that cross the seas, and as a result, large shipments of illegal drugs get through.
- Over-The-Horizon Radar systems give the U.S. military the ability to spot potential drug-carrying planes in 2,000 miles of airspace south of the border. The $150-million system was installed to intercept South American smugglers moving cocaine through Mexico and into the U.S. But the system has an enormous blind spot over northern and central Mexico, and sees only a tiny portion of the Pacific ocean. Once again, the cartels have adjusted and now use this blind spot as an area in which to land planes. American drug agents say the smugglers bring in as much as 15 tons of cocaine at one time (Fineman, Pyes, 1996).

CIVIL LIBERTARIANS WORRY THAT THE USE OF GUNSHOT DETECTORS AND VIDEO CAMERAS — LIKE THOSE INSTALLED IN A 16-BLOCK STRETCH OF DOWNTOWN BALTIMORE THAT MONITOR THE AREA 24 HOURS A DAY — WILL ENCROACH ON PERSONAL PRIVACY. BUT CITIZENS LIVING IN THESE TOUGH NEIGHBORHOODS WELCOME THE INTERVENTION. SAID ONE WOMAN, "IF THEY BUILD A ROBO-COP, HE CAN STAND GUARD IN MY YARD."

SOLVING CRIMES

· Criminal investigation, particularly of serious crimes, has often involved hard work and many hours spent to gather and evaluate information and to ready a case for court. As the science of solving crimes has become more sophisticated, detectives have become more efficient. With the advent of specialized forensic sciences and the addition of unique computer programs and comprehensive records management systems, piecing together the puzzle to figure out the who, what, when, where, why and how of a crime is easier.

FORENSIC SCIENCE

Forensic science is one of the few areas of law enforcement where science and crime solving meet. It is vastly different from the domain inhabited by the detective who interviews victims and witnesses. Criminalistics moves out of that messy and often emotional arena and into the sterile environs of the crime lab. Here the laboratory scientist deals with inanimate objects that cannot lie, fight, or flee.

Forensic science is based on the theory of transfer, that when two objects meet, some evidence of that meeting generally can be established and verified at a later time. Fingerprints left inside a house, shoeprints outside a window, toolmarks around a door. These minute bits of evidence can incriminate, associate, establish, and convict. With the advent of DNA analysis, those bits of evidence keep getting smaller and smaller, to the point that a link between a suspect and a crime can be made with less than 100 cells.

The early days of forensic science can be traced to London in 1888, when doctors were allowed to examine the victims of Jack the Ripper for wound patterns. In 1899, the Marsh test was used to test for arsenic in the death of a Liverpool cotton broker. In the early 1840s, photography was first used to record criminal portraits, and in 1879, Alphonse Bertillon developed a method of identification that used measurements of physical characteristics.

The science of fingerprinting was a culmination of the work of practitioners in several different countries. William Hershel in India in 1877, and Dr. Henry Faulds in Tokyo in 1880 laid the groundwork. Francis Galton published his book *Fingerprints* in 1892, and in 1896, Edward Henry developed a system of classifying and filing large numbers of fingerprints. The Henry system, as it came to be known, was adopted in the British colonies, and ultimately became the most commonly used classification system.

It was not until the end of the nineteenth century that these scattered efforts began to coalesce as the rudiments of an actual science. Sir Arthur Conan Doyle contributed his tremendous powers of observation and deduction in his fictional character of Sherlock Holmes. It was Hans Gross, an examining Austrian magistrate, who compiled the most current information available at the time and in 1893, published *Handbuch fur Untersuchungsrichter* (*A Manual for Examining Magistrates*), the first real handbook of forensic science.

Early practitioners were self-taught. There were no special schools, no university courses, and no formal training. Forensic scientists came from everywhere, from the policing profession and the research lab, from the courtroom and the classroom It wasn't until the early 1930s that universities began offering courses and degrees in criminalistics and police science, with the first curriculum created by August Vollmer at Berkeley, California.

The most rapid advancement came with the creation of the Law Enforcement Assistance Administration in the 1960s. Federal funding allowed the LEAA to offer grants for training, equipment, and research projects.

As the science of criminalistics has advanced, so has the need for specialization and the sophistication of crime labs. In the early days, one scientist examined many types of evidence. As the body of knowledge expanded and the science became more exact, specialization grew. Today, examiners find themselves operating in a single area and within a narrow field of inquiry (Bailey, 1995). Whether the practitioner is doing a sophisticated DNA analysis or simply photographing blood spatters at a crime scene, it is all part of the teamwork involved in solving crimes.

Advances in forensic science are frequent. Each new device or technique offers help to officers who depend on the reliability of DNA analysis or the speed of an AFIS to

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search for one suspect among millions of records.

What experts say investigators and crime scene technicians must improve upon is the collection and processing of evidence. Smarter crooks and tighter controls on police interrogation have reduced the dependence on confessions. While confessions played a pivotal role in 75 percent of the murder cases 20 years ago, they only figure in about 50 percent of them today (Pilant, 1992). Diminished confidence in police, television shows that focus on police mistakes, and criminal cases tried in the media have also played a part. Neither juries nor the courts give confessions the weight they once did. They want corroborating evidence.

The importance of physical evidence and the reliability of forensic science have grown. Protecting the crime scene and gathering or interpreting the evidence accurately is undoubtedly the most important thing an investigator or forensic scientist can do.

Fingerprint Identification

Until the advent of DNA profiling, the fingerprint was the single most precise identifier. It was then, and still is, the most persuasive and conclusive type of evidence. Although fingerprints are often hard to come by, nothing is more recognized or respected by prosecutors, juries, investigators, and suspects.

Fingerprints are unique to a person, and do not change throughout a lifetime. Therefore, the probability of any two people having the same fingerprint patterns is negligible. Over the years, as databases of fingerprints have grown, that probability has been statistically proven to be almost nonexistent.

A fingerprint is actually the impression made when the fingers or thumb are pressed against an article. The ridges in the fingerprint form patterns that are grouped into arches, loops, and whorls. By studying these patterns, fingerprint examiners find identifying characteristics that are unique to the print.

Because most fingerprints are invisible to the naked eye, they are known by forensic scientists as latent prints. They are developed primarily by dusting the area with a fine powder, which sticks to the residue left by the fingers, or with a ninhydrin treatment, which uses a chemical reaction to create a purple-blue print.

In the 1970s, the Japanese discovered that a process known as cyanoacrylate fuming, also known as superglue, could be used to develop prints on smooth surfaces. Superglue fuming polymerizes the print, turning it into a clear, plastic, three-dimensional piece of evidence. By the early 1980s, the process was routinely used in crime labs. Although it created a tough, indestructible print, the process was tedious, cumbersome and had to be confined to the crime lab because none of the equipment was portable. Evidence, regardless of its size, had to be taken to the lab for processing.

In one of its many efforts to support and advance the forensic sciences, the National Institute of Justice funded a grant to Alaska's Scientific Crime Detection Laboratory in Anchorage to find a way to bring the fuming process to the crime scene. The result was a portable vapor pump that lets technicians process a crime scene in less than two hours. Even better was the development of the Vapor Wand (often called the Magic Wand), a miniaturization of the fuming process that used a butane torch and a .223-caliber brass cartridge casing filled with steel wool and saturated with methyl cyanoacrylate. When the wand was lit, it emitted a high concentration of fume to develop the prints. The small, handheld Vapor Wand was the first truly portable fuming device that was also affordable; it could be manufactured for less than $200.

Science is constantly searching for newer and better ways to develop latent prints. Fuming with iodine vapor and silver nitrate, tagging with radioactive material, and using autoradiography (x-rays), have all been explored. These exotic methods are often far too expensive for police work; however, the use of lasers, which causes prints to fluoresce, or glow, has come into the financial reach of many departments.

The NIJ also has been active in this area, funding grants to develop versatile and affordable reagents in the ninhydrin family. The goal has been to find reagents that fluoresce; that do not require the use of a laser; are more sensitive; have increased resolution and good solubility in non-toxic affordable solvents; are environmentally friendly and safe to use; can be used on a variety of surfaces, and that do not fade with time. Additional goals are to find a polymer that results in a permanent print, like that which results from

superglue fuming, as well as reagents that increase the accuracy and speed of processing so law enforcement can keep pace with innovations in computer technology and Automated Fingerprint Identification Systems (AFIS).

As important as these innovations have been to the science of fingerprinting and solving crimes, probably none has had more impact on policing than the Automated Fingerprint Identification Systems. The traditional method of matching fingerprints is to manually search fingerprint card files. But matching the print from a piece of evidence to the print of a suspect is impossible unless a suspect has already been identified. Searching millions of print files for a single match, also known as "cold searching," is simply too tedious and cumbersome. It is also a huge drain on a department's manpower. An AFIS makes cold searching possible by digitizing fingerprints and storing them in a database. Investigators simply enter the evidence print into the database and instruct the computer to search for a match.

The AFIS was originally developed in the 1960s by a member of the French Surete. The Canadians saw the value of AFIS nearly twenty years ago, and installed a system that is integrated with all Canadian law enforcement agencies. American agencies in recent years followed suit, but with a piecemeal effort. Unfortunately, no federal or state agency has taken on the task of installing a nationwide system, nor has any private corporation. AFIS systems in the United States are regional, i.e., they may cover several states, they may be statewide, or they may encompass only the city and a few surrounding municipalities. One of the larger systems is the Western Identification Network, which serves Alaska, California, Idaho, Nevada, Oregon, Utah, Washington and Wyoming.

The obvious disadvantage to such a fractured AFIS network is that today's roving criminals can still escape detection because investigators in one state may not have access to another state's AFIS. Also, communication between AFIS computers can be complicated, even among agencies located in the same state. Differences in technology, operational approaches, equipment, interfaces, and network compatibility make it difficult to ship fingerprints to other agencies or access a variety of fingerprint databases.

The FBI is addressing these problems with the Integrated Automated Fingerprint Identification System (IAFIS). The project has been undertaken in conjunction with NCIC 2000, which is designed to increase the speed and capacity of the current National Crime Information Center (NCIC). Currently, officers can check the NCIC database for wants and warrant information on detained subjects. A "hit" constitutes probable cause for further action. NCIC 2000 will add sophisticated computer technology to increase the capacity of the existing system, and to enable officers to transmit graphic images, like fingerprints and mug shots.

While NCIC 2000 will have a database of single fingerprints of wanted persons, the IAFIS is slated to be a huge database of tenprint cards (cards with prints of all ten fingers). As of 1996, the bureau processes anywhere from 40,000 fingerprints a day to upward of 80,000 on unusually heavy days. Plans are that IAFIS be able to process at least 60,000 per day.

The difference between the two systems is that the images in the NCIC database are not a true and total fingerprint. When printed out, the image is not identical to an inked print; the computerized version has less definition and requires filtering so it doesn't falsely identify and reject possible matches. The technology, in layman's terms known as "one-to-one" matching, is a simple matter of identification verification. It compares one print to one record for a simple "match" or "no match" response. In contrast, IAFIS technology will use "one-to-many" matching, which requires that the computer extract minutiae from the print and compare it to all records in the database.

Law enforcement agencies will not need sophisticated computer technology to access either NCIC 2000 or IAFIS. Varying levels of participation will be available, depending on the level of technological expertise and the agency's equipment. The FBI has made it clear that it will not dictate the type of equipment necessary to access either database. Instead, it is working with the National Institute of Standards and Technology (NIST) to create a technological standard for fingerprint images. This standard will be used for encoding and transmitting fingerprint images. It also will foster a move toward open systems architecture, which allows different systems to communicate with each other.

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OTHER THAN THE TRAINED EYE AND THE WARY NATURE OF A SEASONED DETECTIVE, DNA ANALYSIS IS PROBABLY THE MOST POWERFUL INVESTIGATIVE TOOL IN LAW ENFORCEMENT TODAY. IT IS THE PERFECT CRIMINAL JUSTICE SYSTEM. PERFORMED CORRECTLY, DNA ANALYSIS IS IMPARTIAL AND INFALLIBLE.

Open architecture has more implications than that of communication, however. For years, departments have been shackled to the products and equipment of one vendor because, almost invariably, that vendor's equipment was incompatible with its competitors. It was difficult, if not impossible, to update information systems, or to simply add a new module to an existing system. Open architecture lets one vendor's system interface with another's, and allows for easier and less expensive upgrading.

"By creating technical standards, we have made it so all these private companies can work with us. It doesn't put anybody out of business. In the free market, that's the proper way of doing business," said Harlin McEwen, the FBI's deputy assistant director of the Criminal Justice Information Systems Division, which houses the NCIC 2000 and the IAFIS projects.

The ultimate goal of the two projects is to be a completely integrated system that can transmit textual information, single fingerprints, mug shots, and process tenprint cards. Although the technology for that kind of integration is currently unavailable, McEwen believes its inception is not far away.

DNA Analysis

Other than the trained eye and the wary nature of a seasoned detective, DNA analysis is probably the most powerful investigative tool in law enforcement today. It is the perfect criminal justice system. Performed correctly, DNA analysis is impartial and infallible. It does not discriminate between good guys and bad. It ignores loopholes in the legal system, and persuasive arguments by the defense. It is exquisitely simple and unbelievably complicated. And in its brief tenure in the forensic sciences, it has incited more controversy, faced more legal challenges, and sparked more hope than any other technique in law enforcement history.

DNA, or deoxyribonucleic acid, is the basic hereditary material found in all living cells. It has a distinctive pattern for each individual, giving instructions for eye color, hair color, height, and bone structure.

Visually, DNA looks like a long twisted ladder, called a double helix, with rungs made up of four nitrogenous bases, or nucleotides: thymine (T), cytosine (C), adenine (A), and guanine (G). These nucleotides are arranged two to a rung, with A on one side of the ladder always pairing with T on the other, and G always pairing with C. The sequence in which these "base pairs" are arranged is the blueprint for assembling all living organisms. These base pairs are the basis of DNA testing. If the DNA ladder is split down the middle, each side can be reconstructed if the sequence of its complement is known.

The original method of analysis, known as the Southern Blot, uses an enzyme to split the double helix down the middle, like a pair of molecular scissors. The resulting lengths, or fragments, are called Restriction Fragment Length Polymorphisms, or RFLPs. Through a complex processes of electrophoresis and hybridization, the RFLPs are exposed to an x-ray film to form a picture of small dark bands on a clear background. If the bands from the known sample, such as a suspect, and those taken from the crime scene match, the probability of such a match is calculated. Because interpretation can be difficult, the process is repeated at different sites on different chromosomes, with the frequency of a match calculated at each location.

RFLP and the Southern Blot process was the only method of analysis for many years. Although the results are accurate, the process has its disadvantages. Degraded materials can be a problem. In contrast to medical specimens, which are collected under ideal, sterile conditions, evidence in criminal cases is rarely pristine. Forensic examiners get dried blood scraped with a pocket knife into an envelope, semen mixed with vaginal fluids from a victim, old cigarette butts that have been out in the elements for weeks. Extraction and interpretation using the Southern Blot process can be difficult when samples are extremely degraded.

The process also requires that a large sample be collected. The FBI's crime laboratory, which does much of the nation's DNA analysis, has estimated that it needs a blood stain at least the size of a dime, and a semen stain the size of a pencil eraser for single-site testing. When the specimen is smaller, it is almost impossible to test more than one site because not enough of the sample is available.

In recent years, science has begun to use the Polymerase Chain Reaction, or PCR.

This process is based on replication and can be seen as a way of copying in much the same way DNA copies itself. When DNA replicates, the ladder unwinds and acts like a template to create an exact copy. Polymerases are replication enzymes and regulate how the nucleotides are assembled on the original DNA strand. Polymerases also proofread each new strand and correct any mistakes or mismatched base pairs.

PCR can produce as many copies as are needed for analysis. The strand is unwound with each side serving as a template for new copies. With each cycle, the number doubles. With RFLPs, once the sample is used up, there is no way to get more. With PCR, millions of copies of the DNA can be produced. Even better, though, is that PCR can be used on degraded and minute samples of fewer than 100 nucleated cells.

PCR was instrumental in convicting the killer of an FBI agent, who was shot by a mugger in Kansas City. The only evidence left at the scene was the suspect's baseball cap. The FBI crime lab used PCR to extract DNA from the skin cells left on the hatband.

The science of genetics application dates back to the 1930s, when film star Charlie Chaplin was accused of fathering a child. Although Chaplin's denial was substantiated by blood-type testing, the evidence was ignored by the courts. It was not until the early 1980s that analysis was used as a tool in law enforcement. It can be attributed to Dr. Alec Jeffreys, then a graduate fellow of Leicester University in England, who originally used it to resolve an immigration dispute. In 1986, Jeffreys was asked to use his scientific procedure to help police in the case of a 15-year-old girl who had been raped and murdered.

The only evidence police had were blood test results derived from a vaginal swab. Jeffreys was called in after police arrested a local man, and discovered that the man's DNA profile did not match the evidence taken from the crime scene. In what was then a radical departure from normal investigative procedure, police requested that every male in the surrounding three villages volunteer for blood testing. Ninety-eight percent responded and police tested more than 3,600 samples for blood type. None matched. The murderer was ultimately identified when a man admitted to using a false identification card and giving blood in the name of, and as a favor to, a coworker. The coworker was later tested, and subsequently confessed to the crime.

DNA analysis has had to fight its way through the courts and through the skepticism of the legal community, for acceptance. The science itself has been taken to task, as have testing protocols, the astronomical numbers that result when calculating match frequencies, and how those matches should be interpreted. The science has been validated by a study by the National Academy of Science. With funding by the National Institute of Justice, the FBI and several other agencies, the NAS in 1992 published *DNA Technology in Forensic Science*, saying that it "strongly supported the validity of DNA testing." (Appendix Fifteen describes how DNA analysis cleared some legal hurdles.)

The question of test protocols and quality control has been addressed by the National Institute of Standards and Testing, which, with NIJ funding, developed Standard Reference Material (SRM) 2390. This standard contains a set of materials that are to be used when doing RFLP analysis. SRM 2390 enables forensic scientists to ensure right answers and pinpoint when and where mistakes are made. The standard also lets labs show that its daily working standard is traceable to NIST, which is important if lab results or test protocol are challenged in court. NIST also developed standards for PCR and PCR-based technologies.

Population genetics has been one of the most recent challenges to DNA analysis. When the science was first used in courts, the statistics were based on a small sampling of the population. Defense attorneys demanded proof that the techniques were valid and could be applicable to all racial and ethnic groups. Under an NIJ grant, Dr. Ranajit Chakraborty, a population geneticist with the University of Texas Health Science Center's Graduate School of Biomedical Sciences, built a database by collecting DNA samples from about seventy populations around the world, and developed analytical methods to test the data. Chakraborty used this information to develop standards for computing match probabilities.

But perhaps the most significant endorsement of DNA analysis was an announcement in 1996 by the National Academy of Sciences (NAS) that, with advances in knowledge and technology, genetic evidence analysis is now considered routine, so much

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so that it will soon take its place in the legal system next to fingerprinting and such commonplace techniques as fiber analysis and ballistics matching. The NAS committee of 11 scientific and legal experts stressed that investigators and crime scene technicians use meticulous care in gathering evidence and in maintaining the chain of custody. The committee suggested that evidence be divided into two parts, with one set aside for testing by a second laboratory if requested by the defense. It also advised crime labs to seek accreditation for DNA analysis by the American Society of Crime Lab Directors. The committee noted that only about 30 percent of the nation's crime labs are accredited for DNA work (Leary, 1996).

Photography

Perhaps the best way to give a jury an accurate image of a crime is with pictures. Photographs cut through pre-conceived notions or false interpretations a juror may have from listening to an oral description. They can be stored almost indefinitely, providing the investigator with a visual record of the crime scene. Photography provides the permanent record, and with today's sophisticated computer technology, crime scene photographs can be turned into a digital record that will outlive even the lengthiest of appeals.

Science has made remarkable advances in forensic photography. Researchers in Louisiana found a way to enhance the photographic image of injuries of human skin by extending the technologies of reflective and fluorescent ultraviolet imaging. Their research produced pictures of wounds and marks that are invisible to the naked eye and are as old as six months. Their techniques have been especially effective in cases of child abuse, and have helped clear several murder cases.

With funding from the National Institute of Justice, researchers in New York developed a computer program called "Restoretool," to enhance blurred, grainy or poorly contrasted photographs. Along the same lines is the research currently underway at the NIJ's National Law Enforcement and Corrections Technology Center in El Segundo, California. This facility is using sophisticated computer technology to make the images in photographs from ATM machines and security cameras clear and visible. A number of cases have been cleared as a result of this center's work.

The most obvious innovation in photography, however, has been the use of video cameras. Patrol officers mount them in their cars; evidence technicians use them at crime scenes; academies use videos for simulation and instructional training; investigators use videos for surveillance. There doesn't seem to be any area of policing in which video has not found a place.

Even more important, though, is that videotaping has become accepted in the courtroom as evidence that is almost incontrovertible. Drunk drivers routinely plead guilty after viewing a tape of their arrest. Videotaped confessions show juries that the suspect was not physically or verbally coerced into confessing; the tape protects the suspect from overzealous investigators, and the department against charges of brutality. Surveillance films document activities that are imperative to making a case. Strategically placed cameras show traffic flow and patterns, as well as problems at specific locations. A video camera mounted in the patrol car can be the officer's best friend, documenting every traffic stop. It can also be the only evidence available if the officer is injured or killed, as it was in the case of a Texas constable who was killed by three Mexican nationals during a traffic stop. The camera caught the entire murder, and was the only evidence linking the three men to the crime.

Firearms

Spent ammunition and weapons rank at the top as one of the most frequently submitted types of evidence. Using a comparison microscope with fiber optics, the ballistics examiner matches characteristics from a spent shell casing with the weapon from which it was fired.

New facets of firearms examination have opened up in recent years with the advancement of computer technology and new software programs. An NIJ-funded grant resulted in a computer sourcebook to help firearms experts identify different types of weapons and ammunition. Written in hypertext, it lets examiners point and click their way to more in-depth research, enables them to do trajectory analysis, and helps them prepare cases for court.

> RESEARCHERS IN LOUISIANA FOUND A WAY TO ENHANCE THE PHOTOGRAPHIC IMAGE OF INJURIES OF HUMAN SKIN BY EXTENDING THE TECHNOLOGIES OF REFLECTIVE AND FLUORESCENT ULTRAVIOLET IMAGING. THEIR RESEARCH PRODUCED PICTURES OF WOUNDS AND MARKS THAT ARE INVISIBLE TO THE NAKED EYE AND ARE AS OLD AS SIX MONTHS. THEIR TECHNIQUES HAVE BEEN ESPECIALLY EFFECTIVE IN CASES OF CHILD ABUSE.

The FBI's Drugfire program, in place since 1992, keeps track of cartridge casings retrieved from more than 3,700 shootings in Maryland, Virginia and the District of Columbia. Investigators can access the database to compare spent ammunition found at crime scenes. So far, Drugfire has been able to link ammunition in more than 300 cases.

The Bureau of Alcohol, Tobacco and Firearms (ATF) has its own program. The Integrated Ballistics Identification System does the same work as Drugfire, comparing thousands of rounds in seconds. It has been successful in linking, in one city, 6 percent of about 900 shootings.

Investigators also use ATF to trace firearms from manufacturer to purchaser. The bureau's National Firearms Tracing Center provides this service free to law enforcement agencies throughout the country as a result of the cooperation of federal firearms licensees, and firearms manufacturers, importers, wholesalers and retailers.

Serology

The study of blood and body fluids is probably most well known for scientists' early work in blood typing, and the later advances that led to DNA analysis. Experts in this area examine blood, semen and saliva stains, and hair and skin fragments to determine their origin. Although serological specimens are one of the most often submitted types of evidence, ranking at the top of the list along with firearms evidence, the crime lab generally will not analyze bloodstains unless a suspect has been identified. Because of the immense amount of evidence that is submitted to the lab on a routine basis, most labs find the examination of bloodstains does not help the detective who is still searching for a suspect. The specimen can, however, be preserved until a suspect is arrested, at which time the serologist can begin the analysis. (See also section on DNA analysis.)

Toxicology

Toxicologists detect drugs, alcohol and poisons in the blood of suspects and victims. They look for poisons in the blood of victims. Toxicologists were the experts called in to find the poisons when two Seattle residents died after taking cyanide-laced Sudafed tablets. When the manufacturer pulled the pills from store shelves, it called on the expertise of local toxicologists to test for the deadly poison. When a 16-year-old Texas girl confessed to poisoning her father with barium acetate, it was a toxicologist who, one year later, confirmed her story by testing a sample of the father's blood that had been kept in storage.

This science is finding its way into the investigation of environmental pollution, industrial toxins, and chemical and radiologic hazards (Bailey, 1995). Toxicology has even been effective in the area of questioned documents. With funding from an NIJ grant, Florida toxicologist Dr. Ian Tebbett used Supercritical Fluid Extraction and High Pressure Liquid Chromatography to modernize the process of dating inks, which had not been updated in 50 years.

Anthropology

A skilled forensic anthropologist can determine the age, sex, race, stature, and even the culture of a person simply by examining skeletal remains. They can tell which changes in the body occurred before and after death, and can reconstruct the body's actual physical image.

Tool Marks

They may be jimmy marks on a window or cut marks on a telephone line, but tool marks, like fingerprints, have their own unique characteristics. They carry the unmistakable signature of the tool that made them.

Tool marks are generally divided into two categories: impressions and striations. Impressions can be made by a sudden blow, or a tool that has been wedged between two surfaces. Impressions are usually found at the point of forced entry, while a striation is a scratch or gouge from tools scraping across other surfaces. Investigators preserve tool marks with photographs, or by recovering the item.

Bite Marks

Bite marks are one of the few types of evidence that can provide probable cause and lead investigators to the arrest of a suspect. If a perpetrator leaves marks on a victim or on partially eaten food left at the scene, a forensic odontologist often can gain a great deal of information about the suspect.

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FORENSIC PSYCHIATRISTS ARE EXPERTS IN BEHAVIORAL ANALYSIS. THEY CAN PAINT AN ACCURATE PICTURE OF A SUSPECT WITH WHAT APPEARS TO BE VERY LITTLE INFORMATION. SUCH A SKILL GIVES INVESTIGATORS CLUES ABOUT A SUSPECT'S MENTAL AND EMOTIONAL STATE, PECULIARITIES, LIFESTYLE AND HISTORY, BASED ON NOTHING MORE THAN THE INFORMATION FOUND AT THE CRIME SCENE.

Bite marks are classified by degrees, much like burns. The goal is to preserve them quickly because of the body's rapid ability to heal. Forensic odontologists also can swab a bite mark to detect secretor antigens for blood typing. If it is sufficiently deep, he can make a cast of the impression with silicone rubber. Impressions can also be preserved with a toneline, a black photographic outline of the perimeter of the bite mark that can be directly compared with models of the suspect's teeth.

Hair & Fibers

Hair can tell investigators the suspect's race, age, sex, and the part of the body from which it was taken. It can reveal whether it was pulled out forcibly or fell out naturally, if it was smashed with a blunt object or sheared with a sharp instrument. Fibers are equally specific. Because they vary dramatically in color, source, shape, and composition, they actually have more identifying characteristics than hair.

Fingernails

Much like a fingerprint, nails are unique to each individual and rarely change throughout a person's life. They are examined in much the same way as tool marks and bullet casings, by finding identifying marks that link the suspect to the evidence. Because the striae on fingernails is on the same scale as that found on fired bullets, the same type of microscope is used.

Glass

On close inspection, traces of blood, clothing, hair or fingerprints can be found on glass fragments. When a suspect is arrested, these same fragments can establish his presence at the scene if matching fragments are found in his clothing. Glass can also tell investigators how a crime was committed. By studying conchoidal fractures, radial fractures and concentric breaks, they can determine how the glass was broken, the angle at which a bullet was fired, and even which bullet was fired first through a window with multiple bullet holes. And because glass varies widely in physical and chemical composition, experts can even specify the type of vehicle and the particular car from fragments collected at hit-and-run accidents.

Impressions & Casts

Although criminals have learned a great deal about covering their tracks, the one thing they often forget is to cover up their footprints and tire marks. No two people wear shoes in precisely the same pattern or show damage in the same places. Therefore, footprints can include or exclude suspects, and can show whether the suspect was carrying a heavy object, was walking or running, or was unfamiliar with the area or unsure of the terrain.

Tire marks show the direction and approximate speed of travel, whether the car leaked oil, transmission fluid or water, and will even yield the name of the manufacturer and the year the tires were made.

Forensic Psychiatry

Psychologists and psychiatrists who specialize in forensic science are experts in behavioral analysis and have an ability to paint an accurate picture of a suspect with what appears to be very little information. Such a skill gives investigators clues about a suspect's mental and emotional states, peculiarities, lifestyle and history, based on nothing more than the information found at the crime scene.

The FBI's National Center for the Analysis of Violent Crime has become the nation's expert on criminal behavioral analysis. Its agents regularly interview incarcerated serial killers and kidnappers to learn how and why they committed the crime and how they got caught. They also work with the country's leading psychiatric experts to learn more about the criminal mind.

Forensic psychiatrists also examine defendants for competence to stand trial, or for evidence of insanity at the time the crime was committed. These experts are skilled at offering insights into a suspect's behavior, information that can provide vital clues and facilitate his apprehension.

COMPUTER TECHNOLOGY

The information age has a tremendous impact on investigations: DNA analysis has been automated because of a system developed by the Baylor College of Medicine in Texas. Searching AFIS databases for a fingerprint match is routine. Software programs help crime lab technicians do everything from recreating a crime scene from blood spatters to examining the rifling marks on a spent shell. Forensic scientists have automated serological and toxicological tests to more effectively discern drugs or poisons in the blood of victims and suspects.

Computerizing criminal investigations has been the result of departments investing in records management systems. These help the department process and track every bit of information captured by the Computer Aided Dispatching system and by the agency's officers. The information is fed into the records management system and manipulated to help administrators do case management, analyze beats, track budgets, assign personnel, inventory the property and evidence room, and write statistical reports.

Criminal investigations programs are generally a part of a records management system, as opposed to a stand-alone module. One reason is because investigations make use of information that comes from all areas of the department: incident reports, field interviews, criminal histories, witness statements. Records management systems use a relational database, one that does "link analysis" to chart the relationships between people, places or things. When information is fed into a relational database, it can be manipulated and retrieved based on the criteria of the detective. A photo of a suspect's tattoo, for example, can be entered into the database, which will then link the suspect to a vehicle, a string of other crimes, the suspect's accomplices. Although stand-alone programs are available, they may be limited in their functions, and may not integrate with the department's database.

By automating the many facets of criminal investigations, detectives can track gangs, build criminal histories, do suspect evaluations, track evidence, vehicle information, and stolen and recovered property. They can compute solvability factors for case management, develop leads, manage and analyze data, develop relationships between the data, and prepare documents for court. Detectives did all of these tasks before computers appeared on the scene, but now they can do them more quickly and more efficiently. By making officers more productive, clearance rates go up, and manpower is put to better use.

In one small Texas town, a new computer system is being used to gather information on gangs and share it with other jurisdictions. The system allows officers to enter key pieces of data, such as gang name, legal name, incident date, weapon used, vehicle, photos. Even if the officer has a piece of information as small as a partial license plate, the computer can link it with other information about the individual or the incident. Since the department started using the system, its case closure rate has increased 30 percent, with a 25 percent drop in more serious offenses. Officers can access the system via laptop computer in their patrol vehicles, and can also use it to create wanted bulletins, complete with photo and information about the suspect.

Image processing systems are another facet of computer technology. Documents, photos, fingerprints, or crime scene photographs are scanned, digitized, and stored in the department's database. Photographs of suspects and crime scenes can also be taken with a digital camera. The picture is transferred to a color monitor, where it appears as an electronic image. When the operator gets the best picture possible on the screen, the computer freezes the image, digitizes and stores it. That information is then filed in a case file, an individual's criminal history file, or in the department's records management system.

Image processing has turned computers into much more than an electronic file cabinet. It gives investigators immediate access to case information — no more digging through files, sorting through scraps of paper, rummaging through desk drawers to find lost photos. Computerized images are also more stable; they will not deteriorate like photographs can. Image processing also lets detectives do computerized line-ups, and give patrol officers with mobile computers the ability to access mug shot information to create line-ups at the crime scene. As NCIC 2000 comes on line, transmitting these images will give officers on the street vital information about the people they detain.

> AUTOMATING THE MANY FACETS OF CRIMINAL INVESTIGATION LETS DETECTIVES BUILD CRIMINAL HISTORIES, EVALUATE SUSPECTS, AND TRACK PROPERTY AND EVIDENCE. THEY COMPUTE SOLVABILITY FACTORS, DEVELOP LEADS, MANAGE AND ANALYZE DATA, AND PREPARE DOCUMENTS FOR COURT. DETECTIVES DID ALL OF THIS BEFORE COMPUTERS, BUT NOW THEY DO IT FASTER AND MORE EFFICIENTLY. AS A RESULT, CLEARANCE RATES ARE UP, AND MANPOWER IS PUT TO BETTER USE.

COMMUNICATIONS

Communications is easily the lifeblood of any organization, but in policing, it can mean the difference between confusion and order, efficiency and chaos, life and death.

Today's modern communications are light-years away from those employed by the *rattel wacht*, or rattle watch of the 1600s. These Dutch officers made up the "burgher guard," a force of eight men who patrolled the newly formed city of New Amsterdam. Equipped with little more than their wits and a rattle to summon aid, they stood the night watch over the city that was soon to become New York.

Communications, as a function in and of itself, literally stood still for the next 200 years. New York City in the 1800s wrestled with problems brought on by its burgeoning population. It struggled with vice, corruption and greed among its city officials, its police officers, its citizens. It faced rioters, thieves, and the complaints of citizens served by a meager force of 52 men. Although the Industrial Age was beginning, technologies that could be useful to law enforcement were hardly a consideration in those tumultuous times.

Then, in the mid 1800s, the first call boxes, or street telephones, were installed so citizens could report crimes and patrol officers could communicate with each other. It was not until the 1930s that the first radios were installed in patrol cars. Even then, most of communications abilities were strictly one way. In the Dallas Police Department, officers could receive messages but could not answer the dispatcher or communicate with other patrol cars. In Houston, police calls were broadcast by a local radio station, which interrupted regular programming for police emergencies. In New York, automobiles were introduced in 1919, but these early patrol cars were not equipped with radios until 1932 (Bailey, 1995.)

Radios have undergone dramatic changes since then, from the bulky Dynamotor that was mounted in the trunk, that dimmed the headlights and emitted a loud growl when the microphone was keyed, to today's light portable radios. Tubes changed to crystals, which were replaced by microprocessors. An eight-channel system that was once considered state-of-the-art is today's dinosaur when compared to those that boast as many as 300 channels.

One of the biggest changes in communications has been the move, noted in Part One, to 911 dispatching. As it was originally envisioned, 911 was to be the nationwide emergency number, a system in which telephones were hooked to computers. When the phone rang, the computer checked its database to find the number and display it on the computer screen. The system became "enhanced" (E911) when the computer got smarter, showing the telephone number, address, and in some cases, the name of the person who owned the number. Some systems also showed the fire department or ambulance service responsible for handling emergencies in the caller's area. If the call did not go directly to a law enforcement agency but came into a public safety answering point, or PSAP, the call-taker simply pushed a button on the console to transfer the call to the appropriate agency. The additional information on the screen transferred with the call.

The idea of a nationwide emergency number was popular with citizens and lawmakers, but it became the local political football even after its implementation was mandated by legislation. Some agencies had to fight the telephone company for access to numbers and addresses, a tug-of-war that brought privacy issues into play. Others could not afford to maintain the required database and were happy to let the telephone company handle it. Decisions had to be made about whether to use a PSAP to route calls, or whether each call should go directly to the appropriate agency. That was only the beginning. Each telephone number in the system had to be assigned to a particular law enforcement agency, ambulance service and fire department. Funding had to be secured, hardware purchased, consultants consulted. It was a process that took anywhere from two to five years.

As useful as 911 now is to citizens, in some ways it has become the tail that wags the dog. There are those who criticize the 911 system because it drives the way the department does business, not the other way around. Officers, particularly those in large metropolitan agencies, complain that they are so busy responding to calls for service, they cannot spend time with the people of the community, which means community policing

> IT WAS NOT UNTIL THE 1930s THAT RADIOS WERE INSTALLED IN PATROL CARS. EVEN THEN, MOST COMMUNICATIONS WERE STRICTLY ONE WAY. IN THE DALLAS POLICE DEPARTMENT, OFFICERS COULD RECEIVE MESSAGES BUT COULD NOT ANSWER THE DISPATCHER OR COMMUNICATE WITH OTHER PATROL CARS. IN HOUSTON, POLICE CALLS WERE BROADCAST BY A LOCAL RADIO STATION, WHICH INTERRUPTED REGULAR PROGRAMMING FOR POLICE EMERGENCIES. IN NEW YORK, AUTOMOBILES WERE INTRODUCED IN 1919, BUT WERE NOT EQUIPPED WITH RADIOS UNTIL 1932.

programs may take a back seat to handling emergencies. Proponents of 911 tell a different story, saying that with enhanced 911 and the addition of computer-aided dispatching (CAD) the opportunities to implement community policing programs are improved.

CAD systems give officers a wealth of information about a call for service. Police departments can be inventive in determining the type of information they need and how they will use it. For example, a CAD system can match an incoming call with files that show ownership of a building where a call originates. It can report any associated hazards, such as previous reports of drug involvement, or of allegations of stockpiled weapons or explosives. It can give a complete history of calls made from a location and tell officers whether the residents have chronic problems with domestic violence, if a homeowner has a history of mental instability or makes numerous calls to the police, or if the house was previously used by drug dealers.

A CAD system that is equipped with Global Positioning Satellite/Automatic Vehicle Location technology can track every patrol car on the street, pinpoint each one on a dispatcher's map, and suggest which unit to send to a call for service. It can display a unit's location with relation to an incident, as well as jurisdictional boundaries, landmarks, road networks and routing information. It can provide access to other databases that store information on building floor plans, sprinkler systems, electrical control panels, emergency exits, and gas lines. It can track property watches, false alarms and response times. (For a description on how the police can use a Global Positioning System, see Appendix Sixteen.)

A CAD system can provide a direct interface with state and national computers for warrant checks and license plate and driver's license queries. It can plot water pipes, power lines, rivers, creeks, fire hydrants, and hazardous materials locations. Some CAD software programs even plot wind direction and predict where fire plumage will spread.

A CAD system is essentially a data-gathering tool, an electronic file box that can keep track of every person who has contact with the police agency in any context. It shows the context of that contact, links it with data, and tracks the disposition of a call. Because it acts as a computer-based paper trail for every incident or call for service, it ideally can replace the manual file card system. What a CAD system does not do is give meaning to the information it gathers. That is management's task, to draw the data from the CAD system for reports, such as the number of calls for service on each shift, a breakdown of types of emergencies per beat, the number of calls per service each officer answered. The type of report that can be generated from CAD-gathered data is limited only by the imagination of management. For example, it can be used for crime analysis of specific areas of the city, or geographic mapping to pinpoint high crime areas or find patterns of criminal activity, both of which allow the department to allocate manpower more effectively.

One of the biggest benefits of a CAD system has been its ability to reduce radio traffic. The city of Detroit, for example, integrated its E911 system with CAD, in-car mobile data terminals, and an automatic vehicle locating and mapping system. Dispatchers see a map on their screen, and zoom in for a close-up of the area. By clicking on the closest vehicle, the call is automatically dispatched to the computer terminal in the patrol car. It does not go out over the air. Systems such as this also let officers bypass the dispatcher to access the department's databases, as well as those at the state and national level.

Direct access to critical information, such as that needed for traffic stops, has the benefit of increasing officer safety. With the correct information, an officer is less likely to be surprised or overwhelmed by a situation. CAD systems help to avoid bottlenecks that occur when officers have to wait for voice access to the dispatcher. They increase communications security by reducing the possibility of casual monitoring of unencrypted conversations and decrease the number of errors typically associated with human conversations. Finally, CAD systems' capacity to reduce radio traffic is important owing to the proliferation of cellular phones and paging systems that take up valuable airwaves.

The problem of congested airwaves has existed for years. The diminishing radio spectrum was recognized in the 1967 report of the President's Commission on Law Enforcement and Administration of Justice. The commission's Science and Technology Task Force recognized that the nation's police agencies were basically mobile forces. Its authors

A CAD SYSTEM IS ESSENTIALLY A DATA-GATHERING TOOL, AN ELECTRONIC FILE BOX THAT CAN KEEP TRACK OF EVERY PERSON WHO HAS CONTACT WITH THE POLICE AGENCY. IT SHOWS THE CONTEXT OF THAT CONTACT, LINKS IT WITH DATA, AND TRACKS THE DISPOSITION OF A CALL. BECAUSE IT ACTS AS A COMPUTER-BASED PAPER TRAIL FOR EVERY INCIDENT OR CALL FOR SERVICE, IT IDEALLY CAN REPLACE THE MANUAL FILE CARD SYSTEM.

studied what was then considered an overloaded spectrum and the cities it affected: In New York City, communication for 2,000 mobile units was provided by eight radio channels. At one point, the city put 500 officers on patrol without radios because of a shortage in radio frequencies. In Cook County, Illinois, 35 base stations and 200 mobile units operated on one frequency. Six cities in Los Angeles County with a combined population of 250,000 shared one radio frequency, as did 15 municipalities on the north side of Chicago. The report concluded that law enforcement agencies needed to make more efficient use of the available radio spectrum, and made recommendations to help relieve some of the congestion.

Although cellular telephones did not exist at the time the report was published, their appearance on the communications network has had the effect of reducing some radio traffic. One of the first departments to explore the use of cellular phones was the St. Petersburg, Florida, Police Department in 1985. Officers used them to send incident reports via modem from their laptop computers. They were able to have conversations over the telephone that would have been impossible over police channels, which require brief, cryptic messages. They communicated with other officers, supervisors, detectives, or other agencies, and often talked directly to the citizens. Patrol officers talked to 911 callers while responding to crimes in progress to get clarifying information as they approached the scene. Citizens used them at accident scenes to call family members, and officers used them at crime scenes to coordinate the activities of backup officers. The biggest benefit reported by the officers was that cellular phones saved time. They were more efficient with less assistance from other officers and dispatchers; there was less need for dispatchers to relay information or for other officers to come by, go by or stand by. (Pilant, 1989).

Still, in today's modern world of communications, complaints about diminishing frequencies for law enforcement are not uncommon. Experts warn that the problem may get worse. Until the last several years, transmitting text constituted the extent of an officer's computer query. Departments are currently implementing the kind of technology that will allow them to transmit graphic images, like fingerprints and mug shots. Graphics take an enormous amount of radio spectrum because they take so much time to send; one uncompressed fingerprint would take about 26 minutes. Reducing the amount of transmission time requires that images be compressed with computer algorithms. As part of its NCIC 2000 project, the FBI is developing algorithms to reduce the transmission time of one fingerprint to about seven seconds.

Departments still have to successfully integrate voice and data transmission. There are typically four approaches:

Dedicated data systems are independent of their voice counterparts. A typical installation in a patrol vehicle requires a radio for voice transmission and one for data transmission. This kind of redundant system provides its own backup, but can be costly to build and maintain. Expanding the system also can be quite difficult.

Shared voice/data systems use the same mobile radio for voice and data. This approach may initially appear to be cost effective, but the associated technical problems that occur when humans and computers contend for the same radio channel may make it more expensive in the long run. Officers may not have immediate access to the channel, and data may be queued for an overly long period while awaiting a break in voice transmission.

Trunked systems operate on the same principle as telephone trunk lines, with the system locating an empty line and assigning it to the caller for the duration of the transmission. The advantage here is that a large number of users can access the system. Voice and data transmission can be integrated because short data packets, delivered in bursts, are sandwiched between voice traffic. The disadvantages to this type of system are that it lacks redundancy, since voice and data share the same mobile radio and system infrastructure, and there is little possibility that data services can be extended beyond the range of the voice system.

Public networks are the latest attempt at voice/data integration and are a radical departure from the traditional way of conducting police business. Private networks are those owned by a governmental body, while public networks serve many customers and typically charge a fee based on the amount of activity. Public networks, which can be

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thought of as a telephone company for data, give officers access to information and message-switching services well beyond the normal voice range, and in some cases, even hundreds of miles away. A minimal capital outlay is required because the department does not set up the system. Also, if the infrastructure in the area has been built-out, start-up time is minimal. Public networks are highly reliable, redundant, and generally adaptable to new technology (Pilant, 1994).

With all of this impressive technology, one of the biggest communications problems still remains to be solved — that of law enforcement's inability to communicate across jurisdictions. It is a problem that has existed since the early days of radios in policing. In the 1960s and 70s, when radios were underpowered and cumbersome, one officer described his inability to communicate with his fellow officers: "Mission Control could talk to astronauts on the moon, but we couldn't talk to our partner around the corner less than a block away."

Although today's lightweight, programmable, portable radios have plenty of power to communicate within the department, modern technology has yet to find a way for neighboring agencies to talk to one another unless they use the same radio channels. Illustrative of the problem is a pursuit in Southern California that involved numerous agencies, none of which could communicate with each other. The incident started when an officer from one city tried to pull over a vehicle for a traffic violation. When the driver refused to stop, the pursuit spilled over into the neighboring jurisdiction, and another officer joined the chase. Because the officers could not communicate with one another, they had to give information to their dispatchers, who relayed it to the other jurisdiction's communications supervisor, who relayed it to a dispatcher, who then gave it to the officer. During the chase, units from two state and federal agencies joined in, as did several more from neighboring jurisdictions. A local security guard even switched on his lights and followed along. The second officer to join the chase described the scene:

"Here we were, most of us not able to talk to one another, no one really knowing where we were going, where we were or why. ... Because we could not communicate with one another, no one really had any idea who was involved in the chase or what their function was. We also had units from all over trying to join in the chase, which meant folks cutting one another off and forcing us to lose ground on the crook. And the crook was driving with that old 'reckless abandon,' which meant he was close to having a wreck." (Zeljeznjak, 1995).

The police pursuit was confusing, chaotic, and dangerous. Had the units involved been able to communicate, they might have devised a plan for roadblocks, paralleled the chase to create a show of force and discourage the suspect, or moved ahead of the pursuit and set up a perimeter in case the driver abandoned the car and fled on foot.

Pursuits aren't the only multi-agency activity hampered by the lack of interoperability between jurisdictions. When a fire broke out in Northern California, response times were slowed because there was no common radio channel. The agencies that responded had to trade radios so they could communicate with one another. Another problem is the information that falls through the holes in the communications net. Investigations have been hampered for years because files stored in the database of one department are inaccessible to investigators from a department only a few miles away.

Law enforcement agencies typically operate on UHF and VHF frequencies. However, if radios do not have cross-band capability, they cannot communicate with one another. One manufacturer tried solving the problem by building a vehicle repeater and cross-band capability into its mobile radio. This allowed the officer with a low-powered radio to extend his communication range while transmitting to other agencies. Another solution, and one that addresses the crowded radio spectrum, has been to move to an 800 megahertz system, which operates at a higher frequency than that typically used by law enforcement agencies. In emergencies, multiple agencies can be grouped on one channel if they are all using the 800 MHz frequency. An 800 MHz system also allows for a more creative and efficient use of the airwaves. The disadvantages are that such systems are expensive, and may not let the department integrate existing equipment. They also may not have the range necessary for patrol officers unless the department installs a series of repeaters to pick up the signal and broadcast it to another receiver.

ONE OF THE BIGGEST COMMUNICATIONS PROBLEMS STILL REMAINS TO BE SOLVED — THAT OF LAW ENFORCEMENT'S INABILITY TO COMMUNICATE ACROSS JURISDICTIONS. THE PROBLEM HAS EXISTED SINCE THE EARLY DAYS OF RADIOS IN POLICING. "MISSION CONTROL COULD TALK TO ASTRONAUTS ON THE MOON, BUT WE COULDN'T TALK TO OUR PARTNER AROUND THE CORNER LESS THAN A BLOCK AWAY," SAID ONE OFFICER.

The National Institute of Justice's Rocky Mountain NLECTC center, located at the University of Denver, is investigating solutions to interoperability problems. Important also is its work with experts at Motorola, Ericsson, and the Association of Public Safety Communications Officials International (APCO) to set technical equipment standards.

In the early days of communications, Motorola led the way by developing and manufacturing the first two-way radios. It wasn't long before Motorola was policing's biggest, and, in many cases, its only supplier. When agencies wanted to expand their communications systems or buy new equipment, they found that only Motorola systems integrated with Motorola. New companies had sprung up, but police could not use them because their equipment was incompatible with what the department already owned. It was an equipment dilemma that was also a financial problem. It ruled out competitive bidding entirely and forced law enforcement agencies to "sole source" equipment purchases.

Today's field of communications equipment suppliers has broadened considerably, but many of the interoperability issues still exist. Creating technical standards that set specific criteria for communications equipment will enable these companies to develop radios that work together so departments can seamlessly integrate the equipment of more than one supplier.

The Rocky Mountain Center has also been tasked with finding ways to incorporate the needs of public safety agencies into the development of new technologies. To include the requirements of law enforcement in current technologies generally means retrofitting, redesigning, or rebuilding. By getting in on the ground floor and working with researchers, scientists, engineers and equipment manufacturers, public safety requirements can be incorporated at the development stages.

A significant improvement in communications will be the implementation of NCIC 2000, the FBI's project that is expected to increase the speed and processing of the current NCIC system.

When the National Crime Information Center was established in 1967, only 15 agencies used it. It processed 6,580 transactions per day, which added up to about 2.5 million transactions every year. NCIC currently transmits information to about 79,000 users and processes 574 million requests every year, about 1.5 million a day. It is the largest and most sophisticated system of its kind in the world.

When the NCIC 2000 project first began in 1990, it was intended to update the old NCIC system. It had not been fully modernized since its inception, and was handling millions more transactions than were originally intended. NCIC 2000 will still process requests for wants, warrants and criminal history information, but will have the added ability to transmit graphics such as fingerprints and mugshots by way of a scanning device in the patrol car. Prints and photos will be transmitted by radio to police headquarters and then by wireline to the FBI database.

Departments will access NCIC 2000 in much the same way they do now, but there will be different levels at which to participate, depending on the technical sophistication of the agency. At the highest level, an agency workstation might have a document scanner, live-scan equipment, and a digital video camera. In the patrol vehicle would be a single-finger live-scan machine, a printer and a video camera, along with a mobile computer. Those that do not have or cannot yet afford such sophisticated equipment, can still access the system. Even at the most basic level, data transmission services will be improved as the system's capacity and speed increases.

As noted earlier, the eventual goal is to tie together NCIC 2000 — which, along with wants and warrants information, will have a database of single prints of wanted persons — with the Integrated Automated Fingerprint Identification System (IAFIS), which is slated to be a huge tenprint database.

Street officers need this kind of advanced technology and sophisticated communications systems primarily for reasons of safety. But state-of-the-art communication has many more benefits, like its ability to turn a patrol car into a rolling substation. It also reduces radio traffic and, by acting as a force multiplier, boosts officer productivity. From management's perspective, it encourages efficient resource allocation so a department can effectively respond to the community's needs.

> STREET OFFICERS NEED ADVANCED TECHNOLOGY AND SOPHISTICATED COMMUNICATIONS SYSTEMS PRIMARILY FOR REASONS OF SAFETY. BUT STATE-OF-THE-ART COMMUNICATION HAS MANY MORE BENEFITS, LIKE ITS ABILITY TO TURN A PATROL CAR INTO A ROLLING SUBSTATION. IT ALSO REDUCES RADIO TRAFFIC AND, BY ACTING AS A FORCE MULTIPLIER, BOOSTS OFFICER PRODUCTIVITY.

TRAFFIC ENFORCEMENT

Traffic enforcement dates back to the early 1900s, when horses were the only mode of transportation, and the biggest danger in crossing the street was dodging the occasional runaway horse and buggy. Today more than 44,000 people die in traffic accidents every year. There are 3.2 million traffic-related injuries annually, with an accident happening every 12 minutes. The cost has been estimated at $74 billion.

Experts claim that traffic accidents can be considered the number one health problem in the United States (Pilant, 1995). Although safer vehicles and programs that combat drunk driving have lowered the total of annual traffic deaths from 60,000 to 44,000, the numbers are still high.

Traffic enforcement has a tendency to get short shrift from almost every corner of policing. As the saying goes, "There's no glory in traffic." Within police departments, there are usually no career incentives, promotions, medals or awards for stopping speeders or moving abandoned cars off the shoulder of the highway.

But traffic enforcement involves not just the logistics of clearing an accident, implementing sobriety checkpoints, or stopping speeders. It encompasses matters from setting enforcement policies and teaching pursuit driving to finding ways to communicate with other jurisdictions.

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ENFORCEMENT POLICIES

Traffic jams and other traffic problems can affect the relationship between the public and the police. Thus, an aggressive traffic enforcement policy that addressees these problems can be helpful to police departments. In terms of safety, enforcement policies can enhance community policing programs by addressing specific traffic infractions in a city's neighborhoods. (Appendix Seventeen discusses community policing and enforcement policies.)

Aggressive traffic enforcement can reduce, and in many cases, prevent crime. Studies have shown that an aggressive traffic officer consistently makes more criminal arrests than his detective counterpart. In one small Texas city, which implemented a proactive traffic policy, 20 percent of criminal arrests now come from traffic stops. In another Midwestern city, strong traffic enforcement has had the added benefit of helping to get guns off the streets.

Earl Sweeney, director of the New Hampshire Police Standards and Training Council, observes:

> "If people know they will be intercepted, and they have drugs, contraband, or weapons, they will move on to another jurisdiction. You never hear of a 'walk-by' shooting. The people who tend to commit crimes are also the ones who are driving with their license revoked, who don't renew their registration, who don't replace a burned out taillight or headlight. The guy who won't dim his lights might be drunk. These people are good pickings for an alert traffic officer."

ENFORCEMENT TECHNOLOGIES

The traditional method of speed detection is to use radar, the acronym for detection Radio Detection And Ranging. Radar was first used by the British to measure distance, speed, and the direction of enemy aircraft and navy vessels in World War II. This technology used a pulsed radio wave to measure distance by calculating the time it took the signal to travel to the object and back. Direction was determined by comparing the angle of the signal when transmitted to its angle on return (Bailey, 1995).

Police radar, while essentially the same, uses a constant wave signal instead of a pulse. The signal strikes a vehicle, which reflects back part of the signal to the receiver in the radar unit. The unit then measures the change in signal frequency and converts it to a speed reading. The faster the vehicle is moving, the greater the frequency shift.

Radar has disadvantages, however, in that it cannot differentiate one vehicle from another when a group of cars are traveling together. It can only determine speed at a specific point, and exclusively targets the largest or the fastest vehicle.

Laser, the newest development in speed detection, uses Light Detection And

Ranging, or lidar. Laser units emit a low-powered invisible beam of infrared light that is reflected off a vehicle and picked up by a receiver in the unit. The unit calculates the length of time it takes for the reflected light to return and converts it to a speed reading. Although these units are more expensive, they let officers target a specific vehicle, can read speeds three times per second, and have a range of 2,000 feet as compared to radar, which is limited to under 1,000 feet.

Photo radar is a process that has a strategically placed and unmanned camera taking pictures of the cars, license plates and drivers who violate traffic laws. Although it has been used in Europe for many years, it has found only limited acceptance in the U.S.

American drivers have been known to claim that photo radar is sneaky and gives police an unfair advantage. Some vehicle owners say photo radar can put them in jeopardy of being ticketed for the speed violations of a friend, relative, or family member who is using their car. Karl Emberg, former chief of the Paradise Valley, Arizona, Police Department, has said that people who do not like photo radar have two objections: "They feel like Big Brother is watching them, and they don't get the opportunity to try to talk their way out of a ticket."

Nonetheless, photo radar has several advantages: It can detect speeders and successive vehicles as close as 0.5 seconds apart; it is effective against radar detectors; and it reduces the outlay of financial and personnel resources.

In a real-time outdoor laboratory, the Fort Meade, Florida, Police Department tested several photo radar systems to catch red light violators. Studies showed that at one particular intersection violators traveled as much as six to seven seconds after the red light and were running it at 60 miles per hour, even when there was a deputy with a video camera in plain sight. The department used federal grant money to install systems from two vendors at two intersections — one with a dual left-turn lane where people constantly ran the red light, and another that had a high accident rate. The department found that the cameras reduced the number of red light violators, and were useful in accident investigations to determine fault. One of the systems also included a VCR with a direct feed to the police station, which let dispatchers monitor traffic in real time and send patrol officers after violators.

Chief Emberg's city of Paradise Valley has been successful with photo radar. The city is a small, prosperous, bedroom community of 12,000 on the outskirts of Phoenix.

In the early 1980s, traffic accidents were frequent, with speeders violating the posted limit by as much as 40 miles per hour. Paradise Valley had a limited resource base because it does not collect property taxes. There was no money to buy additional equipment, and even though most of the citizens' complaints were about traffic enforcement, they did not support hiring more officers. Photo radar was implemented in 1988, and since that time, traffic accidents have steadily decreased, with the overall rate reduced by 50 percent. The department had several years without traffic deaths.

Of traffic fines collected, a percentage goes to the company that leases the radar unit to the department. The company also runs the license plates, develops the photos, and prints and mails the citations. The city realizes a $1-$2 profit per paid citation after deducting the cost of operating the system.

In-car video is a recent addition to patrol cars, and one that was not initially welcomed — officers did not want video cameras recording their every move. But as case after case of on-camera murders and accidents was recorded, those who resisted now consider in-car video a significant factor in their safety.

One of those cases was the murder of Texas Constable Darryl Lunsford, who was on patrol in January 1991. Lunsford stopped a car heading north on Interstate 59 in deep East Texas. In less than five minutes, Lunsford was dead, shot with his own gun, and the three illegal immigrants who killed him were gone.

Lunsford was an elected official who ran a one-man department, the kind with a budget that left no room for fancy equipment. Like most police officers, Lunsford made use of every available tool, including his personal video camera, which he installed in his patrol car. It was the video tape that provided the clue that identified Lunsford's killers. They were caught later that night after they abandoned their car a few miles north of the crime scene and fled into a thicket of piney woods.

> "THE PEOPLE WHO TEND TO COMMIT CRIMES ARE ALSO THE ONES WHO ARE DRIVING WITH THEIR LICENSE REVOKED, WHO DON'T RENEW THEIR REGISTRATION, WHO DON'T REPLACE A BURNED OUT TAILLIGHT OR HEADLIGHT. THE GUY WHO WON'T DIM HIS LIGHTS MIGHT BE DRUNK. THESE PEOPLE ARE GOOD PICKINGS FOR AN ALERT TRAFFIC OFFICER."
>
> EARL SWEENEY, DIRECTOR
> NEW HAMPSHIRE POLICE STANDARDS
> AND TRAINING COUNCIL

As tragic as the incident was, it sparked positive change; not long after Lunsford's murder, at least one nearby agency began installing video cameras in all of its patrol cars.

In-car video systems are effective in areas other than officer safety. Video has become a modern courtroom tool. It is the high-tech equivalent of an accurate, unbiased eyewitness. Video is especially effective in traffic cases involving intoxicated drivers. Violators have almost no recourse when trying to dispute the accuracy of the videotape, and as a result, most plead guilty to DWI charges.

In-car video can corroborate the testimony of witnessing officers by showing consistency in their stories. It has been used as evidence for officers accused of brutality or excessive force by allowing internal affairs investigators to check the validity of a complaint against a videotape.

Videotapes can also be an adjunct to incident reports, submitted along with the officer's paperwork. The material is reviewed by the prosecutor, and because videotape evidence is almost irrefutable, in many cases a guilty plea is accepted or a lesser charge negotiated without the need and expense of a trial. Agencies have found that using video results in higher conviction rates and reduced court time for officers. One department experienced a 50 percent reduction in overtime court costs, a savings that paid for the expense of video cameras.

Mobile video also protects the public. Officers who know they are on camera are more likely to act in a professional, appropriate manner. Consequently, many departments have experienced a reduction in citizen complaints. Video cameras also encourage the public to behave. As one officer said, "When I tell them the camera is running, it kind of deflates them. It stops them from blowing up and taking their anger out on me."

VEHICLE INTERDICTION

To pursue fleeing vehicles or not is a complex question for the police. The possible loss of human life in a pursuit gone wrong is always a danger. So also is the threat of civil litigation. Millions of dollars are awarded to the innocent victims and families of those injured or killed as a result of police pursuits that ended badly. In some cases, the award is more than the annual budget of an entire department. In one New York case, the jury awarded $100 million to the family of a child who was hit by a motorcyclist being pursued by police (Boyd, 1994).

What about a police department's mission? Is it in the business of protecting the public and safeguarding life? If so, why does it allow officers to speed in pursuit through city streets? Conversely, how can a department refuse to chase those who pose a threat to the community?

Pursuits involve policy issues such as whether it is appropriate to chase everyone who refuses to stop, or only known violent offenders. And if the department implements a restrictive chase policy, will crime escalate?

Who makes the decision to pursue? A supervisor who is not at the scene and has no involvement other than that via radio, or an officer on site? If the officer is charged with the responsibility, can he make a rational choice in an emotional, adrenaline-charged situation, one in which he takes the refusal to stop as a personal challenge?

There is the question of training: Does the department offer more than a classroom block on the concept, philosophy, and policy of pursuits? Does it equate the use of a vehicle in a pursuit with the use of deadly force? Does it offer driver training in pursuits and techniques to stop fleeing vehicles?

According to Geoffrey Alpert, a professor at the University of South Carolina and an expert on police chases, hundreds of departments are changing pursuit policies, in most cases, placing restrictions on who officers can chase. To many street officers, the decision to restrict pursuits is a budget-driven administrative blunder. They argue that pursuits are a necessary part of policing, that the hazards are worth the risk.

But pursuits are expensive. Studies show that an average cost per chase is $8,000, and experts maintain that figure is low. Studies also show that restrictive policies do not foster an increase in crime. When the Miami Police Department issued a restrictive chase policy, it reduced the number of pursuits from 300 in one year to 50. Crime did not go up.

> THE FORT MEADE, FLORIDA, POLICE DEPARTMENT TESTED SEVERAL PHOTO RADAR SYSTEMS TO CATCH RED LIGHT VIOLATORS. STUDIES SHOWED THAT AT ONE PARTICULAR INTERSECTION VIOLATORS TRAVELED AS MUCH AS SIX TO SEVEN SECONDS AFTER THE RED LIGHT AND WERE RUNNING IT AT 60 MILES PER HOUR, EVEN WHEN THERE WAS A DEPUTY WITH A VIDEO CAMERA IN PLAIN SIGHT. THE CAMERAS REDUCED THE NUMBER OF RED LIGHT VIOLATORS, AND HELPED ACCIDENT INVESTIGATORS DETERMINE FAULT.

PURSUITS: ALL IN FAVOR?

MANY DEPARTMENTS ARE CHANG-ING PURSUIT POLICIES, IN MOST CASES, PLACING RESTRICTIONS ON WHO OFFICERS CAN CHASE. TO MANY STREET OFFICERS, THE DECI-SION TO RESTRICT PURSUITS IS A BUDGET-DRIVEN ADMINISTRATIVE BLUNDER. THEY ARGUE THAT PUR-SUITS ARE A NECESSARY PART OF POLICING, THAT THE HAZARDS ARE WORTH THE RISK.

Policies vary throughout the country. Houston, for example, has one of the least restrictive. But it wasn't always that way. In 1987, the department changed to a more restrictive policy written by Chief Lee Brown. The result was a 40 percent drop in police chases. After Chief Sam Nuchia was appointed in 1992, he quietly dismantled the policy and put in place one that gives field officers total discretion to pursue.

In December 1994, that policy came under fire after 20 patrol cars chased a traffic violator 75 miles at speeds in excess of 100 miles per hour. Only three of the patrol cars were authorized to chase the suspect. Audio tapes had supervisors telling the other offi-cers to stop, and at least five times the convoy was told by dispatchers to back off. They did not, nor did the tow trucks and transit officers who joined in the chase.

The department and the chief were attacked in the local media. But Nuchia's only concession was to offer a revised policy that said officers would be subject to "strict dis-ciplinary action" if they violated the policy.

In contrast is the Baltimore Police Department, which has a virtual no-chase rule. "It's better to allow criminals to temporarily escape apprehension than endanger the safety of citizens and other officers," said department spokesman Officer Robert Wein-hold. "An innocent family killed over what, a stolen car? It's not worth it."

One of the first studies of pursuits was conducted by the California Highway Patrol. The study showed that of the 683 pursuits analyzed, 77 percent of the suspects were apprehended, 70 percent of the chases ended without an accident, 1 percent ended in deaths. A study in Dade County, Florida, had similar findings. Of 932 pursuits analyzed, 38 percent ended in accidents, 1 percent in deaths, 68 percent resulted in arrest, and 36 percent resulted in arrests that were not related to the reason the pursuit was initiated, mostly drug and weapons charges. In 1994, Baltimore County conducted its own inves-tigation and found that of 1,064 pursuits, 36 percent resulted in accidents. Baltimore's study also revealed that the accident-free chases were most often conducted by officers with five to eight years experience, driving in clear weather, and involving only one car (Cody, 1995).

Many experts believe it is time to address what Alpert called the public's "con-tempt of cop," and put the blame where it really belongs: on the people who run. A survey of 40 Salt Lake City felony pursuit-related cases showed that only 3 percent were sentenced on the original charge, which means that 97 percent were pleaded down or had charges dismissed. Fearing that the message to the public would be one of leniency, the Utah state legislature in 1993 passed a law that makes fleeing (whether in a car, boat, or aircraft) a third-degree felony that carries with it a penalty of up to five years in prison and a fine of at least $1,000. Driving privileges are revoked for at least one year, and the vehicle is subject to forfeiture. If the result of the chase is the death or serious injury to an innocent person, the violator can be convicted of a second degree felony, with a penalty of one to 15 years in prison and a fine of at least $5,000. The law also allows seizure proceeds to be used for pursuit training and related public awareness pro-grams.

The Texas state legislature followed Utah's lead with a similar law. Previously, vio-lators were charged with a Class B misdemeanor, punishable by up to 180 days in jail and a $2,000 fine. The new law, although somewhat anemic when compared to Utah's, upgrades the charge to a Class A misdemeanor with a sentence of up to a year in jail and a fine of $4,000. A subsequent conviction could result in up to two years in jail and a $10,000 fine. A second degree felony could be charged against anyone who initiates a chase that ends in injury, and a third-degree felony could be charged if someone dies as a result of a chase, with a penalty of up to 20 years in prison and a $10,000 fine.

Chief John Whetsel, of the Choctaw, Oklahoma, Police Department and past pres-ident of the International Association of Chiefs of Police, has a surprisingly moderate view of police pursuits, considering his history. His wife and one of his daughters were killed as a result of a police pursuit.

Whetsel believes that pursuits must be allowed to protect the public, but, like many other police administrators, he also believes they are the equivalent of using deadly force. Although this belief has been supported in several court cases, there are very few policies, laws, guidelines or restrictions on the use of a vehicle as deadly force.

In Whetsel's view. "Officers need to qualify with the vehicle-as-weapon, just like they do with firearms. They should be trained to react in the same way they do with a firearm, and requalify twice a year. They need to learn how to make the decision to pursue based on the weather, time of day, and location.

"They have to learn when to quit and when not to begin a pursuit. In law enforcement there has been the attitude that you have to get the person you're after. I think we've seen, as accidents have happened, officers gradually getting away from that. They are realizing they are just as much at risk of getting hurt or killed in a traffic accident as anyone else."

The International Association of Chiefs of Police in 1990 issued a restrictive pursuit model policy that said officers should only pursue when the offense would warrant an arrest. The IACP admitted that the policy could be difficult to implement and enforce, particularly in areas where a more permissive policy was the norm. But, it said, "... [L]aw enforcement administrators must be prepared to make difficult decisions based on the cost and benefits of these types of pursuit to the public they serve."

In a paper delivered to the National Transportation Research Board, Alpert supported restrictions, saying that "... the majority of research and professional literature has concluded that pursuits create a far greater risk than a benefit to law enforcement and to the public. ... The interpretation of (the) data has convinced all but a small minority that pursuit driving is an extremely dangerous activity and that officers must not be allowed unbridled discretion."

Alpert's 1995 survey of 600 agencies revealed that the majority are moving toward a restrictive chase policy. Other departments planned to outlaw pursuits entirely, allow officers only to chase violent felons, or mandate that the decision be based on the same rules that apply to the use of deadly force.

Solutions to the pursuit dilemma encompass more than policy, however. Baltimore relies almost exclusively on helicopters. The Maryland State Police sophisticated Aviation Unit also covers chases from the air, keeping ground officers informed of the suspect's location. With its Forward Looking Infrared system (FLIR) mounted on each unit, it also tracks the drivers who bail out of the car and flee into the woods during nighttime chases. Departments report that tracking a fleeing vehicle from the air reduces the speed of the officer trying to keep up with the violator. It has also been found that the violator's speed is usually lower when a police car is not in sight.

The Warren, Michigan, Police Department has helicopter units patrolling like a regular scout car over its 36-square-mile area, which frees up patrol cars for other duties. One agency estimated that a helicopter can cover the territory of 15 patrol cars. Other agencies have been more conservative in their estimates, calculating a seven- or eight-to-one ratio.

Helicopters are another type of force multiplier, freeing patrol cars for other activities and dramatically increasing the safety factor during pursuits. According to a supervisor in the Phoenix Police Department, the department has never experienced a fatality during an air-controlled pursuit. A sound safety record can help to contain and even lower municipal liability insurance rates.

The National Institute of Justice's Office of Science and Technology is focusing on other ways to stop fleeing vehicles. It funded a study by the Idaho National Engineering Laboratory to find feasible techniques and technologies to stop cars.

Here are some technologies envisioned for development and possible commercialization in the next three to five years.

Retractable Barrier Strip
Same as commercial spiked barrier strips, but with retractable spikes that can be operated remotely. Halts fleeing vehicles, but spikes retract before police run over it.

Fleeing Vehicle Tagging System
Attaches small radio-frequency transmitter to fleeing vehicle via handheld or car-mounted launcher. Polymer adhesive adheres transmitter to vehicle; police follow the signal instead of pursuing through city streets.

PURSUITS: ALL AGAINST?
BUT PURSUITS ARE EXPENSIVE. STUDIES SHOW THAT AN AVERAGE COST PER CHASE IS $8,000, AND EXPERTS MAINTAIN THAT FIGURE IS LOW. STUDIES ALSO SHOW THAT RESTRICTIVE POLICIES DO NOT FOSTER AN INCREASE IN CRIME. WHEN THE MIAMI POLICE DEPARTMENT ISSUED A RESTRICTIVE CHASE POLICY, IT REDUCED THE NUMBER OF PURSUITS FROM 300 IN ONE YEAR TO 50. CRIME DID NOT GO UP.

SOLUTIONS TO THE PURSUIT DILEMMA ENCOMPASS MORE THAN POLICY. BALTIMORE RELIES ALMOST EXCLUSIVELY ON HELICOPTERS. THE MARYLAND STATE POLICE ALSO COVER CHASES FROM THE AIR, KEEPING GROUND OFFICERS INFORMED OF THE SUSPECT'S LOCATION. DEPARTMENTS REPORT THAT TRACKING A FLEEING VEHICLE FROM THE AIR REDUCES THE SPEED OF THE OFFICER TRYING TO KEEP UP WITH THE VIOLATOR. IT HAS ALSO BEEN FOUND THAT THE VIOLATOR'S SPEED IS USUALLY LOWER WHEN A POLICE CAR IS NOT IN SIGHT.

Radio Communicator
Uses low-powered transmitter in police vehicle to override commercial radio broadcast signal. Enables police to communicate with the driver of the fleeing vehicle.

Enhanced Police Sirens
Siren delivers a high level of acoustical energy toward the suspect vehicle. Can overcome the inability to hear a siren at high speeds and increasing distance, and also warn other motorists of an oncoming pursuit.

Vehicle Barriers
Technology is of two types — fixed-in-place, used where passage is not permitted; and moveable, used where passage is permitted. Barrier would be adapted from these technologies to stop vehicles.

Caltrops
Iron ball with four projecting spikes set so one spike is always pointed upward. Technology would fit ball with hollow spikes for controlled air leak; may be deployed in stringed formation from frangible canister.

Deployable Nets
Deployed from pursuing vehicle, aircraft, or from a fixed location. Outfitted with mechanism to cause drag or reduce performance to stop vehicle; possibly a parachute system or a net attached to a permanent barrier.

Tire Shredders
Especially for use at border checkpoints to prevent high-speed pursuits. Device will cause rapid loss of air and will shred, not puncture, tires. Deployed with a deflator bar remotely operated by border officer; spikes remain in tire when bar is retracted.

In addition, NIJ supports two other efforts related to vehicle-stopping technologies. One is a laboratory evaluation of five proposed electric or electromagnetic vehicle stopping technologies. The goal is to develop prototype stopping devices. The evaluation is being conducted jointly by the U. S. Army's Army Research Laboratory and NIJ.

The other project is the NIJ-funded Pursuit Management Task Force which seeks to define police practice and the role of technology in high-speed fleeing vehicle pursuits. The task force includes senior law enforcement officials from local, state, regional, and federal agencies.

MANAGEMENT AND COMPUTER TECHNOLOGY

Computer technology has the potential to transform the way a police agency is managed and does its business. The manual 3 x 5 card filing system of the past can now be replaced with a sophisticated records management system. The property and evidence room, with its stacks of evidence, can be neatly organized and inventoried with bar coding and software programs that track evidence from income to case disposition. Officers can use laptop computers to file incident reports from the field. Booking time is down with computer programs that use digital imaging and live-scan technology for mug shots and fingerprint cards. Records management programs can pull information logged by computer-aided dispatching (CAD) systems, the principal repository of call-related data, to learn more about the community's problems and areas of high crime. Relational databases, popularized several years ago for their ability to ferret out links between cases, allow investigators to find similarities in seemingly unrelated incidents.

Police agencies fall into four categories in terms of information systems implementation: the paperwork stage, where all records are processed by hand; the PC stage, where the agency has a few PCs scattered around the department but no real plan for how to use them or the capability to link them together; full automation, where the department uses a records management system linked to every division in the agency and to databases at the state and national level; and regional systems that hook up departments in several adjoining jurisdictions.

Portable computers in patrol cars enhance officer safety by giving them an information edge. They also provide greater accuracy because fewer people handle the information. Reports only have to be entered once, which makes for a more accurate report because the officer enters the information, not data entry clerks who may have to decipher the officer's handwriting.

According to the Law Enforcement Information Management Committee, a subcommittee of the International Association of Chiefs of Police, there are other benefits to portable computers.

* Less paper and a smaller support staff reduces costs.
* In fully automated departments, officers can access policy manuals, reference manuals, and guides to filling out forms. References and referral sources for solving neighborhood problems can also be readily available.
* They have immediate access to intelligence data, *modus operandi*, arrest, and lookout information.
* Portable computers make the increased capabilities of NCIC 2000 available to the patrol car, which eventually will include the transmission of mug shots and fingerprints. A portable can also keep up with the more complex NIBRS reporting if the department loads the information required to complete the incident report into the system

It is a fair assumption that advanced information technology, with its ability to shorten response times, increase clearance rates, and improve officer productivity, would be installed in every department. Its capability to streamline operations should make the expense of acquisition and implementation an easy sell to city officials and to the public. But as noted in Part One, the use of information technology has advanced slowly in policing when compared with how it is being employed in private industry. In 1994, the Law Enforcement Information Management Committee of the International Association of Chiefs of Police estimated that most departments were lagging behind in the implementation of new technologies. Manual index-card filing systems were still in use in some departments, and the word processor on the chief's secretary's desk constituted state-of-the-art technology in others (Pilant, 1994).

In the early 1970s, police information systems were centralized. Information was fed into a mainframe IBM computer and printed out on stacks of green-and-white striped paper. It was at that time that the Law Enforcement Assistance Administration (LEAA) played an important part in marrying policing with computers For example, LEAA funded the development of the Advanced Regional Justice Information System (ARJIS) in San Diego. In those days, ARJIS was considered a technological marvel,

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* THE PAPERWORK STAGE, WHERE ALL RECORDS ARE PROCESSED BY HAND;
* THE PC STAGE, WHERE THE AGENCY HAS A FEW PCs SCATTERED AROUND THE DEPARTMENT BUT NO REAL PLAN FOR HOW TO USE THEM OR THE CAPABILITY TO LINK THEM TOGETHER;
* FULL AUTOMATION, WHERE THE DEPARTMENT USES A RECORDS MANAGEMENT SYSTEM LINKED TO EVERY DIVISION IN THE AGENCY AND TO DATABASES AT THE STATE AND NATIONAL LEVEL;
* REGIONAL SYSTEMS THAT HOOK UP DEPARTMENTS IN SEVERAL ADJOINING JURISDICTIONS.

providing a relational database for the San Diego entire area that helped detectives and patrol officers link information to clear cases. "If a beat cop came across a suspect at any time, all he had to do was run the name through the system. There was none of this 'We had him but we didn't know it,'" said ARJIS Administrator Nancy Angus.

ARJIS was at the cutting edge of computer sophistication for the police, but departments that could not afford it were simply left behind.

In later years, the development of the personal computer had a major impact on the criminal justice system. PCs were relatively inexpensive when weighed against the cost of a mainframe. Officers with an affinity for computers started purchasing them for home use, and quickly saw how they would benefit policing. But implementing systems to manage the huge volumes of information gathered by a police department was a slow and tedious job. The technology was confusing, especially to those unfamiliar with computers and computer terminology, which made it hard for policing to identify its own needs. Management and political support for extensive police computerization was often hard to come by when the need for other city services was equally pressing. When in-house computer expertise was not available, police departments had to hire expensive consultants. Veteran officers, steeped in the traditions of police service, resisted the change.

One of the biggest barriers to moving into the information age was the lack of money and the fragmented police market that is discussed in Part Three.

Private industry moved rapidly ahead with modern technology, and it seemed that law enforcement got stuck with the leftovers. State-of-the-art information systems went to the private companies or the public utilities that could afford them. It was only when existing systems were replaced by newer technologies that the price dropped enough to make the old equipment affordable for policing. Consequently, police often bought systems that were obsolete before they were even unpacked.

Some vendors saw the police as easy prey, and tried selling software programs that were designed for other occupations and only slightly modified to the law enforcement market. The result was that departments had to adapt their way of doing business to the software program, instead of having a program designed specifically to meet department needs. Those that bought software modules piecemeal often found they were incompatible when they tried to integrate them. The lack of equipment standards stymied any further attempts at equipment integration and compatibility.

Even with all of the impediments to implementing an information system, and the confusing array of technologies (there are more than 200 companies that offer records management systems), police agencies have been inventive in devising new ways to put this type of technology to work. Here are some examples.

• The Gang Offender Comprehensive Action Program (GOCAP) is a database in the Oxnard, California, Police Department and the local probation department and courts to identify and track gang members. Information is taken from field interview cards which include everything from gang affiliation and nicknames, to tattoos and samples of individual graffiti. The GOCAP program has turned Oxnard's 90-officer department into a 90-officer gang unit.

• The state of Washington has in place the Homicide Investigation and Tracking System (HITS), which stores, collates and analyzes the characteristics of all murders and sexual offenses. The information is available statewide to help investigators solve related crimes.

• A 40-officer department in Nebraska had an officer with an interest in computers, who got involved in programs that use artificial intelligence. The program he created is used to score similarities in such crimes as rapes, burglaries, robberies and murder.

• A Tennessee agency began its automation process by analyzing its forms; it discovered that at least 15 were used per arrest. With help from the Justice Research and Statistics Association, a nonprofit governmental association that offers free assistance to departments that are building or updating information systems, the agency converted to a one-page, computer-generated form that requires officers to check off certain items. The appropriate narrative is plugged in by the computer, a feature that prosecutors like because it results in technically accurate arrest reports. A 25 percent reduction in paperwork time resulted in a tripled arrest rate because officers quickly returned to their patrol duties.

• The Los Angeles Police Department's auto theft detectives were buried in paper-

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work. By installing two PCs, programming the computer to prioritize, calculate, and manipulate the data, and having clerks, instead of detectives, input information, they essentially gained the equivalent of 36 detectives (Pilant, 1994).

• The Fremont, Ohio, Police Department found extra time for community policing with the installation of the Police Information and Planning System. The search, report and inquiry capabilities of the PIPS software program helped officers end a two-month string of robberies, reduce entry and search time to a fraction of what they were before, reduce the recordkeeping workload, and develop a stolen property recovery program. The result has been that officers have more time to spend with the community, and residents have more confidence in the department's ability to solve crimes (Kibler, 1995).

• A Florida department found that after exhausting a retinue of consultants and sorting through stacks of sales literature, it could put together an image processing system on its own. The agency spent $15,000 for a scanner, 486 processor, optical disk storage, software and a digital camera. The system runs on the city's AS400 computer, and stores and processes information on current cases. Officers built a comprehensive database by inputting information from old cases.

• An investigator with the Cook County Police Department in Illinois uses 3D Computer Aided Drafting to do crime scene reconstruction. It lets juries view complicated technical evidence virtually "at the scene." This 3D reconstruction can also be transferred to videotape or into a Virtual Reality Model Language for availability on the Internet, so remotely located investigators can visually walk through the crime scene. Another aspect of the program lets detectives gather blood stain spatter evidence at the scene, which is then fed into the computer for calculation of the origin and angle of impact for each blood spatter.

• The Prince George's County, Maryland, Police Department has proposed installing a computer system that will let the department use computer mapping to fight crime. The system will collect and analyze crime reports each day and generate electronic maps that show "hot spots" where crimes occur repeatedly (Pan, 1996).

• The Colorado Department of Public Safety created a mapping system that has changed the way police and residents look at crime. Under an old system, crime hot spots labeled an entire neighborhood as crime ridden, something that created anger among residents and barriers between neighborhoods. The new mapping system overlays basic crime statistics with other data, such as poverty rates, domestic violence calls, juvenile arrests, school truants, location of ATMs, liquor stores, to create a more realistic picture of problem areas. The project has fostered unprecedented collaboration between government agencies and businesses as it pinpoints crime and its relationship to other problems (National Crime Prevention Council, 1996).

• At the Anne Arundel County Police Department in Maryland, a pilot project between the department and Westinghouse Electric put a "Smart Car" system in four police cars. It featured an automated dispatch system and on-board computers. Database inquiries were reduced from a 10- to 15-minute wait to less than 60 seconds. The system allows officers to conduct in-vehicle database searches, electronically dispatch, generate reports, locate vehicles on electronic maps, and merge and record data from external sources.

• The Morgan Hill, California, Police Department's efforts at automation started in 1987. The department discovered it would cost $150,000 for a controller device and about $5,000 for individual terminals in police cars. It was a bill the small department, with its 23 sworn officers, couldn't possibly pay. One officer finally found grant money and on a shoestring budget put together a homegrown system consisting of mobile data terminals, radio frequency modems, and DOS-based software. It enabled patrol officers to transmit data, do car-to-car and car-to-base messaging, and query for vehicles, names, guns, and other types of data. The cost was about $7,000 per car.

• The North Olmsted Police Department in Ohio started on the road to high tech like everyone else: with handwritten 3 x 5 cards filed manually by department clerks. In 1984, the department began automating its operations, and in 1995 went on-line with the Cuyahoga Regional Information System (CRIS), a public network that serves nine counties and 80 agencies. With four mainframes, two of which act as backup, CRIS gives officers access to local, state and federal databases, like NCIC and NLETS, as well as infor-

> SOME VENDORS SAW THE POLICE AS EASY PREY, AND TRIED SELLING SOFTWARE PROGRAMS THAT WERE DESIGNED FOR OTHER OCCUPATIONS AND ONLY SLIGHTLY MODIFIED TO THE LAW ENFORCEMENT MARKET. THE RESULT WAS THAT DEPARTMENTS HAD TO ADAPT THEIR WAY OF DOING BUSINESS TO THE SOFTWARE PROGRAM, INSTEAD OF HAVING A PROGRAM DESIGNED SPECIFICALLY TO MEET DEPARTMENT NEEDS.

mation from all of the participating agencies, including incident reports, a master name index, arrested persons file, traffic accident reports, parking tickets, a business directory, badge files, and field contact reports. CRIS serves more than 900 land-based and mobile terminals, with cities currently paying a flat monthly fee regardless of the number of units on-line. Since its inception, radio traffic has dropped 55 percent. Officers now obtain data without waiting for radio traffic to clear, and can file reports from the field. The CRIS also stores the most recent 200 transactions, which means that if an officer is injured during a vehicle stop, the vehicle's license plate is locked into the computer.

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• Another multi-agency system is operated by the Portland, Oregon, Police Bureau. The Portland Police Data System, which was designed and built by in-house personnel, has a database of information on more than 850,000 people and one million cases. It gives officers statewide access to information on everything from stolen property and wanted persons, to restraining orders and criminal history records. The system works on an IBM mainframe that serves 1,100 terminals in 60 different agencies.

• After 20 years of operation, the San Diego Police Department upgraded its Advanced Regional Justice Information System (ARJIS) by partnering with IBM, the system's manufacturer, and the San Diego Data Processing Corporation, a non-profit entity that provides data processing services to the city of San Diego. The old system was text based and operated on a mainframe. The upgrade changed ARJIS to a client-server configuration, an environment that takes advantage of the capabilities of a PC and Windows. It processes graphics, does in-depth link analysis, as well as call mapping and automated field reporting. It also includes "hooks" for technologies and programs that the agency plans to add as funds become available. (Appendix Eighteen provides descriptions on how a large and a medium-sized police department are using computer technology.)

Computer software that can help the police and streamline management processes continues to evolve aided by such developments as (1) the advent of the Pentium chip, which dramatically improves the speed of computer processing; (2) Windows 95, which gives PCs the graphical environment that was once the sole province of Macintosh; (3) an increased reliance on PCs and less on mainframes; and (4) the influx of 32-bit platforms that make processing enormous chunks of information measurably faster. Other technological advances that may help the police include:

• Timeline Analysis System (TAS) that was originally developed by the Air Force's Rome Laboratory to help intelligence analysts visually analyze large amounts of data for cause and effect relationships, trends, and patterns. This collection of software applications uses pictures or symbols to graphically depict events. For example, a telephone represents communication, while a blue cloud may represent a hailstorm or a red cloud a lightning strike. The TAS can be used by law enforcement to analyze trends or to pinpoint cause-and-effect relationships.

• Neural networks which are non-programmed, adaptive information processing systems that can learn to solve problems by developing associations between objects. Unlike the typical information processing system, which is programmed to sort through a set of variables and come up with the optimal solution, neural networks can learn from the data. The system is based on theoretical models of how brain cells (neurons) and their interconnections (synapses) perform complex calculations.

As exciting as new technologies are, it remains true that state and local law enforcement agencies often do not have the resources to obtain them until they become outdated and, perhaps then, affordable. For example, a shortage of computers recently forced one large metropolitan department to pull its laptop computers from auto theft detectives and put them in patrol cars. Not only did this move return detectives to the tedious and slow process of asking a dispatcher to check for information and then transcribing the information by hand, it allowed criminals they deal with to monitor their activities. Compounding the problem is the fact that the laptop manufacturer had stopped making the 10-year-old computers, and the department's computer infrastructure would not support the newer models on the market. The department is currently upgrading its computer system to support the newer mobile computers, but has yet to find the funds to replace the old ones (Bardwell, 1996).

TRAINING

From in-service video lessons to driving simulators to computer-based learning programs, technology is helping to train the police.

For example, private companies use VHS recorders and computers to create shoot-don't-shoot systems in which an officer must decide how he will react in 1-2 seconds. These systems, which may cost tens of thousands of dollars, evaluate an officer's action — whether he drew his weapon, used voice commands or nonlethal force and when he decided to use deadly force — and can determine the accuracy of the officer's shots. This type of "judgmental training" can provide basic through advanced firearms training and will accommodate up to 12 students. It can also include training in report writing by requiring that an officer complete an incident report following each scenario.

Driving simulators are another training tool that use computer technology. These devices have a bank of three to five screens and are programmed to perform like the Chevrolet Caprice or the Ford Crown Victoria, vehicles typically adapted to be patrol cars. The screens show buildings, roads, stop signs, traffic lights, pedestrians, and the typical surroundings an officer might find on any city street. An officer-driver is required to pursue a fleeing offender, and is scored on the ability to stop the bad guy without crashing the car or injuring anyone.

The inability to teach decisionmaking or negotiating skills is probably the biggest shortcoming of simulators. Some trainers say that firearms simulators do not allow instructors to use the entire range of use-of-force options, or teach defusing or deescalation techniques. Other observers say that some video training modules that re-enact dangerous or life-threatening incidents can have the detrimental effect of making impressionable officers and rookies fearful about their jobs. Videos that convey the impression that behind every traffic stop is a killer and hidden beneath every subject's coat is an arsenal may encourage police officers to "adopt an operating style better suited to combat soldiers than to peace officers," according to the authors of *Police Administration*. Officers "should not be made paranoid by unrealistic training that presents their work as an occupation in which one is always no more than an instant away from a gory death or a decision about whether to take another's life."

The disadvantage to driving simulators is that they do not teach good judgment. Said Earl Morris, deputy director of the Utah Department of Public Safety's Law Enforcement and Technical Services Division, "When we look at the liability cases we have to defend against, the real problem is not our ability or inability to drive a vehicle, but our inability to make the correct decision at the right moment."

Text-based interactive computer programs have given police training another dimension. With a lesson on paper and on a computer disk, the program stresses comprehension and lets the student cover the material at his own pace, giving feedback that is continuous and immediate. These self-paced programs can also be used as remediation tools to help recruits better grasp concepts or techniques. This gives the student extra help without holding up the entire class.

Some agencies have taken the next step by marrying video and computer technologies to create training programs. The California POST several years ago created video-interactive computer-based programs and provided them at no cost to the state's police agencies. These programs included a printed study book, computer disk, and a video laser disk. Courses were used in recruit and in-service training and, in some cases, required that students make quick decisions based on realistic scenarios.

The Law Enforcement Television Network (LETN), one of the most innovative uses of training technology, was initiated in 1989 as a relatively inexpensive response to traditional modes of training that were often time-consuming, management intensive, and expensive, particularly if travel, lodging and meals were involved. Via satellite, LETN delivers training modules on everything from domestic violence to defensive tactics to classes in subscriber police departments around the country. Programs repeat twice in every eight-hour shift. Some departments designate the shows to watch and some require that officers report for group sessions, while others leave program selection to officers' discretion. Officers can watch the programs to become better informed and

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can arrange with supervisors to get credit in a particular curriculum.

Most of the network's programs qualify for continuing education credits with Pennsylvania State University and the Southern Police Institute at the University of Louisville in Kentucky. LETN has interactive relationships with state Peace Officer Standards of Training (POST) commissions and professional organizations such as the International Association of Chiefs of Police, the National Sheriff's Association, and the Commission for the Accreditation of Law Enforcement Agencies.

Daily broadcast training modules on LETN are interspersed with television news, certification testing, and a variety of other services. The network has a lending library of videos on such topics as patrol, investigations, supervision, management and special assignments, as well as general information on policing.

The future of training holds the promise of using virtual reality and artificial intelligence. Engineers at the Naval Air Warfare Center Training Systems Division in Orlando, Florida, have created a virtual reality firearms training system that has students using a footpad to move through a scenario that consists of buildings, combatants, and opportunities for weapons engagement and tactical decisionmaking. The use of artificial intelligence allows other training programs to "think." Using voice recognition, it can test the officer's verbal skills and respond to what the officer says.

PROCUREMENT

Lack of cohesiveness among the nation's 17,000 police agencies may be the single largest impediment to cost effective equipment procurement. Law enforcement generally does not bargain collectively for better equipment prices, lobby for technologies specifically designed for police, or demand a set of police equipment standards to which manufacturers must adhere. As a result, police buying efforts are often fragmented, inefficient, and with no in-house personnel to research equipment purchases, sorely uninformed. Additional problems result when private industry makes decisions that are to its advantage, but that are disadvantageous to the police.

Vehicles

Police agencies seeking to buy new vehicles must be certain that the vehicles they select meet performance standards and can be fitted cost effectively with required police equipment. Many departments use the National Institute of Justice's vehicle evaluations to ensure they get a car that fits their needs. Working in conjunction with the Michigan State Police, the agency every year tests police vehicles against specific performance standards. It then publishes its *Consumer Products List* that reports which models measure up and which do not. The NIJ also offers departments vehicle procurement guidelines.

For many years the Ford Motor Company with its Crown Victoria and Chevrolet division of General Motors with its Caprice were the standard suppliers of patrol vehicles. These full-size, rear-wheel drive vehicles met police requirements: enough room for equipment and passengers, an engine that could outdistance the cars of most criminals, and enough weight to safely negotiate in even the worst weather.

In 1995, GM decided to stop production of the Caprice, an unpopular decision with the nation's police agencies. Although many departments had mixed fleets, 56 percent used the Caprice exclusively (Sharp, 1995). The demise of the reliable, cost effective Caprice had a significant impact on large departments, which typically buy the same model car year after year. Such a purchasing strategy lets department mechanics maintain the vehicles with transferable parts and those that are salvaged from models scheduled for retirement.

The decision was made by GM executives after a five-month study and was attributed to poor sales. Said Bob Hapiak, Chevrolet's manager of its fleet program, "The letters and calls we got from police departments — it was not an easy decision."

The decision gave Ford a monopoly on the police vehicle market. Ford subsequently raised prices substantially, while decreasing the amount of dealer incentives. For example, in 1994, the state of Connecticut paid $13,997 for the Crown Victoria, and in 1996, $18,979, an increase of 36 percent. The town of Meriden, Connecticut, paid $12,571 for its Crown Victorias in 1992, and in 1996, $19,105, an increase of more than 50 percent. At the same time, the company's dealer incentives dropped from $3,500 in 1993 to $2,000 in 1996. For Ford, the future was rosy, with orders for the Crown Victoria in 1995 totaling 37,000, and increasing to 55,000 in 1996.

Faced with the demise of the Caprice, some departments considered using smaller, front-wheel drive cars. The District of Columbia reported that GM's police package Lumina was as rugged as the Crown Victoria, but cheaper to run and maintain. But even if smaller cars were a viable option, the initial expense to convert to their use was projected to increase because officers would have to be retrained to handle a vehicle that has most of the engine weight over the front wheels. When one department converted to the front-wheel drive Ford Taurus, it found that its accident statistics soared. Officers complained that the cars would unexpectedly spin off the road. A little research revealed that the officers simply needed more training (Datz, 1995). Conversely, some departments found that the front-wheel drive was an asset, particularly in colder climates. After training, officers in one Wisconsin department found that it outperformed the Crown Victoria. (Appendix Nineteen reports on road tests of possible substitutes for the Caprice.)

Police agencies would not pay a heavy price in conversion and training costs if it

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No SPECIAL POLICE VEHICLE EXISTS BECAUSE LAW ENFORCEMENT HAS NEVER BEEN ABLE TO MUSTER THE INFLUENCE OR THE FUNDING FOR A PURPOSE-BUILT VEHICLE. THE RESPONSE OF CAR MANUFACTURERS TO THE IDEA OF A PURPOSE-BUILT VEHICLE HAS BEEN NEGATIVE, SAYING THAT THE VARYING REQUIREMENTS OF EACH POLICE DEPARTMENT MAKE IT IMPOSSIBLE TO COME UP WITH A STANDARD CAR.

had a vehicle built especially for police, such as those that are designed for fire departments, the U.S. Postal Service, and even some delivery companies. No such police vehicle exists because law enforcement has never been able to muster the influence or the funding for a purpose-built vehicle. The response of car manufacturers to the idea of a purpose-built vehicle has traditionally been negative, saying that the varying requirements of each police department make it impossible to come up with a standard car. Some law enforcement administrators disagree, arguing that there are certain types of equipment every agency needs.

One car conversion company has built a prototype purpose-built police vehicle called a mobile substation. Standard features included a reconfigurable instrument panel; steering wheel with fingertip operator controls for lights, sirens, radio volume control, and an intersection signal interrupt; front door panels with storage pockets; baton holders; flashlight chargers; upper armrests; keyless entry; and a security system. Company officials said they believe production is possible, but only in cooperation with a major automobile manufacturer (Paisner, 1996).

Law enforcement has tried to find a cost-effective way to replace the Caprice, while struggling with what appear to be performance deficiencies in mid-size cars. Some are adding mini-vans and sport utility and four-wheel drive vehicles to their fleets. Some have tried vehicles powered by diesel and propane, and given consideration to purchasing cars that run on solar power or electricity. There seems to be general agreement, however, that no suitable replacement for the Caprice currently exists, and that while administrators still have choices in selecting patrol vehicles, those choices are getting fewer (Sharp, 1995). (Appendix Twenty surveys police officers' comments on mid-size alternatives to the Caprice.)

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PART THREE:

NIJ'S ROLE,

OBSTACLES TO

PROGRESS, AND

THE FUTURE

OF POLICE

TECHNOLOGY

As has been noted, in the late 1960s the federal government began to assume responsibility for fostering the development, availability, and adoption of new technologies to help local and state police. Part Three of the report discusses how the government is fulfilling that responsibility through the National Institute of Justice and its Office of Science and Technology (OST) and the obstacles to their progress. It also looks briefly at the future of police technology.

The mandate of the National Institute of Justice, the criminal justice research and development arm of the U.S. Department of Justice, is to improve and strengthen the nation's system of justice with primary emphasis on local and state agencies. In recent years Congress, with strong bipartisan support, has awarded NIJ significantly increased funding to speed progress in police technology. The expanded funding, through the 1994 Crime Bill and other measures, is federal recognition of the important role technology can play in helping the police in their work.

The purpose of NIJ's Office of Science and Technology (OST) is defined by its name. It is the focal point for advancing criminal justice technology. Through OST, the National Institute of Justice has developed voluntary standards, tested new equipment, and disseminated information on technologies. The newly increased funding has intensified NIJ's efforts to (1) understand policing's overall operations and its specific technological requirements; (2) encourage research and development of successful technologies; and (3) overcome obstacles slowing or derailing technological progress. The final goal is to move the best new technologies from the laboratory to the marketplace.

OBSTACLES TO PROGRESS

As this reports notes at several points, fragmentation of local policing is the source of many of the obstacles to technological progress. It is the price that many believe is required if the nation is to have local control of law enforcement. About 570,000 police officers serve in 17,000 agencies, 90 percent of which have 24 or fewer officers. Local and state police handle 95 percent of the nation's crime.

Fragmentation makes policing an often hard-to-reach, hard-to-sell, and, thereby, unrewarding market for potential developers and manufacturers of new technologies, products, and services. Getting a product and product information to the police market can be expensive.

Fragmentation means most police departments have small budgets and make small buys of equipment. Almost all police agencies spend most of their budgets on personnel and have relatively little left over for equipment purchases. Thus, the local and state law enforcement market have scant available funds to support research and development.

Fragmentation means equipment acquisition is usually on a department-by-department basis; there is little pooled purchasing.

Fragmentation means awareness and information about valuable new technologies seep into the core expertise of police departments at markedly different rates. Some departments are state of the art in technological matters; some lag years behind.

Fragmentation means neighboring police agencies buy incompatible technologies — notably in communications equipment — which undermine their ability to serve a common area. The inability of several adjoining police departments to communicate because of incompatible radio equipment and frequencies is commonplace.

Fragmentation means almost all police agencies are too small to have on staff or on call experts who can provide objective evaluations of proffered technologies. Policing has its share of rueful tales of expensive technologies, notably computer systems, purchased in the glow of a salesman's pitch and without a thorough examination of whether the technology could deliver what was promised.

Fragmentation means no one has the authority to establish standards for law enforcement technology and equipment. The police on their own have developed no national organization for this purpose. Criminal justice has no national regulatory agency. Crime laboratories are not required to undergo accreditation.

LIABILITY CONCERNS

Another brake on progress involves liability concerns and questions of public and police acceptance associated with some existing and proposed law enforcement technologies. "The whole issue of liability is a sobering issue," said Dr. Eric Wenaas, president and CEO of JAYCOR, a leading manufacturer of police products. "You can't underscore the importance of liability to any manufacturer of these products."

Some examples of liability concerns:

• Technologies that use graduated levels of acceptable force can spawn both lawsuits and bad press. An example is pepper spray. Police increasingly use it, and some call it one of the most useful technological innovations of the past 15 years. It is, obviously, less potentially brutal in use than a baton. On the one hand, widespread use of pepper spray has led to some lawsuits and media attention raising questions about its possibly lethality. On the other, use of pepper spray may reduce the total number of lawsuits and citizens complaints arising out of use-of-force incidents.

• Technologies to detect weapons on persons raise legal questions about relative degrees of invasion of privacy. Metal detectors, such as those stationed in airports, are less invasive of privacy — albeit notably less thorough — than prototype x-ray devices that can thoroughly scan people for weapons and explosives. However, x-ray devices can reveal anatomical details that could imply invasion of privacy.

• The specter of Big Brother can influence the development and use of some technologies. For example, some police object to the Big-Brother-over-your-shoulder aspect of Global Positioning Systems. They do not like the notion that their supervisors know where they are at every moment.

Wenaas is chair of the Justice/Industry Committee on Law Enforcement Technology for Law Enforcement which in late 1996 issued a report, *Impediments to Developing and Marketing New Technologies for Law Enforcement*. The report listed these impediments. A sampling:

Impediments to Market Development. Diversity and independence of markets; split acquisition authority; lack of standards, specifications, and test procedures; high development costs in relation to sales volume; lack of funds for product acquisition.

Impediments to Product Standards and Testing. Cost and complexity of effectiveness and safety tests to assure valid results in larger populations; difficulty of performance tests on humans.

Legislative and Judicial Awareness. Liability inhibits development of nonlethal and other emerging technologies; lack of funding deters investment in rising market; potentially invasive technologies may be ruled illegal, thereby discouraging investments; partial funding by government may impair propriety rights.

(Appendix Twenty-One explores private industry's role in police technology.)

OPERATING ASSUMPTIONS

In its efforts to deal with obstacles and further the development and use of new technologies, NIJ operates from several underlying assumptions. The first is that the Institute learn from and avoid earlier mistakes. The flood of federal funding for state and local law enforcement in the 1960s and 1970s was accompanied at times by unrealistic expectations and a top-down, Washington-knows-best viewpoint.

In their presentations and public statements, NIJ officials avoid unrealistic claims. They note that technological progress holds great promise for law enforcement. But they include a caveat: Technology cannot make up for poor judgment, compensate for inadequate or nonexistent training, substitute for poor officer screening and selection processes, replace competent leadership, or usurp the basic skills and street smarts of seasoned police officers.

What technology can do is enhance productivity in matters ranging from preventing and solving crimes to regulating traffic. It can also provide the tools which make law enforcement safer for both citizens and the police, and increase the effectiveness of police management.

To determine law enforcement's needs and to get successful new technologies out

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LIABILITY CONCERNS:

• TECHNOLOGIES THAT USE GRADUATED LEVELS OF ACCEPTABLE FORCE CAN SPAWN BOTH LAWSUITS AND BAD PRESS.

• TECHNOLOGIES TO DETECT WEAPONS ON PERSONS RAISE LEGAL QUESTIONS ABOUT RELATIVE DEGREES OF INVASION OF PRIVACY.

• THE SPECTER OF BIG BROTHER CAN INFLUENCE THE DEVELOPMENT AND USE OF SOME TECHNOLOGIES.

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> equipment and technologies.

to the nation's police agencies, NIJ works closely with state and local departments, as well as a number of advisory panels whose members have expertise in everything from patrol techniques to liability issues. One purpose is to let the grassroots of American policing, and not just Washington, set priorities for the development and implementation of technologies. The goal is federal support, but local direction. Heeding the directives of local and state agencies, NIJ's priorities currently include research and development in the areas of less-than-lethal technologies, forensic science including DNA, information technology, new communications and surveillance devices, and weapons and explosives detection.

A second assumption is that NIJ does not have to develop its own research and development capacity to foster progress. NIJ believes the capacity exists in the remarkable technology infrastructure of national laboratories and government-funded nonprofit corporations which U.S. taxpayers already support. These are the technology-creating facilities which helped win the Cold War and are seedbeds of innovation for government and the private sector. For example, Aerospace Corporation, NIJ's partner in its Western regional center, provides systems engineering and integration for more than 70 U.S. space programs.

NIJ also has cooperative agreements with the Departments of Defense and Energy. The agreement with the Department of Defense (DOD) is the result of a 1994 memorandum of understanding between the Justice Department and DOD. The purpose is to share and develop jointly technologies applicable to both policing and military undertakings other than war. The interagency activity is managed on a daily basis by a Joint Program Steering Group consisting of personnel from NIJ and the Defense Advanced Research Projects Agency. Joint programs involve research and development in such matters as concealed weapons and explosives detection, biomedical and information technologies, sniper and mortar detection, and improved body armor. Funding to support this research is essential in bringing these technologies to maturity in support of law enforcement needs.

A third assumption is that the job of fostering research, development, and adoption of new technologies is unpredictable, and frustration can be the norm. The job inevitably carries with it some false starts, often slow progress, and unfulfilled expectations that can test the patience of the law enforcement community as well as NIJ and collaborating organizations.

NIJ's response is to attempt, when possible, experimenting with several different approaches to a problem, whether the problem is detecting concealed weapons, stopping fleeing vehicles or subduing dangerous persons. The belief is: Keep plugging away in consultation with technology developers, providers, and police users, and successful technologies as well as new equipment will emerge.

The most difficult part of this process is probably commercialization — the manufacture of products and new technological devices once they have been developed, tested, and deemed workable and useful. One police chief has formulated a checklist for police products brought to market. They must be necessary, practical, inexpensive, require a minimum of training, and be sturdy yet inexpensive to repair. Checklists like this can inhibit even the most adventuresome manufacturers.

A final assumption is that there is no single pathway through the web of impediments to technological progress for policing. NIJ has attempted to develop an agile approach, examined below, providing an array of ways to get its job done.

NIJ's Approach

To achieve its ends, NIJ (1) continuously seeks to determine the technology needs of law enforcement; (2) sponsors research and development to meet those needs; (3) develops voluntary standards along with compliance and testing processes; and (4) disseminates essential information about existing and developing police equipment and technologies.

1. Determining Needs
NIJ depends on several practitioners' panels and joint government committees for

advice on technology and development of new technologies. The largest is the Law Enforcement and Corrections Technology Advisory Council (LECTAC), which direct-ly advises NIJ's system of National Law Enforcement and Corrections Technology Cen-ters (NLECTC). The council consists of leaders, experts, and practitioners in law enforcement agencies at all levels of government and in professional associations. The council plays a significant role in setting priorities for technology development, helping to launch new technologies, cautioning against inappropriate ones, identifying serious equipment problems, and enhancing law enforcement understanding of issues and advances in technology.

Another important advisory panel is the Less Than Lethal (LTL) Technology and Policy Assessment Executive Panel and its associated body, the Less Than Lethal Lia-bility Task Group. The LTL panel is made up of state and local law enforcement, elect-ed officials, and current as well as former high-ranking federal government officials. It reviews technology needs, developments, and innovations from a national perspective and makes regular recommendations to NIJ. The panel also advises the law enforce-ment community on ways of developing government and national support in fulfilling an aggressive technology agenda while ensuring that law enforcement needs are being fulfilled.

As noted, liability questions and civil lawsuits can play a significant role in limiting the use of certain current technologies and influencing the development of future ones. The Liability Task Group assesses civil liability issues associated with technologies in various stages of research, development, and use. The task group has examined the lia-bility aspects of such technologies as pepper spray, chemical darts, sticky foam, aqueous foam, smart guns, projectable nets, disabling strobe lights, projectable bean bags, microwave devices to disable automobiles, weapons detection devices, thermal imaging and forward-looking infrared devices (FLIR), and rear seat airbag restraints.

2. Research and Development

In terms of research and development, NIJ seeks out law enforcement technology projects, advocates and funds their development, and encourages the transfer of success-ful technologies to industry for introduction into the marketplace. It also supports ways to enhance the use of established technologies, such as DNA, and assesses technologies caught in controversy, such as pepper spray. NIJ often works cooperatively, leveraging its relatively modest funding through additional contributions and expertise of national laboratories and federal agencies.

In setting its research and development agenda, NIJ is guided closely by what the Law Enforcement and Corrections Advisory Council reports to the NLECTC system. LECTAC's top police priorities, restated as recently as January 1997, include develop-ment of technologies to detect concealed weapons and contraband in a nonintrusive way; to incapacitate unruly persons through less-than-lethal means; to stop fleeing vehicles; and to enhance DNA testing.

These priorities as well as some others set by LECTAC can be met only through special research and development. Many technologies the police use were developed for general commercial purposes. Automobiles, radios, computers, and firearms are earlier noted examples. The police, or manufacturers serving the police market, adapted these and other widely available commercial technologies to police needs. But the commer-cial marketplace does not readily provide easy-to-adapt technologies to meet many pri-orities set by LECTAC. NIJ's research and development program seeks to respond to vital police technology requirements that otherwise would go unfulfilled. Additional research dollars are essential in meeting these goals.

To meet special police needs, NIJ is supporting a wide range of research in such areas as concealed weapons detection, less-than-lethal incapacitation, and ways to stop fleeing vehicles. These research efforts were described in Part Two.

NIJ is also supporting the expansion of DNA testing. As noted, DNA analysis is among the most powerful investigative tools in law enforcement today.

One five-year NIJ project costing $40 million seeks to increase DNA testing through funding improvements in the laboratories of state and local law enforcement

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agencies. A second five-year NIJ project seeks to help secure impartial and infallible DNA analysis in a timely, cost-effective way. Project goals are to reduce dramatically the cost of DNA tests, from $700 a test to less than $10; to reduce test times from hours to minutes; to increase the reliability and legal credibility of DNA testing; and to develop standard reference materials for population database genetics. Earlier NIJ fund-ed National Academy of Science examinations of DNA testing and resulting publica-tions. In 1996, the National Academy of Science announced that there is no longer any reason to question the reliability of DNA evidence.

3-4. Voluntary Standards and Dissemination

Voluntary standards and dissemination are two of several functions that come under the umbrella of the National Law Enforcement and Corrections Technology Center (NLECTC), a network of hub, regional, and specialized offices that the Office of Science and Technology uses as a national governance and management structure.

In a time of rapidly advancing technologies, NLECTC serves as a one-stop tech-nology education, assessment, and referral source for the nation's law enforcement agencies. NLECTC consists of a national hub in Rockville, Maryland; regional centers in New York, South Carolina, Colorado, and California; and four specialized offices: the Border Research and Technology Center (BRTC) in California; the Office of Law Enforcement Technology Commercialization (OLETC) in West Virginia; the Office of Law Enforcement Standards (OLES) in Maryland, and the National Center for Foren-sic Science, located at the University of Central Florida in Orlando. (Appendix Twen-ty-Two provides details on the regional centers.)

NLECTC's hub in a Maryland suburb of Washington, D.C., has several functions.

Dissemination. The Maryland office is the nation's collection agent and repository of information about law enforcement and corrections technology. It publishes and dis-tributes a large collection of reports on diverse matters, such as body armor, pepper spray, patrol car tire tests, metallic handcuffs, and DNA profiling. It also publishes *Tech-Beat*, a periodical covering the latest information on law enforcement technology. It created and manages JUSTNET, NLECTC's site on the World Wide Web.

Voluntary Standards. The Maryland office and the Office of Law Enforcement Stan-dards jointly perform NIJ's work of developing standards and testing police equipment. OLES develops the measurement methods and voluntary national performance stan-dards for equipment and technology used by criminal justice practitioners. Areas of research and standard-setting include clothing, communications systems, emergency equipment, investigative aids, protective equipment, security systems, vehicles, weapons, and analytical techniques and standard reference materials used by forensic scientists. OLES is housed at the National Institute of Standards and Technology, whose resources it uses. It works closely with NLECTC's national center to conduct tests and guarantee the quality and performance of equipment used by law enforcement and corrections officers.

Coordination. The Maryland office staffs and coordinates the work of the Law Enforcement and Corrections Technology Advisory Council.

Four regional NLECTC centers each serve law enforcement and corrections agen-cies in nine or more states. Each office (1) has a specialized technology focus; (2) may provide on a case-by-case basis expert assistance to police agencies within its region and nationwide; (3) disseminates information to the law enforcement agencies in its area; and (4) uses an advisory council of state and local law enforcement and corrections per-sonnel and officials to ensure the center's relevance and effectiveness.

Each center's technology focus makes it responsible for encouraging research and development within specific areas of law enforcement and corrections as well as provid-ing test beds for experimentation and evaluation. An example is the Southeast regional center, which is testing at a local Navy brig an eight-kilobyte electronic "smart" card for prisoners. The card, which includes a photo identification and a bar code, contains a prisoner's criminal record and medical information, and may be used to allow or deny access to certain brig areas.

Each center has a special area of expertise which can be made available to police

agencies nationwide. An example is the assistance the Western regional center, expert in forensic imagery, has provided to police departments from California to Delaware in enhancing the quality of video tapes capturing crimes in progress on security cameras and cameras installed in bank ATM machines.

Information dissemination means each center helps the agencies in its area to obtain information on current and emerging technologies. For example, the centers can provide manufacturer and product information to local agencies.

The regional advisory councils provide feedback from the grassroots about law enforcement's technology needs and problems, then help disseminate information about technological responses to those needs.

The recently created Office of Law Enforcement Technology Commercialization (OLETC) encourages the commercial development and manufacture of promising, innovative technologies. It offers support and information about the intricacies of commercialization to law enforcement agencies and criminal justice organizations, as well as the research, product development, and manufacturing communities. OLETC is a joint project sponsored by NIJ, the National Aeronautics and Space Administration, and the National Technology Transfer Center.

As its name suggests, the Border Research and Technology Center in San Diego has the special mission of fostering technologies which provide improved capabilities in border surveillance, security, and identification. The center works closely with the U.S. Customs Service, the U.S. Border Patrol, and local law enforcement agencies concerned with border problems.

The National Center for Forensic Science is located at the University of Central Florida in Orlando. This center focuses on research and training in the area of arson and explosives. Its goals include the development of a restricted-access electronic library for forensic and law enforcement professionals; support for the development of standard protocols for the collection and analysis of fire and explosion debris; supplemental training via the Internet, and through distance education and professional seminars; fundamental research to scientifically validate evidence collection and analysis procedures.

THE FUTURE OF POLICE TECHNOLOGY

Discussion of the future of technology in any arena can quickly turn to speculation about dramatic breakthroughs on the outer edges of high tech and the engineering of dazzling devices to solve problems. Policing likely will have its share of as-yet-unanticipated technological breakthroughs in the next century. But for now, technology's future benefits for policing depend to a considerable degree on practical and near-term matters. One such matter is the availability of funding to pay for current and new technologies. Another is the outcome of several current efforts by the National Institute of Justice and the FBI. A third is the police response to the use of high technology by some criminals.

FUNDING FOR POLICE TECHNOLOGY

Technological advances are useful only if police agencies can afford them. That point is made in the results of a survey issued in 1996 by the Police Executive Research Forum (PERF). *Technology Resources for Police: A National Assessment* found, "In their efforts to improve the patrol function and maximize the impact of community policing programs, police nationwide are acquiring new technology designed to decrease response time and speed information dissemination." The PERF survey also found that 83 percent of survey "respondents listed the high cost of acquiring these technologies as the primary deterrent in their past efforts to become better equipped." Other factors: "Twenty-five percent of respondents noted lack of information about available products as a significant factor. A smaller percentage of respondents also mentioned the complexity of the technologies and the need for more support from management as obstacles to new acquisitions."

A case study included in the Forum's survey report illustrates how an agency bene-

"IN THEIR EFFORTS TO IMPROVE THE PATROL FUNCTION AND MAXIMIZE THE IMPACT OF COMMUNITY POLICING PROGRAMS, POLICE ARE ACQUIRING NEW TECHNOLOGY DESIGNED TO DECREASE RESPONSE TIME AND SPEED INFORMATION DISSEMINATION." BUT "RESPONDENTS LISTED THE HIGH COST OF ACQUIRING THESE TECHNOLOGIES AS THE PRIMARY DETERRENT IN THEIR PAST EFFORTS TO BECOME BETTER EQUIPPED."

TECHNOLOGY RESOURCES FOR POLICE: A NATIONAL ASSESSMENT
POLICE EXECUTIVE RESEARCH FORUM

fits when it can afford to upgrade information technology. The case study summary says: "Ten years ago, the Pinellas County (Florida) Sheriff's Office was working with an antiquated system of reporting, with four separate databases operating simultaneously and each serving limited purposes. As in most other police departments nationwide, police officers and detectives were bogged down with administrative detail and report writing, which cut down on their time on the streets.

"Today, the department is a model of efficiency. All four databases have been consolidated into one major network, and average report times have been cut from 35 to 40 minutes to ten minutes, essentially deploying officers from behind their desks to the communities where they are needed most. The office is nearly paper-free, operating on an intra-office e-mail system and the Augmented Criminal Investigative Support System (ACISS) database, which contains almost all relevant case information dating back ten years."

The Forum survey sampled 600 police agencies and had a 35 percent response rate.

FULFILLMENT OF CURRENT EFFORTS

Several efforts to improve the use of existing police technologies and foster the development and availability of new ones are underway.

NIJ

The National Institute of Justice has assumed several formidable tasks in attempting to encourage police technology. The tasks include (1) surmounting impediments to progress such as the fragmentation of American policing and liability concerns; (2) harnessing the resources of the national laboratories and other federally funded facilities to the advancement of police technology; and (3) speeding innovation from the laboratory to the police marketplace, perhaps the most difficult of the three tasks. To the extent that NIJ succeeds, it will help to transform the future of police technology.

> THE NIJ HAS ASSUMED SEVERAL FORMIDABLE TASKS IN ATTEMPTING TO ENCOURAGE POLICE TECHNOLOGY: (1) SURMOUNTING IMPEDIMENTS TO PROGRESS SUCH AS THE FRAGMENTATION OF AMERICAN POLICING AND LIABILITY CONCERNS; (2) HARNESSING THE RESOURCES OF THE NATIONAL LABORATORIES AND OTHER FEDERALLY FUNDED FACILITIES TO THE ADVANCEMENT OF POLICE TECHNOLOGY; (3) SPEEDING INNOVATION FROM THE LABORATORY TO THE POLICE MARKETPLACE, PERHAPS THE MOST DIFFICULT OF THE THREE TASKS.

The successful fulfillment of specific NIJ projects is also important. Two examples:
- If productive, the Institute's program to improve the quality and availability of DNA technology to local and state law enforcement will strengthen criminal investigation and prosecution in the 21st Century.
- NIJ supports several projects designed to help protect police officers and citizens. The projects include already noted efforts to help police identify concealed weapons and to use less-than-lethal force in ways that protect both the police and citizens. If these projects achieve their goals, life will be safer for everyone in the next century.

FBI and Other Federal Agencies

The Federal Bureau of Investigation is seeking to make two indispensable contributions to American law enforcement. As noted in Part Two, it is upgrading the National Crime Information Center in a project called NCIC 2000 and attempting to remedy the fragmented state of the nation's Automated Fingerprint Identification Systems (AFIS) through its IAFIS project. The projects are being undertaken in conjunction with each other.

NCIC 2000 is designed to increase the speed and capacity of the current NCIC system, which allows officers to check the NCIC database for wants and warrant information on detained subjects. If the officer gets a "hit," probable cause is established for further action. NCIC 2000 seeks to add sophisticated computer technology, thereby increasing the capacity of the existing system and to enable officers to transmit graphic images such as fingerprints and mug shots.

While NCIC 2000 is to have a database of single fingerprints of wanted persons, the Integrated Automated Fingerprint Identification System (IAFIS) is slated to be a huge database of tenprint cards (cards with prints of all ten fingers). As of 1996, the bureau processed anywhere from 40,000 fingerprints a day to upward of 80,000 on unusually heavy days. Plans are that IAFIS be able to process at least 60,000 per day.

The difference between the two systems is that the images in the NCIC database are not a true and total fingerprint. When printed out, the image is not identical to an

inked print; the computerized version has less definition and requires filtering so it doesn't falsely identify and reject possible matches. The technology, in layman's terms known as "one-to-one" matching, is a matter of identification verification. It compares one print to one record for a simple "match" or "no match" response.

In contrast, IAFIS technology is designed to use "one-to-many" matching, which requires that the computer extract minutiae from the print and compare it to all records in the database. One of the most important uses of IAFIS will be the ability to search unknown fingerprints, including those obtained at crime scenes, in a national database of significant offenders. This capability, when added to enhanced DNA capabilities, criminal profiling, and tracking of serial offenders through the FBI'S VICAP program, is designed to improve significantly the identification, apprehension, and prosecution of career criminals.

Law enforcement agencies will not need sophisticated computer technology to access either NCIC 2000 or IAFIS. Varying levels of participation will be available, depending on the level of technological expertise and the equipment available at the agency.

When fully realized, the two projects will provide a completely integrated system that can transmit textual information, single fingerprints, and mug shots and process tenprint cards. Law enforcement technology will be significantly advanced.

The FBI also has its Drugfire program. In place since 1992, Drugfire has kept track of cartridge casings retrieved from more than 3,700 shootings in Maryland, Virginia and the District of Columbia. Investigators can access the database to compare spent ammunition found at crime scenes and link fired cartridge casings or projectiles to other crimes. So far, Drugfire has been able to link ammunition in more than 300 cases.

The Bureau of Alcohol, Tobacco and Firearms (ATF) has its own program. The ATF's Integrated Ballistics Identification System does the same work as Drugfire, comparing thousands of rounds in seconds. It has been successful in linking a number of shootings to one weapon or suspect. Both programs are currently being implemented in cities throughout the country. Unlike the fragmented state of AFIS, it is hoped that investigators will be able to access either database in the near future.

In an effort to streamline the booking process, the Drug Enforcement Agency developed and implemented the Joint Automated Booking Station, which uses computer technology to reduce booking time from 75 minutes to 15.

CRIMINAL USE OF HIGH TECHNOLOGY

High technology such as computerization and wireless communications is transforming the ways of some criminals. For example, the Forum study reports that domestic and international "drug trafficking organizations routinely surpass the communications capabilities of law enforcement. Street-level dealers and kingpins have access to the best communications technologies.... E-mail, the Internet, and cellular communications have made illegal transactions more and more difficult to trace." The development of police technology in the next century will be keyed in part to attempting to keep up with the criminals' use of technology.

> LAW ENFORCEMENT AGENCIES WILL NOT NEED SOPHISTICATED COMPUTER TECHNOLOGY TO ACCESS NCIC 2000 OR IAFIS. VARYING LEVELS OF PARTICIPATION WILL BE AVAILABLE, DEPENDING ON THE LEVEL OF TECHNOLOGICAL EXPERTISE AND THE EQUIPMENT AVAILABLE AT THE AGENCY. WHEN FULLY REALIZED, THE TWO PROJECTS WILL PROVIDE A COMPLETELY INTEGRATED SYSTEM THAT CAN TRANSMIT TEXT, SINGLE FINGERPRINTS AND MUG SHOTS, AND PROCESS TENPRINT CARDS.

PART FOUR:

FEDERAL

EFFORTS

Our intention for this report is to inform. There is no list of firm recommendations for action in the report. However, we have articulated and categorized some observations for federal policymakers seeking to spur development of successful law enforcement technologies that enhance crime-fighting efforts.

COORDINATING FEDERAL EFFORTS

Many federal agencies sponsor law enforcement technology projects. Most federal law enforcement agencies — among them, the Federal Bureau of Investigation, the Drug Enforcement Administration, the Immigration and Naturalization Service, Customs, Secret Service, the Bureau of Alcohol, Tobacco and Firearms — have technology development budgets. These budgets are generally used to meet specific agency requirements.

Additionally, other federal agencies have significant programs in security technology. Notable examples are the Department of Defense and the Department of Energy's nuclear security programs. Both agencies have produced and are working on programs with law enforcement applications. Similarly, the Federal Aviation Administration has invested in developing explosives detection technology, a law enforcement priority, and is now working with NIJ.

Amidst all these efforts, fragmentation and duplication of effort will likely occur. Systems may be developed that are incompatible with each other. Thus, federal policymakers may wish to consider designating a coordinating point for law enforcement technology programs. If a specific technology development program is required to meet multiple requirements, one agency could be tasked with leading the development effort. That agency could be required to obtain and provide an overview of all of federal government programs within a law enforcement technology area. It could encourage collaboration and help ensure that proposed technologies meet interoperability standards, thereby reducing the recurring problem of incompatible systems within law enforcement.

It is our observation that the National Institute of Justice is well suited to coordinate, when needed, federal efforts in the development of law enforcement technology. We base this observation on these factors:

Experience
As this report notes, the agency in recent years has made considerable progress in supporting federal, state, and local law enforcement in technology development. It has learned how to coordinate activities benefitting law enforcement across government and agency boundaries.

Reputation
NIJ has established a reputation as an objective source of information, assessment, and development. It champions science in projects such as those it sponsors to foster and enhance DNA technology and other forensic advances.

Single Mission
The agency has no investigative or other law enforcement role; its only products are research, development, dissemination, and coordination of efforts to improve criminal justice.

Established Partnerships
Within the federal arena, NIJ has created successful partnerships with the Departments of Defense and Energy and the National Aeronautics and Space Administration for adapting already existing technologies to meet law enforcement needs. It has worked with the Deputy Attorney General's office to establish the Justice Technology Coordination Council to encourage cooperation and reduce duplication among federal agencies.

Another means of coordinating federal efforts to develop law enforcement technology would be the appointment of a science and technology adviser by the Attorney General. The adviser would chair a coordinating council to track law enforcement

technology development programs within the federal government. The adviser and council would have no fiscal or operational authority, but would help reduce duplication of effort, increase cooperation, and seek adequate resources for needed technology programs.

The Attorney General's appointment of a science and technology adviser would emphasize the importance of developing law enforcement technology. Consideration should also be given to appointing a senior law enforcement official to the Technology Policy Board of the White House Office of Science and Technology. The board currently does not address law enforcement technology matters in its deliberations.

ENCOURAGING INDUSTRY

Among the obstacles to progress in the development and adoption of new technologies are the consequences of fragmentation of local policing as well as liability concerns, particularly on the part of manufacturers. There are measures which could encourage industry to serve the police market with new products, including:

- Industries are sometimes reluctant to manufacture and market technologies developed under NIJ's aegis unless they are assured of a profit. That generally requires a period of exclusive patent rights. NIJ could be authorized to waive government patent rights or assign exclusive use of a license when necessary.
- One of industry's principal concerns in developing and manufacturing new police technologies is the lack of protection from liability suits for products meeting appropriate standards and passing required tests. Although federal agencies are generally protected from product liability suits, such is not the case for state and local police agencies. The result is that manufacturers may be reluctant to make and market new technologies, and the police are subject to liability suits involving innovative technologies. This is particularly true in matters involving safety and less-than-lethal technologies. Federal policymakers may wish to provide the law enforcement technology industry with the same liability protection that defense-sector industries receive.

STRENGTHENING STANDARDS

NIJ enforces product standards through a generally successful voluntary compliance program. Although voluntary compliance is preferred, NIJ has no means for investigation and enforcement if a technology provider is in consistent noncompliance with established standards. Because police technologies are critical tools in maintaining officer and public safety, inadequate or faulty equipment can cause injury and death. Thus, policymakers may want to consider adding an enforcement element to NIJ's standards setting authority with the objective of providing NIJ with clear, firm authority to develop and enforce a standards program.

HELPING THE POLICE ACQUIRE TECHNOLOGY

As previously noted, police spend most of their budgets on personnel and standard equipment and have little left over to buy new technologies. There are several options that policymakers could explore as a means to help state and local police acquire new equipment. These options include:

- Promoting buying consortiums which allow the police to achieve economies of scale by obtaining technologies through purchasing pools. Industry is helped with its marketing problems through obtaining bulk rather than resource-draining individual sales.
- Promoting the use of state and regional economic development agencies. These help other fragmented market communities similar to the law enforcement community.
- Expanding the availability of technology-purchasing grants to local and state police.
- Establishing a federal low interest loan program for purchasing police equipment.

ENCOURAGING INDUSTRY:

- INDUSTRIES ARE RELUCTANT TO MANUFACTURE AND MARKET TECHNOLOGIES DEVELOPED UNDER NIJ'S AEGIS UNLESS THEY ARE ASSURED OF A PROFIT. THAT GENERALLY REQUIRES A PERIOD OF EXCLUSIVE PATENT RIGHTS. NIJ COULD BE AUTHORIZED TO WAIVE GOVERNMENT PATENT RIGHTS OR ASSIGN EXCLUSIVE USE OF A LICENSE WHEN NECESSARY.
- ONE OF INDUSTRY'S PRINCIPAL CONCERNS IS THE LACK OF PROTECTION FROM LIABILITY SUITS FOR PRODUCTS MEETING APPROPRIATE STANDARDS AND PASSING REQUIRED TESTS. ALTHOUGH FEDERAL AGENCIES ARE GENERALLY PROTECTED FROM PRODUCT LIABILITY SUITS, SUCH IS NOT THE CASE FOR STATE AND LOCAL POLICE AGENCIES. FEDERAL POLICYMAKERS MAY WISH TO PROVIDE THE LAW ENFORCEMENT TECHNOLOGY INDUSTRY WITH THE SAME LIABILITY PROTECTION THAT DEFENSE-SECTOR INDUSTRIES RECEIVE.

- Further loosening restrictions on Department of Defense surplus property. The Department of Defense holds significant amounts of surplus property that would benefit state and local police. Under current legislation, the department has a program to expedite transfer of surplus property to the police, and this effort should be accelerated.

PUBLIC SAFETY IS THE NATION'S TOP PRIORITY. PROVIDING STABILIZED FUNDING FOR TECHNOLOGY DEVELOPMENT MUST BE GIVEN THE HIGHEST PRIORITY IF THE CAUSE OF PUBLIC SAFETY IS TO BE SERVED.

FUNDING AN ADEQUATE TECHNOLOGY BUDGET

Although funding for NIJ's Office of Science and Technology has increased significantly in recent years, it is still inadequate to address the level of research and technology development necessary for bringing much needed technologies to near-term fruition in supporting the requirements of our nation's law enforcement agencies. Much of the NIJ/OST budget has been earmarked for specific projects that are often not the high priority technologies identified by local and state law enforcement.

In spite of these restrictions, NIJ has done a remarkable job in establishing a technology development infrastructure to support its police consumers. As youth violence increases, organized crime proliferates, criminals increasingly show less respect for police authority, and criminals become more capable in combating police weaponry and tactics, it is essential that funding be made more immediately available for developing timely technologies to support police agencies.

Through the LECTAC and other forums, police officials have consistently identified vital technology needs, including (1) detecting concealed weapons; (2) stopping fleeing felons; and (3) new devices for using less-than-lethal force. A fourth critical requirement, DNA laboratory and database improvements, will require additional funding in coming years beyond the current level of effort.

In addition, each of the NIJ/OST regional technology centers have now matured and developed a list of technology initiatives that should be funded to support their regional concerns. Without adequate funding, the centers, and their important advisory councils, will not be able to realize the next level of community support and outreach so essential to continued regional law enforcement acceptance.

In conclusion, we must not forget that public safety remains the nation's NUMBER ONE priority. Providing stabilized funding for technology development to support law enforcement must be given the highest priority if the cause of public safety is to be served. Of equal high priority should be the careful consideration of the policy changes, as noted above, which can further improve the effectiveness of federal support for law enforcement.

APPENDICES

APPENDIX ONE

A REVOLUTION IN POLICE METHODS

Chief Francis O'Neill of the Chicago Police Department was an enthusiastic, turn-of-the-century chronicler of advances in police technology. Here are some of his 1903 reminisces for the International Association of Chiefs of Police.

Less than one-quarter of a century ago the policeman on post had no aid from science in communicating with his station or in securing assistance in case of need. When required by duty to care for the sick and injured or to remove a dead body, an appeal to the owner of some suitable vehicle was his only resource....

These were desperate times for policemen in a hostile country with unpaved streets and uneven sidewalks, sometimes miles from the police station, with little prospects of assistance in case of need. Scores of instances does the writer remember when prisoners were rescued, officers assaulted, maimed and even killed before assistance could reach them. It took nerve to be a policeman in those days, but now how changed.

The invention of the patrol wagon and signal service has effected a revolution in police methods. It is a milestone in the path of police progress and like many other epoch-making inventions, was the offspring of necessity.

An express wagon remodeled with seats within, rails on top, steps in the rear, and drawn by one horse, was the first patrol wagon. The covered patrol wagon was a later improvement, resulting from an act of the Illinois Legislature, the open wagon being regarded as entailing too much publicity and humiliation on its patrols...

At a picnic of the United Irish Societies of Chicago on August 15, 1881, Austin J. Doyle, then General Superintendent of police, outlined to Professor John P. Barrett, City Electrician, a scheme which, when developed and elaborated by the latter, became the police signal service, originated in Chicago and now in operation all over the civilized world. At one police precinct in the most turbulent part of Chicago, the police signal service was installed as an experiment. Its success and popularity was instantaneous and the system was extended all over the city as the capacity of the police department shops would permit....

The introduction of electricity as a means of communication between stations was the first notable advance in the improvement of police methods. Not many here present will remember the time when the manipulation of the dial telegraph by the station keeper while sending messages excited the greatest wonder and admiration....

Source: *The Blue and the Brass: American Policing 1890-1910*, Donald C. Dilworth, editor, International Association of Chiefs of Police, 1976.

APPENDIX TWO

A CONFESSION FOR SCIENCE

George S. Doughtery, the second deputy police commissioner of New York City, reported this endorsement of the use of fingerprints in criminal investigations to the International Association of Chiefs of Police in 1911.

The loft of H. M. Bernstein & Brothers, 171 Wooster Street, manufacturers of ladies' garments, was burglarized on the early morning of February 23, 1911. Finger impressions found in this burglary were discovered to be that of Cesare J. Cella, alias Charles Crisp, who, upon this identification, was arrested and indicted for the crime of burglary in the second degree, second defense.

At first, Cella's attorneys proceeded with his trial on the plea of not guilty, but after Captain Joseph Faurot, our fingerprint expert, had testified, the attorneys for the defendant withdrew the plea of not guilty and pleaded guilty to the crime of burglary. Judge Rosalsky, after the plea had been taken, said to Cella: "I want you to make a full confession. I can assure you that no indictment will be found against you, or any witnesses who testified in your behalf in the course of the trial, for perjury, but it is more for the interest of justice and science that you tell the truth. It is invaluable for us to know whether or not the expert testimony given during your trial was correct or otherwise. The fingerprint experts are of the opinion that the science of identification, by means of fingerprints, is more exact than the Bertillon system and photography. Did you remove the pane of glass, in evidence here, from the door of the loft of H. M. Bernstein & Brothers?"

The defendant answered that "he did," and then gave the full details of the burglary. In view of the fact that he had assisted in the science of fingerprint, Cella was given the minimum sentence of six months in prison.

Source: *Identification Wanted: Development of the American Criminal Identification System 1893-1943*, Donald C. Dilworth, editor, International Association of Chiefs of Police, 1977.

APPENDIX THREE

TWO COMMUNITIES WITH MUCH TO OFFER

The natural sciences and technology have long helped the police to solve specific crimes. Scientists and engineers have had very little impact, however, on the overall operations of the criminal justice system and its principal components: police, courts, and corrections. More than 200,000 scientists and engineers have applied themselves to solving military problems and hundreds of thousands more to innovations in other areas of modern life, but only a handful are working to control the crimes that injure or frighten millions of Americans each year. Yet the two communities have much to offer each other: science and technology is a valuable source of knowledge and techniques for combatting crime; the criminal justice system represents a vast area of challenging problems.

Source: *Task Force Report: Science and Technology*, a 1967 report to the President's Commission on Law Enforcement and Criminal Justice.

APPENDIX FOUR

THE POLICE TECHNOLOGY RECOMMENDATIONS OF THE PRESIDENT'S 1967 COMMISSION ON LAW ENFORCEMENT AND ADMINISTRATION OF JUSTICE

- Similar studies exploring the detailed characteristics of crimes, arrests, and field investigation practices should be undertaken in large metropolitan police departments.
- Police callboxes should be designated "public emergency callboxes," should be better marked and lighted, and should be left unlocked.
- Wherever practical, a single police telephone number should be established, at least within a metropolitan area and eventually over the entire United States, comparable to the telephone company's long-distance number.
- A versatile laboratory for continuing simulation of communications center operations, looking primarily toward changes in operating procedures and arrangements, should be established with Federal support.
- An experimental program to develop a computer-assisted command-and-control system should be established with Federal support.
- Frequencies should be shared through the development of larger and more integrated police mobile radio networks.
- The FCC should require metropolitan areas to submit coordinated requests for additional frequencies, with the manner in which action on a local level is coordinated left to the discretion of local governments.
- Greater use should be made of multichannel radio trunks.
- The FCC should develop plans for allocating portions of the TV spectrum to police use.
- The Federal government should assume the leadership in initiating portable-radio development programs and consider guaranteeing the sales of the first production lots of perhaps 20,000 units.
- Two studies leading to the development of a semiautomatic fingerprint recognition system should be undertaken: A basic study of classification techniques and a utility study to assess the value of latent print-searching capability.
- Police departments should undertake data collection and experimentation programs to develop appropriate statistical procedures for manpower allocation.

Source: *The Challenge of Crime in a Free Society*, a report by the President's Commission on Law Enforcement and Administration of Justice, 1967.

APPENDIX FIVE

ON THE SLOW PROCESS OF COMPUTERIZATION

In 1982, *Police Magazine* asked three leading police chiefs why law enforcement was not making more effective use of data processing. The following is the magazine's report of viewpoints in the early 1980s.

• Chief George Sicaras of the Hartford, Connecticut, Police Department blames a lot of the problems on the complexities of computer technology. "A lot of law enforcement people have little or no idea what computers can do for them and don't even know what questions to ask. To many police, computers are awesome and threatening."

• Anthony Bouza, former chief of police in Minneapolis and an advocate of technology in policing, likens the situation to that of doctors practicing medicine in the 19th century. "We're still using leeches to cure pneumonia," he says. "In the harsh world of profits, hiring and firing which is the private sector, competition forces you to innovate or fall behind. But a police department is an island apart from the rest of society. There are huge breakwaters to protect it from the waves of change. Cops are conservative by nature. Young cops learn quickly that the way to get ahead is to conform. Everything cops experience has taught them to be cautious."

• Chief Joseph MacNamara of the San Jose, California, Police Department sees political obstacles as well. "The biggest," he believes, "is our national heritage of fear of Big Brother. Computers raise serious civil liberties questions for many well-intentioned people.

"Four years ago, for example, I went to our city council to get permission to request a $50,000 LEAA grant to automate our field interview files. All I wanted to do was computerize records that we were already keeping manually of people who had been stopped and questioned because they were acting suspiciously. It wouldn't have cost the city a cent, but the council voted against it. Some of the members were concerned that we'd be keeping files on innocent citizens." (MacNamara later was able to get his council to relent when he was able to cite "some pretty dramatic cases where having this information on file had led to important arrests.")

Source: *Police Magazine*, September 1982.

Appendix Six

Deadly Force

Deadly force is generally defined as the use of firearms to stop or incapacitate a subject, or the level of force that is likely to kill or cause serious bodily injury. It has also been viewed from the officer's perspective, that of the decision to shoot, rather than the consequences of shooting.

Historically, police have been authorized to use deadly force in two situations: the "defense of life" rule, which allows officers to defend themselves or others against threats to their lives and safety; and the "fleeing felon rule," which lets officers use deadly force to stop fleeing suspects when no other means is available.

The defense of life rule is found in case law of every state and is generally unquestioned. But the fleeing felon rule has been the cause of much controversy over the years. The rule originated in England, when felonies were usually punished by execution. Because punishment was harsh and swift, deadly hand-to-hand fights between suspects and the unarmed citizens assigned to apprehend them were common. In the mind of the citizens, there was little difference between defending life and stopping a fleeing felon, in philosophy or practice.

By the 1930s, the American criminal justice system was being criticized for the incongruence of laws that allowed for the punishment and/or execution of felony offenders, as well as the use of deadly force against those who were only suspected of a felony crime. In 1967, the President's Commission on Law Enforcement and Administration of Justice posited that some of the country's urban riots were caused by an overzealous use of force, and suggested that law enforcement's absolute discretion in this area be restricted. The commission recommended that agencies formulate written firearms policies that limited the use of deadly force to situations that showed a clear and compelling need. But some departments, regardless of more permissive state law, already had policies that limited deadly force, especially with regard to the fleeing felon rule. Officers were only allowed to use deadly force on armed fleeing felons or those they believed had committed violent felonies.

It was not until 1985, though, that deadly force policies were radically altered with the Supreme Court's decision in *Tennessee vs. Garner* (471 U.S. 1 [1985]). This case stemmed from an incident in which police officers responded to a burglary call. When the officers arrived at the scene, they saw a suspect fleeing the house. The suspect failed to stop when ordered by the police, and was fired upon by one of the officers. The shot killed the suspect, who was later determined to be fifteen years old. In his pocket was a wallet and $10 that had been stolen from the house.

Under Tennessee law, it was legal at that time to use deadly force to stop a fleeing felon. The suspect's parents sued the department, contending that the law was unconstitutional. The case reached the Supreme Court in 1985, which ruled for the parents. The court determined that firing at a fleeing nonviolent, unarmed felony suspect was a violation of the Fourth Amendment's protection against unreasonable search and seizure. The ruling abolished the deadly force laws in more than thirty states. Officers were thereafter only allowed to use deadly force if they believed the suspect posed a serious threat to themselves or to another person.

Source: *Encyclopedia of Police Science*, Second Edition.

NONLETHAL WEAPONS STUDY

Force Type	Study Cases	Success Rate	% of Major/Moderate Injuries	
			Officers	Suspects
Baton	121	85%	16%	61%
Kick	41	87%	11%	26%
Punch	27	75%	36%	64%
Miscellaneous	135	94%	15%	46%
Flashlight	24	96%	4%	80%
Swarm	47	92%	16%	24%
Chemical Sprays	19	90%	0%	0%
TASER	88	86%	0%	0%
Total	502	88%	13%	38%

This 1991 study looked at 502 use-of-force incidents in which a specific tactic was used to cause a suspect to fall to the ground: baton, karate kick, punch, flashlight, swarm or an organized tackle, miscellaneous bodily force (pushing, shoving, tackling), chemical irritant spray, and the TASER. Major injuries were defined as breaks, concussions, large lacerations or contusions, sprains, strains, with suspects hospitalized or officers placed off duty or on light duty. Moderate injuries were small lacerations, welts, contusions and bruises. Minor injuries included complaints of pain, minor scratches, skin redness and the effects of the TASER and chemical sprays. Success rates were defined as whether the application of a given type of force ended the altercation.

Source: Greg Meyer, "Nonlethal Weapons versus Conventional Police Tactics: The Los Angeles Police Department Experience," 1991.

APPENDIX EIGHT

STATEMENT OF THE LESS THAN LETHAL LIABILITY TASK GROUP

For the past four years, the NIJ Less Than Lethal Liability Task Group has been monitoring law enforcement's use of Oleoresin Capsicum (also known as "OC spray" or "pepper spray"), and various scientific and medical studies and literature on the use of OC spray.

Studies and statistical information indicate that OC spray is employed by most (almost all) law enforcement agencies in the country and, in fact, has become the most widely used less-than-lethal technology. The Task Group has carefully reviewed reports from leading medical scientists and forensic scientists, including studies initiated by the National Institute of Justice and the Federal Bureau of Investigation, which have thoroughly examined the available scientific and medical literature and reports of the cases where OC spray was present and death occurred. The Task Group also reviewed reports from other organizations which have concluded OC spray may be harmful, but which lack any credible medical or scientific basis for their conclusions.

OC spray has been used in tens if not hundreds of thousands of incidents.

Available factual and anecdotal evidence indicates that use of pepper spray has

- reduced injuries to suspects (citizens);
- reduced injuries to law enforcement officers;
- reduced excessive force complaints;
- reduced workers' compensation claims;
- reduced use-of-force litigation;
- been found objectively reasonable in almost all uses which have been litigated;
- produced no finding of proximate cause in carefully studied death cases.

The Task Group has found that OC spray has become the most common method of force used by law enforcement in this country, in the place of other more hazardous levels of force such as the use of batons or firearms. The Task Group has found that as a direct result of this transition to OC spray, serious injuries to both citizens and law enforcement officers have been reduced, as have litigation, medical, and workers' compensation costs.

We know of no reason why law enforcement authorities should not continue using OC spray in an appropriate manner and under appropriate circumstances.

Source: The statement was issued Oct 7, 1997, to David Boyd, Director, Office of Science and Technology, National Institute of Justice.

TALLAHASSEE STUDIES 2,000 PEPPER SPRAY INCIDENTS

The Tallahassee, Florida, Police Department in 1996 conducted a study of more than 2,000 use-of-force incidents that took place between May 1993, and December 1995. Officers used pepper spray in 999 of these cases.

The TPD uses a six-tier use-of-force matrix to govern officer response.

	Suspect	Officer Response
Level I	Presence	Presence
Level II	Verbal Resistance	Verbal control
Level III	Passive physical resistance	Physical control
Level IV	Active physical resistance	Intermediate weapons
Level V	Aggressive physical resistance	Incapacitating control
Level VI	Aggravated physical/assaultive	Deadly force

The first phase of the study looked at OC spray as a Level IV response, or an intermediate weapon. At lower offender resistance levels, officers chose spray over the baton. When the resistance level increased beyond active physical resistance, officers chose to use impact weapons.

In 1994, the department downgraded the use of OC to a Level III response, or that of physical control. The study compared OC with physical control techniques — come-alongs, takedowns, and the use of pressure points — and found that officers chose OC spray over control tactics. When offender resistance increased beyond passive physical resistance, the use of OC spray declined.

The second phase of the study examined the effectiveness of pepper spray, and found that it worked in 72.7 percent of the time. It was effective against mentally ill and intoxicated individuals, but not more so than on other subjects. The study also found that multiple doses were not more effective.

Other conclusions included:
- Officers who were shorter and lighter relative to the suspects preferred OC over personal weapons, like hands and feet.
- Pepper spray was used more frequently against less dangerous suspects.
- OC spray resulted in fewer injuries for officers and offenders. Spray resulted in two officer injuries and six suspect injuries. When officers used other physical control techniques, 72 officers and 73 suspects were injured.
- Offender race and gender were not a factor in the decision to use OC, nor were officer race, gender, educational level and experience.

One of the most interesting findings was that officers routinely used less force than was allowed by the department. This result counters the popular perception than police are "violence-crazed abusers of force."

Source: *Law Enforcement News*, Vol. 23, No. 445; John Jay College of Criminal Justice, CUNY.

APPENDIX TEN

<u>"IT WAS LIKE TRYING TO EMPTY THE OCEAN WITH A BUCKET."</u>

Civil disturbances can test the mettle of any law enforcement agency. It may be that the goal is simply to restore order and make as few arrests as possible. Or the operation might call for mass arrests, putting personnel under fire and requiring armed back-up from department snipers. Although the goal is always a peaceful solution with no loss of life, it doesn't always end that way.

In the late 1980s, the Metro Dade and Miami police departments faced 10 days of rioting following the acquittal of five officers charged in the death of Arthur McDuffie, a black insurance salesman. McDuffie died as the result of injuries he suffered after a high-speed pursuit, arrest and the use of excessive force. Five officers were charged with manslaughter and convicted. They appealed the verdict, were given a new trial and subsequently acquitted. Although nine officers were ultimately fired in the aftermath of the incident, it did nothing to stem the anger of the citizens and sparked 10 days of rioting.

"We took a hard look at ourselves. We were criticized by the government and by ourselves. We saw our flaws, and we found out what didn't work," said Lieutenant Jerome Coney, a Metro Dade training supervisor. The result was an extensive search for riot control strategies that did work.

Today, Miami's response is tightly controlled and militaristic. Officers march to cadence in a well-ordered, disciplined formation, at times beating on shields to intimidate. Basic direction is given by a series of blasts from a marine air horn. One patrol vehicle follows the line, with the other cars parked nearby, an officer standing guard.

The Los Angeles Police Department also revamped its crowd control strategy. But it had taken a proactive stance, training its officers prior to what eventually erupted into the South Central riots of 1992.

The department had increased the number of officers in each squad from seven to as many as sixteen. Officers — four to a car — were instructed to drive behind a line of marching officers. The vehicles were a tactical tool, used to block areas or maneuver the direction of the crowd. Lights and sirens intimidated, while the PA system gave directions and orders. The vehicles enabled officers to recover injured officers or citizens, and to pursue suspects.

But the department soon discovered that conventional tactics do not work in unconventional situations. The LAPD and the Los Angeles Sheriff's Department, regardless of their skill and tactical planning, were overwhelmed.

"Things happened the media never saw," Lieutenant Michael Hillman, a platoon commander in the LAPD's Metro Division, said of the 1992 riots. "One of those was one of the most hellacious firefights our department has ever seen. Three or four armed suspects were shot when they tried to ambush two tactical units and the fire department. Our counterforce options were put in place and they worked, but as a result, we had to bring in a special component of SWAT officers in an armored vehicle to rescue our people.

"Throughout the rioting, we were committed and engaged at every turn of the road. For four days, these officers were sent out, would return, be rearmed and sent back out again and again. It was like trying to empty the ocean with a bucket."

Source: *Police Chief* magazine, International Association of Chiefs of Police, March 1993, by Lois Pilant.

APPENDIX ELEVEN

LESS-THAN-LETHAL CRITERIA

- Nonlethal weapons should be considered as supplements to firearms, not replacements for them.
- Nonlethal weapons must be related to user needs and constraints. Factors such as the type of encounters in which they are used, the nature of the threat involved, the law enforcement objective, the circumstances of the encounter, and the range of tactical options available influence the weapons that law enforcement officers utilize. The decision to use a particular weapon involves a balancing of the hazards it creates against the risks that might result from less effective responses.
- Performance criteria that is established for nonlethal weapons should take into account:
    Public safety and weapon side-effects
    Reliability, range and accuracy
    Immediacy and duration of effects
    Observability
    Vulnerability to countermeasures
    Public acceptance
    Effectiveness under different environmental conditions
    Ease of use and skills required for effective utilization
    Suitability in terms of risks involved
    Quality control
    Stability
    Cost effectiveness

Source: *Nonlethal Weapons for Law Enforcement: Research Needs Priorities*, U.S. Department of Justice, 1982.

APPENDIX TWELVE

LESS-THAN-LETHAL ISSUES AND CONSTRAINTS

The 1987 study on less-than-lethal weapons, *Report on the Attorney General's Conference on Less Than Lethal Weapons*, provides six reasons to develop such devices and outlines a number of related issues and constraints.

Needs:
- Avoid serious injury and death of fleeing felons
- Deal with hostage-terrorist situations
- Decrease the number of law enforcement officers shot with their own weapons
- Provide adequate force options for the increasing number of women officers
- Respond effectively to violent, emotionally disturbed persons
- Decrease high insurance rates and lessen the number of lawsuits involving police officers

Issues & Constraints
- Since any force that is used against an individual can be potentially lethal, acceptable limits of potential risk must be set.
- No single device can be expected to serve the many operational needs in the field.
- The design of a new device should incorporate features to limit the potential for abusive use.
- Successful research should include Department of Defense participation because much of the existing technology is classified.
- The participation of biomedical experts is mandatory in order to clarify the physiological effects and consequences of new weapons.
- Public acceptance of any new device will be a critical concern since public perceptions of propriety will strongly influence the use of a given weapon.
- Acceptance by the officers who would use the weapon is equally critical.
- Human experiments will eventually be essential to demonstrate the effectiveness of a new device.
- Administrative controls for actual use should be considered in development.
- Devices must not be overly complex; they must be durable and simple for the officer to use, but potentially difficult for others to use, should the officer lose possession during a confrontation.
- The delivery system (method of applying the active element to the subject) must be at least as accurate as a conventional handgun.

Appendix Thirteen

The Objectives of State and Local Police in the U.S.

1. To prevent and control conduct widely recognized as threatening to life and property (serious crime).
2. To aid individuals who are in danger of physical harm, such as the victim of a criminal attack.
3. To protect constitutional guarantees, such as the right of free speech and assembly.
4. To facilitate the movement of people and vehicles.
5. To assist those who cannot care for themselves; the intoxicated, the addicted, the mentally ill, the physically disabled, the old, and the young.
6. To resolve conflict, whether it be between individuals, groups of individuals, or individuals and their government.
7. To identify problems that have the potential for becoming more serious problems for the individual citizen, for the police, or for government.
8. To create and maintain a feeling of security in the community.

Herman Goldstein, *Policing a Free Society*, (Cambridge, Mass.: Ballinger, 1977).

KILLING THE POLICE

Killed in the Line of Duty: A Study of Selected Felonious Killings of Law Enforcement Officers, published in 1992, was a three-year comprehensive study by FBI researchers Anthony J. Pinizzotto and Edward F. Davis. They examined 51 cases in which 50 offenders killed 54 officers, with the original intent of drawing a profile of the typical cop killer.

The offenders did have some common characteristics, such as diagnosed personality disorders, gender (male), race (white), education (60 percent were high school graduates), and drug and alcohol use at the time of the killing. More than half of the offenders reported a childhood socio-economic status as average to comfortable. They claimed a history of verbal abuse and physical violence, and had criminal records that started at about age 12. Perhaps the most notable trait was that more than 45 percent admitted to murder or attempted murder prior to killing an officer, and 18 percent said they assaulted an officer or resisted arrest prior to the incident in which the officer was killed.

Although the study was an effort to learn more about those who kill, the only clear profile that emerged was one of the victims. The demographics of slain officers were similar to those of the offenders, except in three areas. The victims had more education (83 percent graduated high school and 9 percent had a college degree), were older by an average of eight years, and more of them were married.

Although these statistics were revealing, what was even more interesting were the descriptions that emerged after studying department-supplied information and interviewing the officers' coworkers. The original purpose of the study was not to analyze the officers' personalities, but some specific traits were obvious. And lest someone say these descriptors were a way of canonizing the slain officers, it should be noted that the offenders used the same or similar words to describe their victims.

- Friendly to everyone
- Well-liked by the community and department
- Tended to use less force than other officers felt they would have used in similar circumstances
- Hard working
- Tended to perceive self as more public relations than law enforcement
- Service oriented
- Used force only as a last resort; peers claimed they would use force at an early point in similar circumstances
- Didn't follow all the rules, especially with regard to arrest, confrontation with prisoners, traffic stops, and did not wait for backup when it was available
- Felt he/she could "read" others or situations and would drop guard as a result
- Tended to look for the good in others
- "Laid back" and "easy going;" good natured
- Conservative in use of authority

At first glance, these descriptors appear to be positive traits. But a closer look finds that in some cases, they are not. Using force only as a last resort — especially when most other officers say they would have used it earlier — suggests that the victim officer also should have used force sooner. This conclusion is supported by the offenders; 57 percent said the officer was unprepared or surprised during the confrontation. The descriptor, "not following all the procedures," can clearly result in injury if, for example, the prisoner is not handcuffed correctly or proper precautions are not employed.

The study also discovered that:

- Most officers were slain during arrest or crime-in-progress situations; on streets, highways, parking lots, and within five miles of the offender's residence. Also, the killings generally occurred at the same location at which the officer first encountered the offender.
- Most incidents occurred at night, with weather that involved snow, rain, or fog.
- Forty-one percent of the slayings involved a .38 Special. Fifteen percent involved a .357 Remington magnum, with the .32 Smith & Wesson and 9mm Luger at 10 percent each.
- Seventy-seven percent chose their weapon because it was available and familiar, with 64 percent reporting that they had been familiar with the weapon since childhood. Thirty-four percent said they carried the weapon on them, 20 percent said they kept it under the seat of their vehicle, and 12 percent said they left it on the seat of the vehicle. Interestingly, more than 50 percent said they practiced with their firearm at least once a month.

- The offenders never mentioned race as a factor in the officer's death, nor was age, physical size, or sex important. Several did say, though, that they would not have killed a female officer. Apparently killing a woman does not distinguish a person in the prison setting; one inmate was even reluctant to talk about the fact that he killed a female officer.
- More than 75 percent said they were using alcohol or drugs at the time of the shooting, with 41 percent saying they used both.
- More officer killings occurred in the South. The authors were unable to explain why. It is not because more officers are employed in the South, or because the South has a higher concentration of people. The South also accounts for more murders, racking up 43 percent of the total throughout the nation, and has more accidental killings than in other regions.

Ferreting out the statistical elements of an officer's death pointed out procedural mistakes and revealed facets of training that could be improved. But what the study's authors really wanted to know was why the officers were murdered. What turned a petty thief or a drunk driver into a killer? Why did someone who was previously arrested without incident suddenly turn violent? Who was the typical cop killer?

An attempt to come up with an offender profile failed. Instead, the authors discovered the common denominator of personality disorders — most offenders were at some time diagnosed with one. Although there are at least six types of personality disorders (antisocial, dependent, narcissistic, borderline, passive-aggressive, and organic) the two most commonly found among cop killers were antisocial and dependent. Fifty-six percent of the offenders were diagnosed as antisocial, while 23 percent were labeled as dependent personality disorders.

The antisocial lacks a conscience or moral fiber, which years ago, resulted in the label "moral imbecile," and later, "sociopath." This person has a pathological — a negative and almost diseased — relationship with society. He has no positive regard or feeling for others and believes he is entitled to their possessions. He may enter into relationships that he feels can work to his advantage. As soon as the relationship becomes inconvenient or no longer gives him the expected reward, he abandons it quickly and callously. Antisocial personalities lack remorse and generally do not learn from their mistakes. They have high levels of aggression, a low tolerance for frustration, and blame others for their own wrongdoing.

The dependent personality is seen by those who know them as passive, weak and ineffective. They relate poorly with others from an early age and have a consistent pattern of submissive behavior. But these people are vastly different from their outer persona. Because they are unable to deal with their anger, frustration, and hostility, they are like a giant coiled spring. The coil at birth begins to compress, and as the person experiences frustration, anger, or hostility, it compresses even more. At the same time, an emotional button develops that can trigger the coil to expand or explode. There is no way to determine which incident will trigger it, only that the person "has had enough." Two types of incidents can precipitate violence: Either the person's mate or loved one is threatened, or the pressure from years of anger and frustration reaches a level than can no longer be tolerated. When a situation occurs that the person perceives as hostile, they react excessively and inappropriately.

Perhaps the most important question the study tried to answer was whether there was anything the officer could have done to save his own life. In interviews with the killers, the answer seemed clear: absolutely nothing. Forty-seven percent said the officer was powerless to save himself, a factor that could be attributed to a high percentage of the offenders having been shot or shot at before. They vowed never to be shot again, and said they would shoot first if necessary.

Eight percent of the offenders claimed that if the officer had been more "professional," he might still be alive. But none of them were able to define what they meant by "professional." In only three cases was the officer's death attributed to mistaken identity. In each incident, the officer was not in uniform and did not identify himself as a police officer.

The authors took a holistic view of officer slayings. They studied the circumstances of the incident, reviewed the law enforcement procedures involved, and took into account the personality traits of the victims and offenders. The authors found two broad categories of concern: approaches to vehicles and suspects, and lack of control of people and situations. According to the study, 41 percent of the officers made an improper approach to a suspect or vehicle, and 65 percent were unable to properly control the subject or the situation.

DNA ANALYSIS CLEARS LEGAL HURDLES

DNA analysis, an unknown and untried scientific phenomenon in 1986, is today as important a factor in the science of solving crimes as the fingerprint. Its most ringing endorsement came in June 1996 from the National Academy of Sciences, which proclaimed that there was no longer any reason to question the reliability of DNA evidence. It was a stunning affirmation from one of the world's most prestigious scientific bodies, and was of particular note when one considers the fact that a few short years ago, DNA analysis was questioned at every turn.

One of the first cases to legally test the science was *New York v. Castro*, which tried a 38-year-old man accused of murdering his neighbor and her 2-year-old child. A bloodstain on Jose Castro's watch was analyzed by a private lab and resulted in a three-site match to one of the victims. The probability of such a match occurring at random, according to the lab, was one in 100 million.

After three months of expert testimony, the Supreme Court of New York ruled that the evidence had to pass three tests: 1) Was there a theory that was accepted in the scientific community that DNA profiling could produce reliable results? 2) Did the techniques exist to produce reliable results and were they generally accepted in the scientific community? 3) Did the lab use those same accepted scientific techniques when analyzing the sample?

Castro passed the first two tests, but failed the third. The court ruled that because the lab did not use accepted scientific procedures to analyze the evidence, the DNA profile could only be used to show that the blood on the watch was not Castro's. It could not be used to show that it belonged to the victim (Office of Technology Assessment, 1990).

To ensure future admissibility, DNA analysis needed standards that determined testing protocol. Those standards were created by the FBI and the Technical Working Group on DNA Analysis Methods. DNA analysis also needed quality control, which was supplied by the National Institute of Standards and Technology when it developed Standard Reference Material 2390 for RFLP testing.

The third most frequently cited objection to DNA analysis was the calculation of match frequencies and the question of population genetics. When DNA was first introduced to the courts, the match statistics were based on a small sampling of the population. Since that time, however, a database of DNA samples has been developed from the world's populations, which validated the methods used in computing match probabilities.

In just 10 years, DNA analysis cleared enough legal hurdles to be as incriminating as any fingerprint. Plus, it exonerates as easily and as thoroughly as it can accuse. But as the science becomes commonplace, another phenomenon has begun to take place. DNA analysis is being used to free innocent people from long-term prison sentences.

One case was the result of a college class project for journalism students at Northwestern University in Chicago. The students were told to find a real crime and reinvestigate it to see whether the right people were punished. The project took six months, and when it was over, three men had been freed from prison, two of whom were on death row.

The men were convicted in the 1978 murders of a gas station worker and his fiance. Four men were arrested and charged; one was sentenced to 75 years in prison, and two went to death row. The fourth man won an appeal and was free on bail in 1996. The students tracked the case from death row to East Chicago Heights, talking to crack dealers, ex-convicts, and anybody else who might know something about the case. But the decisive factor was DNA analysis, which showed that semen found on the dead woman could not have come from any of the four men.

After serving 18 years in prison, the men were released in June 1996 (Bergstein, 1996; Terry, 1996).

Another case, this one in California, freed a 37-year-old man who was accused of bludgeoning his wife nearly to death and killing his unborn child 17 years ago. The case came to light when staffers in the local sheriff's crime lab were updating their computer database with thousands of new DNA profiles from state files. They found a match between this case and another inmate, an already convicted and incarcerated rapist. They also matched the inmate's DNA with several other unsolved murder and rape cases.

The inmate later confessed and was charged with six counts of murder dating back to 1978 and 1979. The innocent man was freed after spending 16 years in prison (Houston Chronicle, 1996).

A Department of Justice study said that from 1989 to 1996, 28 men who were convicted of rape were freed from prison after DNA analysis proved their innocence. A report by the NAACP Legal Defense and Education Fund revealed that at least 48 people have been released from death row since 1973 because DNA helped to prove their innocence (Bergstein, 1996).

APPENDIX SIXTEEN

<u>CAR 54 WHERE ARE YOU?</u>

The Global Positioning System, quite possibly the greatest revolution in navigation since the sextant, is helping police departments use their resources more efficiently.

GPS was initially designed for the military. Foot soldiers in Desert Storm used hand-held GPS units to find their way around the desert sands and to seek out, locate and destroy the enemy. The technology has since made its way into the civilian sector and into applications as diverse as yachting, hiking, fishing and civil aviation.

The GPS receiver locks in on the Defense Department's NAVSTAR network of satellites and provides a reading of the user's exact position to within an accuracy of a few feet. The system consists of 24 satellites in high earth orbit transmitting a constant stream of radio signals. Each satellite has an extremely accurate, miniature atomic clock. The exact time the signal is sent, along with the position of the satellite, is encoded in the broadcast. The GPS receiver has a similar clock and compares the time the signal arrives with the time it was sent. This tells the device the precise distance to the satellite. The device homes in on three satellites, determines their distances, and through triangulation, provides the latitude, longitude and elevation anywhere on the face of the globe. For military uses, the GPS is accurate to within 10 meters. In peacetime this accuracy is available to all users with special equipment. But to keep a potential enemy on a par lower than the United States, an "error" is encrypted in the signal giving an ordinary GPS user coordinates accurate to only about 100 meters.

The public safety arena is one of the most important applications of GPS. City bus services, fire departments, and ambulance services — all organizations that maintain large fleets of vehicles — use a system based on GPS called Automated Vehicle Location (AVL). The system keeps dispatchers constantly informed of vehicle locations.

The principle behind AVL is simple. Each vehicle in the fleet has a GPS receiver which gives latitude, longitude and time. This information is translated into speed, heading and estimated time of arrival, which is then relayed via modem to the central dispatch location. But GPS is only one facet of an AVL system. An AVL system can also determine the vehicle's location, translate the coordinates into a street location, and communicate that location to the dispatch center. This information is broadcast quickly and frequently, about every 15 seconds for critical units, and every minute for other units. The system translates the latitude/longitude coordinates into an icon on a digital map of the city, or a text statement giving the street address, intersection or mile marker.

Location information is transmitted without any help from the driver. The dispatcher can even tell if the officer's lights and sirens are in use. Not only does this give the dispatcher and supervisor an accurate idea of where the department's vehicles are located, it keeps the officer from diverting his attention to relay information in what may be an emotional or adrenaline-charged situation.

AVL can support operations involving multiple vehicles, as in the case of pursuits. It can reduce radio time. It can be used to document a series of events, which can supplement the legal testimony of police officers. It can also provide the statistical information needed to redraw beat boundaries and allocate resources more effectively.

The police department of Schaumburg, Illinois, was one of the first to implement a GPS/AVL system. Schaumburg is a 70,000-population residential suburb of Chicago in which 19 dispatchers take 50,000 calls per year and send out 130 officers to cover 24 square miles. In the past, dispatchers assigned a call to the nearest beat car. They kept the information in their heads, continuously juggling locations, headings, speeds and assignments of all cars. Each of Schaumburg's critical response units now has a GPS receiver/antenna mounted on the trunk. The GPS provides the car's computer with the local coordinates, which it converts and sends along a frequency separate from voice transmissions to the CAD system at headquarters. Dispatchers see vehicle locations either on their individual screens or on a large terminal that displays a map of the entire city.

Although no quantitative study has been done to show how Schaumburg's GPS/AVL system has benefited the officers or the community, department officials believe it has helped immensely, said Lt. Tom Osterman, the system's architect. In one instance, an officer called for backup but neglected to inform dispatchers of his location. AVL enabled the dispatchers to pinpoint the officer and send assistance. In another incident, an officer pressed his emergency button before he was incapacitated, which enabled the department to send backup.

Since the system was implemented in 1992, the department has added some new features: vehicle polling, which has the computer selectively tracking certain vehicles; unit analysis to optimize the department's coverage and place vehicles in high-activity areas; real-time and archival use of a fast-reporting chase mode to "see" vehicles in pursuit.

The Schaumburg Police Department had two primary objectives when implementing AVL: improved response times and increased officer safety. According to Osterman, both goals have been met. Officers feel safer because they know the dispatcher is constantly monitoring their location and status. They know backup units can be dispatched many times faster than before. The system has also been surprisingly durable. Schaumburg's GPS receivers logged more than 600,000 vehicle hours with no functional problems. Schaumburg also saved money by purchasing a system that was not the most sophisticated but is still extremely accurate, Osterman said. "If you were to walk to the vehicle location that was reported by the GPS receiver, you would see the patrol car. We've always found the car right where the system said it would be."

Source: *Police Chief* magazine, International Association of Chiefs of Police, September 1994, by Lois Pilant.

COMMUNITY POLICING ON PATROL

An aggressive enforcement policy does not conflict with community policing principles, but can work in conjunction with them.

Enlisting citizen help

REDDI (Report Every Drunk Driver Immediately) uses toll-free telephone lines to turn in drunk drivers. Neighborhood watch programs teach citizens how to report dangerous drivers. Citizens with two-way radios — taxi drivers, truckers with CB radios, and citizens with cellular phones — can also be a part of an enforcement policy.

Concentrating on problems identified by citizens.

Reducing fear is an important part of community policing. Departments deploying officers where citizens are troubled by dangerous drivers will address those fears. Officers are also taught to rely on more than just the radar gun. Low-profile cars are moved from crossovers to high visibility activities, like monitoring solid lines, stop signs, and school bus stops; sitting in locations where people complain about careless drivers; and checking vehicles with defective lighting equipment, especially near bars and clubs.

Emphasizing proactive policing by focusing on specific problems instead of 911 calls

By examining traffic records, departments find the locations, days of the week, times of day, and the violations that are the cause of the city's most serious crashes. Efforts are concentrated in these areas.

Using nontraditional approaches.

One department, which had limited manpower, teamed up with the public works department to erect temporary barricades. Another had the city condemn and tear down vacant buildings to make room for left-turn lanes. Some form partnerships with neighboring agencies to pool resources for a high-profile, multijurisdictional approach.

Encouraging employees to come up with solutions.

Putting officers in high-profile stationary positions at strategic times and locations provides a visible deterrent to traffic violations, and gives the neighborhood a kind of mini-substation. "You'd be surprised how many citizens will approach a parked patrol car to talk about neighborhood problems," said Earl Sweeney, director of the New Hampshire Police Standards and Training Council, and the chairman of the International Association of Chiefs of Police Highway Safety Advisory Committee.

Source: *Police Chief* magazine, June 1995.

INNOVATIONS IN POLICING:
CHARLOTTE-MECKLENBURG POLICE DEPARTMENT, NORTH CAROLINA

The Charlotte-Mecklenburg Police Department is building a Police Master Information System for this North Carolina department that has 1,386 sworn and 424 civilian employees, and a commitment to community policing. The project is funded by COPS MORE 95 and 96 grants, as well as local matching funds and additional local funding.

Each officer is issued a laptop computer configured to have the same capability as a desktop computer. The system will support the CMPD's philosophy of Community Problem Oriented Policing (CPOP), and be comprised of several key components, all of which are viewed as critical to the overall success of the information system and to the actualization of CPOP within this police department.

The first component is the Police Local Area Network (LAN), which was implemented in early June, 1998. The LAN is structured in a way that links all workstations within the headquarters building and workstations at 18 remote police facilities (district offices, training academy, service area centers). The LAN servers are centrally located within the headquarters facility and connected with workstations in the headquarters and remote sites. The LAN operates on a Windows NT 4.0 server/workstation platform and utilizes Microsoft Exchange/Outlook 97 as its E-Mail server/workstation application.

A second component of the system is the Mobile Data Communications System (MDCS). This component, scheduled for implementation in August-September 1998, will enable officers to receive their dispatches, perform queries of local, state and federal databases, perform the wireless transfer and query of police offense reports, field interview records and other local records, and allow officers to utilize E-Mail (with attachments) in a wireless setting, thereby eliminating many of the traditional communication barriers which exist between members of the patrol force and investigators and administrators. The MDCS will enable officers to have field access to mugshot photographs. In addition, the MDCS will provide field officers with access to the legacy IBM mainframe computers. In essence, the MDCS has been designed to truly promote and actualize the "mobile office."

The KB-COPS records management system (Knowledge-Based Community Oriented Policing System) is a custom developed database which provides the department with advanced reporting detail and querying capabilities, based upon the elements of the North Carolina criminal statutes. The implementation of KB-COPS started in June 1998.

The department has conducted a thorough needs analysis and design concept, including templates for the police offense report and supplemental individual offense categories (e.g., robbery, burglary, larceny).

The Computer Aided Dispatch (CAD) system will provide the traditional functions a CAD system provides, with several enhancements. The CAD will aid the department in becoming less "call-for-service" driven and enable officers to manage time for problem-solving efforts through making appointments and call selection features. The CAD will provide address histories to officers in the field to enhance safety and provide the necessary background to identify and begin resolving problems. Also, the CAD will enable enhanced query capabilities as well as interfacing directly with the KB-COPS records management system. The CAD is scheduled for implementation in Summer 1999.

The Field Interview system will enable officers to directly input field interviews from laptop computers in the police vehicles and to query the field interview database when they contact a suspicious person. The effect of this system is that officers will be able to more easily and readily identify patterns among suspects in offenses and take appropriate measures to investigate them further or to refer information to investigators for proper follow up. The result is that fewer suspects in crimes will be able to slip through the net woven by incomplete, ill-conceived, or inadequate paper-to-computer collection systems.

The Future Alert Contact Network (FALCON) is a triggering/alerting software application being developed through a joint venture between the CMPD and the University of North Carolina at Charlotte. Its purpose is to use technology, more so than officers, to sort through reports and records to establish patterns, trends, particular offenses or incidents, contacts with individuals or suspects. The application is based on officers setting database queries for any of the databases mentioned in this narrative. Incoming reports are filtered through FALCON and, upon a query threshold being met, FALCON sends an E-Mail, a page, or both to the inquiring officer. The officer can then respond accordingly to address an issue to which he or she is alerted.

The Internal Affairs Case Management component, which will automate all internal investigation forms and data, is designed to enable the department to conduct trend and other analyses of complaints in general or against individual officers, case dispositions, problem behaviors, and training and policy issues.

IMPORTANT TECHNOLOGY LESSONS LEARNED

The Charlotte-Mecklenburg Police Department has undergone an exhaustive process of identifying and analyzing its information system and data needs. The needs analysis was conducted involving a majority of the department's patrol, investigative and civilian staff. It was conceived in the spirit of providing the data and system needs of those who make community policing a reality. While the system enables the management and direction of resources and data; and will provide the department with information necessary to fulfill its mission and obligations to the community, it is not a "management" system.

Off the shelf software products were incapable of fulfilling the needs identified by the department. As a result, the department has had to look to software vendors for custom development of applications to meet its information system needs.

The results of the needs analysis are likely to be very applicable to police organizations both large and small throughout the country. The development of system components such as Field Interview, FALCON, and possibly Internal Affairs are also likely to be transferrable in such a manner. However, the KB-COPS records management system and CAD are likely to have more limited transferability, such as throughout the state of North Carolina. Particularly with KBCOPS, the system is based upon the criminal statutes (and thus the elements of offenses) of North Carolina. Such an application can be modified to incorporate the elements of offenses of another state, however, these changes would require additional coding and programming costs.

The department has developed a very comprehensive information system plan and is proceeding in a fashion which places it at the forefront of technology initiatives and applications within police agencies. Department personnel welcome anyone interested in learning more about these initiatives, believing that the lessons learned and the analyses it has completed can and should be available to other agencies both large and small.

Source: CMPD Web page (www.charmeck.nc.us/cipolice/cmpdhome.htm), and the Web page of the International Association of Chiefs of Police committee on Law Enforcement Information Management (www.iacptechnology.org).

INNOVATIONS IN POLICING:
OXNARD POLICE DEPARTMENT, CALIFORNIA

In 1995 the Oxnard Police Department received federal funding under COPS MORE to institute a laptop computer field reporting program. The grant allowed for the purchase of 30 mobile computers, a Windows NT 4.0 network, and software for use in field report writing. Upon deployment, the project was to allow the completion of report face pages in the field and a subsequent download of appropriate information directly into the records management system (RMS), thereby eliminating data input downstream. Officers would dictate the narrative portion of their police reports, as they have done in Oxnard for some 15 years.

Initial field deployment was to be in briefcases followed by docking station mounting in field units. The laptops were to be loaded not only with the field reporting program, but also with reference materials, such as the *California Peace Officers' Legal Sourcebook* and electronic editions of the Penal and Vehicle Codes. The department also considered adding instructional programs in Spanish and tutorials in typing.

In 1996 Oxnard signed a contract with the developer of a report writing package. The package printed out the department-specific forms on blank paper and downloaded report data back to the records management system. In June 1997, seven months into the pilot phase of the report writing project, the department recalled all machines loaded with the report writing software, and re-examined the priority of field reporting versus replacing its existing CAD/RMS system. The recalled laptops were redeployed to field officers with software that supports the Microsoft Office suite of applications.

THE VENTURA COUNTY CONSORTIUM

The Ventura County Sheriff's Department, the Simi Valley Police Department and Oxnard Police Department formed a consortium of agencies in pursuit of a shared mobile data information system. The group visited 15 public safety sites that used various solutions to capture and process mobile data. The group discovered:

- Few officers make use of laptop features. It is rare for them to actually take computers out of their units.
- Some agencies experienced, and many more feared, damage to laptops by removing/replacing them throughout an officer's shift.
- It was difficult to obtain both officer acceptance and airbag compliance with most mounting solutions for laptops.
- Seeing screens in oblique or direct sunlight is nearly impossible, with the exception of the MobileVU screen.
- Modular installations are less likely than laptops to be stolen.
- Although more expensive than its laptop counterpart, it is hoped that a modular installation's durability will outlast two to three generations of laptops.

OXNARD INNOVATIONS

Exchange
Probably the biggest boost in productivity was the June 1997 roll-out of Exchange 4.0 on the department's NT 4.0 network. Gone forever is the need to photocopy memos to every commander, sergeant and officer. Exchange works equally well on laptops or desktop PCs. Exchange was a big hit internally, and plans are to fold it into a wireless system for use by field units.

Red Light Enforcement
After a successful testing period where motorists were only warned about red light violations, in July 1997 the city of Oxnard began issuing citations for red light violations caught on camera. The U.S. Public Technologies company installed photo red light enforcement cameras at key intersections. Such systems have been used in the U.S. since 1968, and there are more than 8,000 such systems in 45 countries today. The camera system takes photographs of the vehicle's front license plate and the driver's face as the vehicle crosses the limit line on a red light.

In addition to the cameras, the company installed poles and cabinets to mount the cameras; installed roadway detection loops; installed warning signs at major entrances of the city; distributed pre-enforcement notices; provided all supplies; maintains all equipment; provides training to department staff; performs processing of all phases of the program, up to and including notices to appear; handles media and community relations, including public service announcements and presentations to local groups and schools; participates in community activities; provides expert witness testimony; maintains a toll-free, bilingual service for violators to call; manages reports and provides statistical studies.

It is important to note that this system is not intended to generate revenue. The cost is 90 percent of the city's normal revenue from like tickets issued by officers.

TeleMinder
The TeleMinder system makes it easy to quickly identify and telephone thousands of people with emergency instructions. It can be used for neighborhood-specific crime alerts, staff recalls, neighborhood watch notifications and senior citizen check-ups. It includes faxing capabilities with features that allow for automatically faxed reports, fax broadcasting, and fax-back service.

GO/TRAK
The Gang Offender Tracking Program grew out of the Oxnard Police Department's role as a national demonstration site for the Department of Justice's Serious Habitual Offender program. GO/TRAK catalogs information on gangs and gang members, allowing officers to pull up photographs of the offender at computer terminals.

InfoCOP

The Information Management for Community Oriented Policing program is administered and funded by the Department of Justice's Office of Community Oriented Policing Services. InfoCOP is the next generation of crime analysis software designed for the collection and analysis of crime, operations, and calls for service data. The program was written by John Simmons and Dennis Jay Kenney of the Police Executive Research Forum.

AutoCAD R13

This program provides to-scale representations of major crime and critical traffic collision scenes. AutoCAD graphically represents the circumstances of major incidents for both investigators and juries.

LCD Projector

The Oxnard Police Department said goodbye forever to overhead slides when it started using the Sharp XGE1000UB LCD Projector. It provides color images with enough lumens to operate in a fully lit room. It operates off a variety of input sources, including external laptop monitor parts, TV cable, VCF and even laser discs.

Source: OPD Web page, and the Web page of the International Association of Chiefs of Police committee on Law Enforcement Information Management (www.iacptechnology.org).

STUDY LOOKS AT NEW MODELS

In 1995, well aware of the demise of the Chevrolet Caprice, two writers road-tested several different vehicle models, searching for a suitable replacement for what had become an industry favorite. Minimum requirements included 0-60 in less than 10 seconds, 0-100 in 24 seconds or less, and a top speed of 125 mph or better. The vehicles also had to have superior handling, good brakes and adequate interior room. Here is what they learned:

Pontiac Bonneville SSEi
- 1995: 3.8 liter, V-6, 225 bhp at 5,000 rpm, 275 pound-feet of torque at 3,000 rpm. 1996: 3800 Series II, with 240 bhp at 5,200 rpm and 280 pound-feet at 3,200 rpm. Weight: 3,620 pounds.
- Ample interior room, with front bucket seats, generous headroom, and enough space in the rear to install a cage.
- 0-60 in 7.3 seconds; 0-100 in 19.5 seconds; 1/4 mile in 15.4 seconds at 92 mph; top speed is 128.
- Front-wheel handling biased toward understeer; moderate levels of lateral grip and reasonably controlled body roll.

Dodge Intrepid
- 3.5 liter, 24-valve V-6, 214 bhp at 5,800 rpm, 221 pound-feet of torque at 3,100 rpm. Weight: 3,600 pounds.
- Cavernous rear seat and lots of rear leg room, enough for a cage and three occupants. Front cabin wide enough to permit mounting a shotgun next to driver's B-post. Wide gap between front buckets allows for installation of large center console for computer, without encroaching on front passenger room.
- 0-60 in 8.3 seconds; 0-100 in 23.9 seconds; 1/4 mile in 16.4 seconds at 85 mph; top speed 127 mph.
- Well checked body roll, minimal understeer, highly accurate steering, comfortable ride.

Chevrolet Tahoe
- 1995, LT1 model: 5.7 liter V-8, 250 bhp. 1996, LO5 model: 5.7 liter, 260 bhp.
- Huge cockpit, user-friendly dash. Optional bucket seats were short on lower back support and uncomfortable after a few hours at the wheel. 70 cubic feet in rear seat, 123 cubic feet with seat removed.
- Due to redesign of Suburban frame, rides and handles like a car.
- 0-60 in 11.6 seconds; 1/4 mile in 18.4 seconds at 74 mph; governor stopped at 99 mph and could not test 0-100 or get top speed.

Source: *Police* magazine, written by Russell Datz, with Craig Peterson contributing; December 1995.

GOOD THINGS COME IN SMALL PACKAGES... OR DO THEY?

American consumer's preferences have changed in the last decade, switching from the traditional family sedan to light trucks. In fact, trucks accounted for 40 percent of vehicle sales in 1994, a 13 percent jump in the last decade. General Motors stopped production of its Chevrolet Caprice, claiming that meager sales did not justify continued production. And though the Caprice was one of two cars used by nearly every department in the country, such a certain market was still too small.

Law enforcement prepared itself by experimenting with what appeared to be its only option — mid-size, front-wheel drive vehicles. The criteria was, in descending order of importance: cost, size, safety, durability, availability of high performance/police packages, and comfort.

The following comments are based on agency experience; some specified which models their officers drove, some did not. The results of a 1995 survey indicated that 81 percent of the respondents said officers need large cars to perform their duties; 69 percent believe the disappearance of large cruisers will lead to higher expenses if smaller cars are used — initial costs might be lower, but long-term maintenance costs would go up as would the need for more frequent purchases; 78 percent said they tried smaller cars, and 61 percent of those said they were dissatisfied with the vehicle's performance.

It is interesting to note, however, that dissatisfaction did not prevent a purchase. Administrators know that performance and comfort take a back seat to cost. They also know that complaining won't bring back the Caprice.

PRO	CON
Shelburne, Vermont: If traded at 80,000 miles, are no problem. If pushed to 100,000 their maintenance cost is too high. *Whatcom County, Washington:* Good for some duties, such as detective, administration, and traffic enforcement. *Maple Bluff, Wisconsin:* Performed well, in some cases it outperformed the Crown Vic. In-service drivers training made a big difference in changing from RWD to FWD vehicle. *Hillsborough County, Florida:* Cost savings was important factor. Also, maintenance costs actually decreased. Did not have any more problems with mid-size car than with any particular model of full-size car. *Darien, Wisconsin:* Fuel economy and handling of front-wheel-drive cars was biggest attraction. *New Orleans, Louisiana:* Although not practical for patrol officers, they have been used by supervisors and detectives.	*Portland, Oregon:* Break down too much, are too slow, make prisoner transport difficult. Uncomfortable for driving and unsafe in pursuits. *Spartanburg, South Carolina:* Resulted in high maintenance costs, could not take 24-hour use, could not carry prisoners. *West Palm Beach, Florida:* Door openings too small and prisoners were injured. Did not hold up, maintenance costs were too high. Also, cars were too small for officers. *East Providence, Rhode Island:* Unsatisfactory due to higher costs such as increased maintenance and additional features. Also created an atmosphere in which officers were concerned about their safety. Most accidents resulted in major damage. Injury rates also increased for officers. *Milwaukee County, Wisconsin:* Short on interior space and lacked the bulk necessary to push large disabled vehicles on the expressway. Smaller size jeopardizes citizens' and officers' safety, and inhibits the amount of equipment that can be carried. *Teton County, Wyoming:* Insufficient room for drivers and their personal equipment. Insufficient space for patrol equipment. *Rogers, Arkansas:* Uncomfortable, required expensive upkeep, had unresponsive power and handling. *Chino, California:* Did not hold up under the demand put on them by first responder personnel. "Basically, they fell apart." *Minnesota Highway Patrol:* Smaller cars used only in unmarked enforcement fleet. *Newton, Massachusetts:* Smaller cars used only for non-patrol functions, like traffic and meter maids. *Whitman County, Washington:* Did not hold up to rural county use, too small for equipment normally carried. *Agency asked not to be named:* "A horrible police car." Pulled some out of service and sold them with as little as 27,000 miles on them. Some units went through four engines and 10 transmissions. In the shop more than on the road. *Darien, Wisconsin:* Biggest problem was the electrical system, especially the alternators. Not big enough to handle all the equipment officers need. *Hastings, Nebraska:* Broke down constantly. Of the eight cars purchased, "we had eight lemons."

Note: Many departments noted that mid-size cars could not accommodate large or tall officers, especially after a cage was installed. They also commented that mid-size cars may be suited for some purposes but not for others. For example, the Florida Highway Patrol needs vehicles that have a power train that will endure hard acceleration, sustained high-speed driving, and have plenty of room for equipment because officers do not physically report to a patrol station each day. Some departments do not need such a fast, heavy vehicle. Other departments have found that they can use the smaller cars for detectives, administrators, and other non-patrol functions.

Source: *Law and Order*, September 1995; articles written by Arthur G. Sharp and Tom Yates; survey from Arthur G. Sharp.

PRIVATE INDUSTRY'S ROLE IN POLICE TECHNOLOGY

The law enforcement market admittedly is not an easy one. Agencies are spread coast to coast, they have very little money, and are subject to stringent procurement guidelines, department policies and state law. The market is not collectively big enough to give private industry much pause — or much profit — but neither is it so small that it can easily be ignored.

Being caught in this kind of a marketing no-man's land means police often get old technology which is affordable only because it is finally obsolete. As private industry and the military complex rocket into the next century, law enforcement lumbers behind, weighed down with hand-me-down technology that has been reworked to fit police needs.

"Law enforcement is so far behind the curve in terms of technology that they really haven't had anything new in years. It may be a little fancier, a little newer, a little more expensive, but to fight crime on the street, we have not armed our local officers with the full weight of technology," said Bill Tincup, president of Systems Engineering and Management Co., in Carlsbad, California, a Department of Defense contractor that spent the last several years engineering weapons and communications systems for aircraft and missiles.

The problems of selling to the police market are especially acute when it comes to automation, a risky business at best for the seller and buyer. Information systems can cost into the millions, especially those with all the modern bells and whistles. The cost often decreases as the department gets larger, yet it is the smaller departments that often need these systems the most. At least one company limits its marketing efforts to departments that serve at least 50,000 people or counties serving no less than 150,000 residents.

Another problem is the lack of industry standards. Agencies that buy from one vendor may have to stay with that vendor for the life of the system. And when it is time to upgrade, most of the system has to be mothballed because it cannot be integrated with new technology.

The result has been that very few products, other than handcuffs and batons, are developed specifically for police. As a consumer market, it is too small to attract the attention of private industry, which claims it cannot make up its enormous research and development investment on such a minuscule population. Gun manufacturers, for example, make the bulk of their profits selling to private citizens, not police officers.

Several years ago the NIJ began a strong push toward finding better tools for police. It funded advances in DNA profiling, put new tools in the hands of forensic scientists, found new less-than-lethal weapons for police, and with the help of money from the federal government's Technology Reinvestment Initiative and the defense drawdown, has been transferring military technology to the law enforcement arsenal. A number of companies followed the government's lead. Some were defense contractors that saw profits dwindling with cuts in defense spending — staying in the black meant selling to the blue.

Soft body armor is an area in which police continually reap the rewards of manufacturers trying to build a better mousetrap. In its original incarnation, the typical ballistic vest resembled the military flak jacket — bulky, hot and uncomfortable. "It was like wearing a corset," said one veteran police officer.

DuPont and Allied Signal, both manufacturers of ballistic materials, continually improve their products. Vest manufacturers try new stitching patterns, new strapping combinations, new carrier materials, new pocket combinations. The result is a ballistic vest that is lighter and tougher than those built as little as five years ago.

Ballistic material is used in other configurations, including bullet-resistant helmets. It lines the door panels of police vehicles, and is turned into ballistic seat covers and floormats in helicopters. The panels, which weigh less than 35 pounds, can stop a .44 Magnum round fired from 15 feet away. Ballistic material is also used as a liner in gloves to make them cut resistant, and as a tire seal on patrol cars. DuPont recently responded to the corrections market by creating a puncture-resistant vest for corrections officers.

Traffic enforcement is another area that has benefited from new technology. Gone are the days when patrol officers sat in stationary vehicles, pointing an unwieldy radar gun at the leader of the pack. In the old days, adding new features to radar devices meant adding circuitry or changing the structure of the radar. With the advent of computerization, various features can be enabled or disabled by simply changing the programming in the computer chip. Today's technology uses digital signal processing to identify the speed of the fastest vehicle, recognize fan speed, and avoid patrol speed "shadowing."

The new devices are smaller and more versatile. They mount almost anywhere and accommodate airbags and other equipment. They let officers look at the entire traffic spectrum, not just one car. They can hook into a printer to print the time, date, measurement of speed, and whether the violation was recorded in a moving or stationary mode. They can also connect to a PC to download information for statistical purposes.

Another new twist comes, ironically, from the makers of radar detectors. Safety Radar, introduced by Dynascan, is a small unit installed in emergency vehicles — police, fire or EMS — that alerts drivers with radar detectors that an emergency vehicle is within 3/4 of a mile.

"We've been kind of the bad guys for years," said a company spokesman. "We've been sitting there with all this technology and we knew there had to be another application. So we put a reverse spin on it. We did some focus groups and found out that motorists

just don't hear emergency vehicles because cars are so soundproof these days. We took the existing technology and put it to new use."

One company has a breath alcohol screening instrument designed especially for zero tolerance. It is calibrated to accommodate the new state laws by measuring alcohol content as low as .02. Another built a prototype patrol car that incorporates everything from a fiberglass back seat to 12-volt accessory outlets, and mounts for video recorder, radio, scanner, radar, computer. The company is also working on its car of the future. "Everyone tries to take a sedan and turn it into a police car," said a company spokesman. "But our long-term concept is to take a vehicle and build it from the ground up for police use. We are building prototypes now and putting together the partnerships with some of the suppliers who will be working with us."

Patrol cars, in addition to having sophisticated computer technology, are being fitted with Forward Looking Infrared (FLIR) systems that let officers see in the dark by pinpointing heat-emitting objects and projecting the image on an in-car monitor. "It turns night into day," said Capt. Bobby Richardson of the Highland Park Police Department in downtown Dallas, Texas. "We are in an area that is heavy with foliage, and even with a searchlight, it's hard to pick out people hiding behind a honeysuckle vine. This system will shine through the vine and see the person underneath it."

The camera is mounted in front of the light bar, with a small 9-inch black-and-white screen mounted inside the car. It scans a 180-degree area and picks up energy from people, glowing tire tracks left by speeding cars, and discarded guns and knives that are still giving off heat from contact with human hands. It even can spot a gun under a pedestrian's shirt by picking up the cold spot against the person's body.

Some departments are using an updated version of the old tachograph, the "black box" of patrol cars. The traditional tacho-graph used a stylus and a paper chart to record speed, rpm, and the status of lights and siren. It recorded vehicle activity prior to an accident, and detailed how the vehicle was being operated in the moments before the crash. The newest version uses an electronic format that can be incorporated into the onboard computer system.

Information from the device has been used in court, in one case exonerating a police officer who accidentally hit a woman who suddenly stepped off a street corner. The woman and eye witnesses claimed the officer was not using lights and siren. The tacho-graph said otherwise. It showed that the officer had his lights on, and activated the siren at least three seconds prior to colliding with the woman. It showed how many feet prior to impact the siren was activated and the exact speed of impact, which was 26 mph, not 40 as was charged by the victim. Because of the accurate tachograph readings, the department's liability was severely reduced.

These are just a few examples of companies that are "pushing the technological envelope," and working on new technologies without a guarantee of future profits. Unfortunately, they are few. One large weapons manufacturer, for example, refused to help the NIJ develop the Smart Gun — a weapon that can only be fired by its owner. According to a company representative, the cost of research and development would be too great to recoup from the law enforcement market alone. The company did, however, say it would be happy to manufacture and sell the weapon after the technology was perfected.

Clearly the law enforcement market is daunting. But private industry can play a significant role by working with researchers, engineers and scientists to incorporate law enforcement needs into new technologies as they are developed. This kind of partner-ship will enable police to piggyback on state-of-the-art developments and give them access to the technologies of the future.

The National Law Enforcement and Corrections Technology Center

In October 1994, the National Institute of Justice inaugurated the National Law Enforcement and Corrections Technology Center (NLECTC) as a component of its Office of Science and Technology. The NLECTC system offers support, research findings, and technical expertise to state and local law enforcement, corrections, and forensic science personnel. The system consists of facilities located across the country that are colocated with an organization or agency that specializes in one or more specific areas of research and development. Although each center and facility has a different technology focus, they work together to form a seamless web of support and technology development information.

NATIONAL OFFICE
P.O. BOX 1169
ROCKVILLE, MD 20849
800-248-2742
The National Office administers the voluntary equipment standards and testing program; supplies consumer product lists, testing bulletins and equipment performance reports; manages JUSTNET, the NLECTC system's Web site; offers equipment, technology and research information through its hotline; and publishes *TechBeat*, the NLECTC system newsletter.

NORTHEAST REGION
26 ELECTRONIC PARKWAY
ROME NY 13441
888-338-0584
Partnership: The Rome Laboratory which is the Air Force Super Laboratory for command, control, communications, computers and intelligence research and development.
Technology emphasis: Concealed weapons detection, covert tracking and tagging, advanced database design, and voice identification.

SOUTHEAST REGION
7325 PEPPERMILL PARKWAY
NORTH CHARLESTON, SC 29418
800-292-4385
Partnership: Navy In-Service Engineering-East, a U. S. Navy facility.
Technology emphasis: Corrections and surplus U. S. government property for redistribution to law enforcement, corrections, and other criminal justice agencies. The office seeks to facilitate identification, development, manufacture, and adoption of new products and technologies specifically meant for corrections.

ROCKY MOUNTAIN
2050 EAST ILIFF AVENUE
DENVER, CO 80208
800-416-8086
Partnership: Denver Research Institute, Denver University, and the Sandia National Laboratories.
Emphasis: Command, control, and communications, interoperability, explosives' detection and disablement, and ballistics.

WESTERN REGION
C/O THE AEROSPACE CORP.
2350 EAST EL SEGUNDO BOULEVARD
EL SEGUNDO, CA 90245
888-548-1618
Partnership: Aerospace Corporation, a federally funded research

and development center of the U.S. Air Force.
Technology emphasis: Forensic analysis, imaging technologies, and technologies to prevent high-speed vehicle pursuits.

BORDER RESEARCH AND
TECHNOLOGY CENTER
225 BROADWAY, SUITE 740
SAN DIEGO, CA 92101
888-656-2782
The center's mission is to advance technologies that provide improved capabilities in border surveillance, security, and identification. It coordinates its efforts closely with the U.S. Customs Service, the U.S. Border Patrol, and local law enforcement agencies concerned with border matters.

OFFICE OF LAW ENFORCEMENT
TECHNOLOGY COMMERCIALIZATION
WHEELING JESUIT UNIVERSITY
316 WASHINGTON AVENUE
WHEELING, WV 26003
888-306-5382
OLETC fosters commercial development and manufacture of promising, innovative technologies. OLETC is a joint project sponsored by NIJ, the National Aeronautics and Space Administration, and the National Technology Transfer Center.

NATIONAL CENTER FOR FORENSIC SCIENCE
UNIVERSITY OF CENTRAL FLORIDA
P.O. BOX 162367
ORLANDO, FL 32816
407-823-6469
This center focuses on research and training in the area of arson and explosives. Its goals include the development of a restricted-access electronic library for forensic and law enforcement professionals; support for the development of standard protocols for the collection and analysis of fire and explosion debris; supplemental training; and research to scientifically validate evidence collection and analysis procedures.

OFFICE OF LAW ENFORCEMENT STANDARDS
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
BUILDING 225, ROOM A323
GAITHERSBURG, MD 20899
301-975-2757
OLES works in partnership with NIST to develop equipment performance standards, testing methodologies, and operating procedures; standard reference materials for crime laboratories; test methods for forensic analysis; and offers research findings and technical support to NIJ and criminal justice agencies.