International Association of Chiefs of Police
515 N. Washington St., Alexandria, VA ■ 703/836-6767

Executive Brief

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Less-than-Lethal Weapons: New Solutions for Law Enforcement

By Lois Pilant

Every day we see evidence of America as an increasingly violent society. Our acceptance of it grows as we bat not an eyelash at even heinous crimes. We are not an uncaring society, but we simply do not know what to do. How do we react when we hear about a four-year-old girl dead from the sexual abuse of her stepfather and his two buddies, her body dumped in the bathroom shower stall? Or the three teenage boys who randomly chose a house one hot August afternoon and proceeded to rape the mother, daughter and son, then shot the son when he tried to defend his family? What is our reaction? We buy more locks for our doors. We buy bigger guns. We toss a blister-packed canister of Mace in our grocery baskets as blithely as we toss in this week's issue of *Time*. We cry for help from the police. We demand more officers on the streets and better protection of our homes and families.

What many of us fail to realize is that the cops need help, too.

The pressure to add new less-than-lethal (LTL) weapons to the crime-fighting arsenal is tremendous. Although government agencies began to address the problem more than 20 years ago, it was not until 1985 that the task was given new impetus. It was a landmark year for law enforcement: the Supreme Court ruled in *Tennessee v. Garner* that the use of deadly force to apprehend apparently unarmed, nonviolent fleeing felons was an unreasonable seizure under the Fourth Amendment. Then-Attorney General Edwin Meese called a conference to address the need for alternatives to deadly force, which resulted in the nonlethal ball landing squarely in the court of the National Institute of Justice (NIJ). The NIJ started to investigate several ideas and ultimately funded a study on chemical incapacitants.

Then came Rodney King, the incident that left Los Angeles reeling. In its aftermath, a commission was appointed, articles were written and debates ensued on the causes of such an incident and what could be done to prevent a recurrence. The media nearly bled its inkwells dry. Finding suitable nonlethal tools for police became a priority.

When federal law enforcement agents met the Branch Davidians outside Waco, Texas, the pressure increased even more, with Attorney General Janet Reno calling for accelerated efforts and additional funding to find tools that would subdue criminals without using deadly force.

The search for LTL devices has been painfully slow, primarily because funding is so limited. Only seven cents of every $100 in federal research and development (R&D) money goes to criminal justice, and not all of that goes for technology. In fact, said David Boyd, director of the NIJ's Science and Technology Division, only about a cent and a half goes for actual technological work. That cent and a half constitutes Boyd's budget. Although it has enabled the division to devise an LTL strategy, it has

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also dictated that any real development will be excruciatingly slow.

Still, Boyd's division has been able to accomplish some remarkable things. In 1992 and 1993, the NIJ initiated cooperative agreements, interagency agreements and a series of grants that focused on finding out what police needed. To ensure that policy, liability and sociological factors were addressed, the agency included social scientists and criminal justice researchers on its LTL technology team. The NIJ then hosted a brainstorming session that included representatives from all levels and disciplines of law enforcement, including police chiefs, SWAT commanders, narcotics detectives, deputy sheriffs, line officers, representatives from jails and prisons, and practitioners from other disciplines in the criminal justice profession.

The participants were divided into focus groups with each studying the need for an LTL tool in a variety of scenarios. What came out of that meeting was a wish list of sorts, a compendium of devices that law enforcement wanted, including some ideas that were as farfetched as the Star Trek phaser. It also included a number of projects that were not only feasible, but could be developed by adapting existing technology.

The NIJ then turned to the scientists at the Department of Energy's (DOE) national laboratories through DOE's Special Technologies Programs, a division charged with developing tools to support intelligence, law enforcement and military special operations. As a result, four of the DOE labs—Sandia, Idaho, Lawrence Livermore and Oak Ridge—are currently working on a number of projects.

Early this year, work on the LTL program accelerated. The NIJ funded a grant to convene a panel chaired by Vice Admiral E.A. Burkhalter. The panel was charged with examining LTL technologies that could be adapted from military technology. Other panel members include William Webster, former director of the FBI and CIA; Dr. Ruth Davis, former Undersecretary of Defense and former Secretary of Energy; Gen. Paul Gorman, former Commander-in-Chief, U.S. Southern Command; William Geller, associate director of the Police Executive Research Forum; Hubert Williams, president of the Police Foundation; Dr. David Mann, former Assistant Secretary of the Navy; James Falk, former White House Domestic Counsel; Mayor Kurt Schmoke of Baltimore; and Elizabeth Watson, chief of the Austin, Texas, police department and former Houston police chief.

As the LTL program has evolved, so has the idea behind it. At one time, the search for nonlethal weapons was considered a search for an alternative to deadly force. Today, it is viewed as an effort to find tools or devices that subdue subjects without harm. Although these tools can be lethal if used inappropriately or in unusual circumstances, they are not considered weapons in the usual sense nor are they seen as alternatives to deadly force. Deadly force is at the top of the use-of-force continuum, and LTL devices are simply lower rungs on the same ladder. To distinguish between "less-than-lethal" and "nonlethal," the latter refers to a device that cannot cause death no matter how it is used.

Better Alternatives

According to NIJ statistics, the federal government spends $75 billion on law enforcement and the criminal justice system every year, a figure that does not include the estimated $50 billion spent on private security. That $75 billion is intended to somehow address, through prevention, prosecution or corrections, the 1.2 million violent crimes and the 12 million property thefts committed every year.

If the productivity of law enforcement and the criminal justice system could be improved by a mere 1 percent, Boyd said, it would have astounding and far-reaching effects. It would mean 250 fewer murders; 1,000 fewer rapes; 11,000 fewer assaults; 127,000 fewer burglaries, larcenies and robberies; 14,000 fewer victims of crime burdening the health care system, and $700,000,000 less in economic loss.

Achieving this one percent productivity increase would be the equivalent of spending an additional $750 million each year on law enforcement. "Police still have the same choices Wyatt Earp had," Boyd said "They can talk a subject into cooperating, they can beat him into submission or they can shoot him. What police need are better alternatives."

Developing new technologies that will improve productivity and give law enforcement those alternatives is what the LTL Program is about. When the NIJ hosted its brainstorming session in 1991, participants were given a set of parameters for any LTL device or idea under consideration:

- It had to improve on a present practice;
- It could not overburden the officer;
- It had to be inexpensive;
- It could not require extensive training;
- It could not require dedicated manpower;
- The liability issues had to be manageable;
- And, of course, it had to work.

The LTL Program got underway with an inventory of technology that was already available from the military and private industry. Potential projects were divided into three categories: "off the shelf," technology that was already in use; "some assembly required," technology that did not require extensive scientific development; and "scratch," projects that would require building from the ground up. At the same time, social scientists, researchers and criminal justice practitioners began studying policy issues, liability issues, public reaction to LTL tools and the political ramifications of using such devices.

Although the strategy of the LTL Program was put into effect, progress has been slow because NIJ projects are often relegated to the back of the scientific burner. In some cases, DOE engineers have only been able to dedicate a small amount of their time because the NIJ does not have the money to pay for their full-time services. "The Science and Technology Division has a budget of six million dollars, only about half of which is available for research and development," Boyd said. "That means we usually don't have enough money to support a full-time person (at a DOE lab), which makes our projects a lower priority. As they finish working on larger projects, they work on ours."

Development of current projects is expected to take at least three to five years. Within the last year, however, several have shown great promise as being useful LTL and nonlethal devices for law enforcement.

Restraint Devices

One of the problems cited by patrol officers throughout the country has been the difficulty of safely transporting out-of-control suspects who are in the back seat of the patrol car. Although some officers have tried a sudden tap on the brakes, such a tactic, which has been called an inappropriate use of force, only seems to madden an already incensed prisoner. A better method may be to use an airbag, one that inflates in the back seat and immobilizes the suspect but still allows him to breathe.

Such a device is currently in the development stage at the Idaho National Engineering Lab in Idaho Falls. Donna Marts, the project engineer, said it has come along faster than expected. Initially charged with proving the concept, Marts went a step further by developing a prototype that consists of a small box with an airbag inside and an opening big enough for a person's forearm. By turning on an air compressor attached to the box, Marts can rapidly pin a person's arm to the side of the box.

The patrol car airbag is different from those that are becoming standard equipment in today's passenger cars. The material in a commercial airbag is nonporous and acts more like a balloon, inflating instantly and deflating quickly after deployment.

In contrast, a patrol car airbag must have some permeability because the prisoner has to be able to breathe. Marts's model uses a mixture of canvas and nonporous nylon, a combination that has worked well on the prototype. What has yet to be determined is the airbag design and the ratio of permeable to non-permeable fabric. Too much nylon will not let the prisoner breathe; too little will allow the bag to deflate.

Other considerations are the means and rate of inflation. Commercial airbags, which inflate in about 1/20 of a second, use a gas or chemical reaction as the means of inflation. Marts said police may not need immediate inflation or the use of chemicals. Warning the prisoner about the airbag and following up the warning with slow inflation may have the necessary psychological effect and give the prisoner time to calm down.

Chemical or gas reaction also affords only a limited inflation time, a factor that could make the airbag useless for officers who need it inflated for a longer period. Marts wants to use air to inflate the bag and wants to give officers an unlimited supply by devising a system that would use a fan or air compressor stored under the front seats or in the trunk. Tubing would run to the roof, in almost the same configuration as a rollbar, and would feed into the main header of the airbag. The airbag would be manually operated by a switch on the dashboard.

Marts is also trying to find a fast and inexpensive way to reload the airbag. Commercial airbags must be professionally repacked, which is an expensive process that law enforcement cannot afford. Marts said she hopes to come up with an airbag that can be quickly and inexpensively cleaned and repacked by police personnel.

Although the project has come along faster than anyone expected, a great deal of work still needs to be done. Marts is looking at the different types of cars used by law enforcement and will be developing a mounting configuration that can be used on all models. Plans are to have a unit available for field evaluations by 1994. If the airbag proves to be a successful LTL tool, the technology will be transferred to a commercial manufacturer within the next two years.

At the Sandia National Laboratory in Albuquerque, New Mexico, project engineers Tom Goolsby and Steve Scott have been working on a different type of restraint system: a foam so sticky it can literally stop a suspect in his tracks. "If an officer covers an approaching suspect's torso with it and the suspect touches it, he will become entangled in the material. You can immobilize the person," Scott said. "You can glue his pants legs together so he can't move away."

Sticky foam could be used in certain SWAT or hostage situations and could be especially useful during disturbances in jails or prisons. It could also be used to deny access to certain rooms or corridors, as in the case of a drug raid or a prison riot.

The foam is delivered from a specially developed dispenser that is carried in a shoulder sling. When fired, it ejects the sticky foam from the dispenser's cylinder and can entangle a person from as far away as 35 feet.

Although early development indicates that sticky foam could be a successful restraining and blocking device, it does have its problems. One of those is that it currently has no "antidote"; while the foam is non-toxic, the solvents that unstick a person are potentially toxic, and so far, no totally safe and effective solvent has been found.

Cost is another issue. One of the parameters of any LTL device is that it be affordable. The sticky foam meets that criteria at $5 a pound, but the hardware is expensive, running as high as $750 per unit.

Scott said that work is progressing in identifying an acceptable solvent to use with the dispenser. Hardware prototypes should be finished by the end of this year. After additional testing and an independent risk assessment are completed, it may be possible to begin field evaluations with security officers in Florida prisons sometime next year.

Another restraint system that is currently in the development stages may be the most effective, but is easily the most controversial: chemical incapacitants. It was a promising alternative in the wake of the *Tennessee* v. *Garner* decision and the ensuing Meese conference. In response to the strong interest expressed at that conference, the NIJ funded a feasibility study of chemical incapacitants that could be delivered by dart. When the study was completed in 1989, the NIJ put $500,000 toward R&D, with another $580,000 dedicated to additional research in 1990.

The result was the discovery of Alfentanyl, a drug that has been used in hospital operating rooms for many years. A derivative of the Fentanyl family, Alfentanyl is a synthetic narcotic that is commonly used as a surgical anesthetic. It has been considered the most promising because it is a highly

potent drug that acts as a central nervous system depressant. While that can be effective when trying to restrain a suspect, Alfentanyl also depresses, or inhibits, respiration.

Research at the Lawrence Livermore National Laboratory in Livermore, California, is taking a second look at several problems associated with the use of Alfentanyl, primarily its effect on respiration. Ray Finucane, project engineer, said scientists are trying to find a drug that could be administered simultaneously and would act as an antidote by preventing Alfentanyl from affecting the subject's breathing.

Additional research is focusing on the very thing that makes Alfentanyl so effective: its potency. What scientists must do, Finucane said, is increase the drug's "dose safety margin." In a hospital setting, the dose safety margin of Alfentanyl is 4:1, which means that the lethal dose is four times that of the therapeutic dose. While a 4:1 margin may be appropriate for a hospital setting, it is far too low to use on the street. What is needed is a margin that would enable a police officer to administer the same dose to a child or an adult and have it be sufficiently incapacitating, yet nonlethal.

One way to increase the dose safety margin is to combine another drug with the original, thereby decreasing its potency. Another method is to slightly change the original drug's chemical structure and essentially create a new one. Current efforts, however, have shifted to Lofentanyl, another Fentanyl derivative. Lofentanyl has a higher dose safety margin than Alfentanyl, and, like all the drugs in the Fentanyl family, passes quickly and easily through the blood/brain barrier to go directly to the brain. It can bypass any other drugs that are already in the subject's system and incapacitate for one to two minutes with no side effects.

The time it takes the dose to be effective, or onset, is of particular importance when considering a chemical incapacitant. At one time, experiments showed that Alfentanyl had a 20-second onset, which was far too long for the kind of volatile situations police often encounter. The drug that is ultimately chosen, Finucane said, must have a rapid onset if it is to be an effective LTL tool.

Scientists and engineers at LLNL have also been charged with the difficult task of coming up with a delivery system for chemical incapacitants. In the mid-1980s, when chemical incapacitants were first studied, the idea was to administer the chemical in dart form. It was even suggested that the patrolman's baton be turned into a combination nightstick/dart gun. It would have added a new weapon to the patrolman's arsenal without adding more paraphernalia to the duty belt. But the prototype, which looked like a standard PR-24 baton with laser sights, was a failure. Such are the hazards of R&D; failures are what make technology development tedious, expensive and often frustrating.

Scientists are now looking at other possibilities. One is to lace a paintball with DMSO and a chemical incapacitant. The paintball would splatter on the subject, and the DMSO, which is absorbed immediately through the skin, would carry the drug into the body. Because the first and most natural reaction is to touch the spot that has been hit or injured, paintball technology could be effective even if it only splattered on a subject's clothing.

Scientists will also have to address the controversial side of chemical incapacitants: the public's acceptance, or lack of it. Public acceptance may hinge on skewering one of the bigger myths about handguns: that when a person is shot, he dies. What most people fail to realize is that guns are not as dependable at bringing down an assailant as television and movies portray. Instant death is a Hollywood myth that often leaves the public with the mistaken impression that police have all the weapons they need. But a chemical incapacitant that acts instantly and has the ability to disable a suspect for up to two minutes could be many times more effective, more humane, and therefore, more socially acceptable, than a handgun.

Distraction and Disorientation Devices

One of the primary considerations when developing LTL devices is proximity, keeping officers at a safe distance without diminishing their ability to do the job. Prisons and jails are areas of particular concern because of the volatile atmosphere and the violent disturbances that can break out in high-security units. Breaking up a riot or inmate fights, or extracting a prisoner from a cell, can put a corrections officer in close and often dangerous proximity to prisoners.

What is needed is a way to stop or interrupt unruly or violent behavior. The NIJ decided to study the use of different types of light to distract, disorient and possibly disable. Unexpectedly shining brilliant white light into an area was one possibility, while using lasers was another. Because the eye has a different focal point for different colors and cannot move quickly between those points, flashing lasers can disorient as effectively as bright white light. But the idea that received the most attention was the use of pulsed, or strobe, light. Pulsed light can be used in areas that are dark or poorly lit, such as in prison situations where the lights can be turned off. It can do more than just distract; it can have such a disorienting effect that it can temporarily disarm a subject by interrupting or disabling coordinated motor movements.

The kind of light source that is currently being considered operates in millionths of a second with a pulse of light as bright and blinding as a noise-flash diversionary device (often called a "flash bang"). The tremendous candlepower of diversionary devices can temporarily blind anyone in the room. Generally used as tactical devices in hostage situations, they can distract a suspect just long enough to get SWAT team members safely in the door. What engineers at the Livermore lab hope to use are pulses or bursts of the same kind of light, either from a fixed unit installed in a wall or ceiling, or a portable unit that could be tossed in the window or door during a hostage or barricade situation.

Because light sources are commercially available, they are not the subject of the lab's study. What engineers are trying to develop is a way to keep officers from being affected by pulsed light. To do that, they are developing goggles that can "gate out" the bright light. One possibility is to use a

type of glass or plastic that is activated by ultraviolet light, and darkens or lightens automatically. If it is used for goggles, however, it will have to perform faster than the eye can see. Another possibility is to use a gating device that would be synchronized to actually open and close as the light flashes. The device would close when the light was on and open when it was off.

Although researchers are working on a prototype, Finucane estimated that full development of the project is at least two years away. One of the primary considerations, he said, is cost. "Many prisons and jails are on tight budgets, so it has to be worth pursuing and that may be the biggest obstacle. I have no idea what it would cost because every application would be different and every installation unique. Each would have to be engineered a little differently, which would drive the cost up. We can develop the technology. It's not that complex. What we would like to do is come up with a system that costs very little to deploy."

Another distraction/disorientation technology being studied is Oleoresin Capsicum (OC), or pepper spray as it is more commonly known. OC is the newcomer to the commercially available nonlethal market and in some areas, has completely eclipsed the use of Ortho/Chlorobenzal-Malononitrile and Chloroacetophenone (CS/CN) sprays. It has several advantages over CS/CN: it does not contaminate the patrol car or the officers; it can work on dogs;and it seems to be more effective on individuals who are out of control, whether from drugs, alcohol or mental illness. Furthermore, while CS/CN is a chemical and an irritant, OC is an inflammatory derived from a product that occurs naturally in hot peppers.

OC will cause a suspect to react in much the same way as someone who has just eaten a plate of fiery Mexican food. The juice of the hot peppers causes the eyes to water involuntarily and in some cases, can cause the breathing passages to swell. A subject sprayed with OC will have similar yet considerably stronger reactions. His eyes will involuntarily slam shut, his breathing will become short and shallow, and he will have an intense burning sensation in his eyes, throat and any area of the skin that was sprayed. He may feel as if he were choking. He may cough, feel nauseous, become uncoordinated, lack upper body strength, and feel disoriented and afraid.

Although OC is used extensively in the field, there have been relatively few formal studies on its effectiveness or its health risks. It is not regulated by the Food and Drug Administration, the EPA or the Consumer Product Safety Council. As a result, OC manufacturers have rapidly proliferated in what has become a hotly competitive market. The lack of regulation, the dearth of studies, the novelty of OC spray and manufacturers' product claims that range from the credible to the ridiculous, have left many administrators frustrated and confused, not knowing whether their officers should be carrying CS/CN, OC, or nothing at all.

The NIJ, as part of its LTL program, assigned the task of gathering what studies have been done on OC sprays and analyzing the field data to the International Association of Chiefs of Police (IACP), which is using report forms, interviews and archived police department data to produce a scientifically based study on the use of OC.

A preliminary report indicates that OC spray is an effective nonlethal tool. The results of a two-year study conducted by the FBI Firearms Training Unit and the U.S. Army Chemical Research and Development Center were that its use posed no long-term health risks. The FBI reported no ill effects or adverse reactions among its 899 subjects. The CRDEC said OC did not cause cancer or mutations in laboratory animals. The Kansas City, Kansas, Police Department contracted a private company to conduct its own study, which concluded that in rare instances, it was possible for people with respiratory problems to die as a result of being sprayed with OC. They added, however, that it was statistically improbable given the FBI data and the fact that none of its 899 subjects were adversely affected.

The IACP also found that courts have upheld the use of chemical irritants, which may spill over as a kind of tacit approval of OC sprays. Anecdotal evidence indicates that field experience with OC has been successful, and in many cases, has reduced officer and subject injuries and associated expenses, as well as civil litigation and excessive force complaints. In addition, an effectiveness rate of nine out of 10 was reported by Alaska State Troopers who used OC on intoxicated individuals.

The NIJ is also initiating a model program to track information on new or emerging technology, with OC spray as its first subject. Dr. Charles Petty, the former medical examiner for Dallas County, Texas, currently a professor at the University of Texas, and Bob Tolle, former director of the Naval Investigative Service, will implement and oversee the collection and study of data. "The information given us will be confidential because these will be ongoing studies," Boyd said. "We are not going to second-guess anybody or do any investigations. This is an academic scientific study using real field data so we can establish the safety and effectiveness of any new technology. If we find something wrong, it will also allow us to warn law enforcement because they should be the first to know if there are problems."

Although the NIJ's efforts in the area of distraction and disorientation devices are primarily focused on existing technology, the agency is also working to open up new areas. A study is currently underway at the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, to look at the volumes of literature on physiological responses to external stimuli. Vivian Baylor, deputy director of the Special Projects Office, said the study is primarily a review of testing that has been done by other organizations. "It's a literature study that looks at how the body responds to various types of physical stimuli so we can understand how the body reacts to various agents. Then we will look at different types of scenarios and judge how each one of those agents might be used in that environment, if at all. We are looking at what has been done in the past to see if it can be applied to law enforcement," Baylor said. ORNL is looking at the literature on the body's susceptibility to sound, light, and ionizing and non-ionizing electromagnetic waves, which can cause a disabling, but not harmful, seizure.

As part of its own LTL program, ORNL is proposing to develop two types of weapons based on existing technology: the magnetophosphene gun and the thermal gun. The magnetophosphene gun can make a subject "see stars" by delivering what feels like a blow to the head, said Baylor. One advantage is that it will work in cases where drugs, alcohol or mental illness have rendered a subject impervious to other devices. It has a range of 10 to 20 yards and can deliver through a wall if necessary.

The thermal gun is another device being proposed by ORNL. It can be aimed through a wall, has a range of up to 50 yards and will force a suspect's body temperature up to 107 degrees, with the result being near 100 percent incapacitation. "Although neither of these projects is a part of the NIJ's less-than-lethal program,we hope that in a year we can come to the NIJ with some technology and hardware proposals on devices that could be developed into viable LTL tools," Baylor said.

Vehicle Interdiction

Vehicle pursuit is one of law enforcement's more dangerous activities. It does not matter how many hours of driver training the officer has had, nor does it matter whether that training was on a track or in front of a computer simulator. Statistics show that more people are killed or injured during a chase than during any other police action. The financial ramifications alone can be devastating. Estimates are that it costs approximately $1 million to replace just one officer, while one failed civil lawsuit can wipe out a department's entire budget for years to come.

Some cities have gone so far as to outlaw pursuits, operating instead under the assumption that the suspect will eventually get caught. Other departments have restricted chases, such as prohibiting pursuits of those suspected of misdemeanor or nonviolent crimes. Some departments allow a group of pursuing officers to surround the vehicle. As the group slows to a stop, so does the suspect. Some departments even allow ramming to force the suspect off the road. But what law enforcement could really use is a way to safely stop a fleeing vehicle, one that keeps everyone—officers, suspects and bystanders—from getting hurt.

Developing such a device is the subject of a study being conducted by John Richardson, a project engineer at the Idaho lab. Richardson said his research is covering an enormous amount of territory by trying to consider all of the factors involved in pursuits. When the study is completed, Richardson will have enough information to recommend to the NIJ the most feasible and cost-effective technology to pursue.

The possibilities are numerous, with some sounding like something out of a James Bond movie. Police could use combustion inhibitors, like spraying polyurethane foam in front of the vehicle to clog the intakes. They could try combustion enhancers, like acetylene, to cause an engine meltdown. They could use electromagnetic pulses to destroy critical engine parts, or access radio and microwave signals to confuse, interrupt or create false signals in the ignition and control sensor systems. (Although this particular technology is used by the military, it is designed to knock out the controls of an entire convoy of trucks.) Other alternatives include fogs that coat the windshield and impair driver visibility, and physical restraining devices like spiked barrier strips or nets like those used on aircraft carriers.

Although the object of the study is simple—to identify the safest and most effective technology for vehicle interdiction—getting there is not quite so easy. "We are looking at liability issues and police policies. We're studying the conditions of the pursuit. Are there other vehicles in the area? Is it rural or urban? How close can the pursuing vehicle get to the vehicle being pursued? Is it a misdemeanor or felony?" Richardson said.

The study will look at vehicle interdiction in three parts—mode of power, driver and environment—and will determine which of the three is easiest and safest to disable. "We've developed a failure-event tree to look at all three of these areas. With mode of power, we are looking at what causes failures in a car. We break the vehicle down into components—ignition, fuel, electrical, lubrication—and look at what causes each of these systems to fail. For example, can we use very strong radar signals to disrupt or damage the ignition system? We look at what kinds of technology can cause these components to fail and find out which ones exist and which ones need to be developed. Then we go back to our requirements and ask which technologies are reasonable to implement on a patrol car. Can we deploy this device and stop a vehicle in a benign manner? We have a lot of ideas and solutions, but we have to look at the operational constraints." Richardson said his report will review pursuit scenarios and determine the operational requirements associated with vehicle interdiction. It will also address the liabilities and legal precedents that influence department policy, assess pursuit failures and vulnerabilities, and recommend technologies that can meet the needs of law enforcement. The optimal solution, he said, must be safe, reliable, portable, reasonably priced and deployable by any trained officer.

Crowd Control

Riots in Miami, Detroit, Chicago, and in particular, Los Angeles, have shown law enforcement that the tactics used during the demonstrations of the 1960s are useless against the rioters of the 1990s. The Los Angeles riots, described by one officer as "urban guerilla warfare," had roving bands of protestors and looters who moved quickly through areas and forced the police to keep up. They had ready access to weapons and no qualms about using them. It cost the city $1 billion and 42 lives. Even though some divisions had adopted modern riot control techniques, they were no match for the angry population.

Law enforcement has an array of LTL tools to use in these situations. Chemical munitions, like those that use smoke, CS/CN and OC, are readily available and are effective at dispersing crowds, denying access to a specific area or routing large groups of looters from stores. Projectiles—foam rubber

baton rounds, rubber pellet rounds, bean bags—are also effective and help to keep officers at a safe distance.

The disadvantage of these LTL rounds is that if they are fired too close to a crowd, they can be fatal. The Livermore lab is working on a way to combat the lethality of blunt trauma projectiles fired from a special launcher by developing a device that will measure the distance to the target and automatically adjust the velocity of the round.

Engineers originally looked at range-finding technology used in cameras but found that the field of view was too broad. Current efforts are focused on the ProSurvey 1000, a laser range finder used in surveying that automatically detects and measures the range between two points. Experiments on adjusting the muzzle velocity are being conducted with a tennis ball launcher, which uses compressed air to fire tennis balls. "At this point, we are just trying to demonstrate the technology. We are developing a prototype to show how the whole system might work," said Ray Finucane.

A velocity and range correction device would have several applications. Officers could choose their distance instead of being forced to stand at the limit of the launcher's range. The device would diminish the possibility of human error by automatically adjusting its velocity if, for example, an innocent bystander or a child inadvertently walked in front of the launcher prior to firing. It could also be used in situations where an out-of-control suspect could not be subdued or restrained without harming the officers, the suspect or someone else. When such an incident occurred at one police department, the officers managed to arrest the man, without endangering themselves, by knocking him to the ground with a projectile fired at close range. Although the prototype is nearing completion, Finucane said putting a workable device in the hands of law enforcement is at least two years away.

A Strong Foundation

The NIJ has funded a number of studies that will dovetail into its technological research. The National Sheriffs' Association is reviewing use-of-force reports and will be conducting on-site interviews to assess the need for LTL technology in jails and on patrol. Similar research is being conducted by the American Correctional Association, emphasizing the special problems faced by corrections officers. The Police Foundation has taken on the task of analyzing large data bases to determine when LTL technology might have been useful in each of five scenarios: search warrants and raids, hostage situations, domestic disturbances, fleeing felons and patrol situations, and barricade/tactical assaults. The Department of Criminal Justice at the University of Baltimore is helping to coordinate and evaluate the LTL program. The university is especially focused on evaluating research plans and the progress of the social science studies.

One of the more important aspects of the program, one which will be studied by the Institute for Law and Justice, is the public's reaction to LTL technology. "The image is not so good right now because of the abuse of some of the existing less-than-lethal weapons, like stun guns and batons," said Dr. Alan Preszler, who spent a year as the NIJ's visiting scientist in charge of the LTL Program. "I think it's hard for the public to imagine controlling some of these things. There is an elaborate process now to control the use of handguns. We critique every fired shot, and I think the public feels comfortable with that. They know that if there is abuse, that person is going to be punished. But when you start talking about being able to stop a car with the push of a button or using a chemical dart that puts you out, even if it's only for two minutes, that is something else entirely. It's a conflict. It's the age-old fight between tyranny and anarchy. We want order, but we don't want order at the expense of our personal freedom."

Equally important to technological development is the law enforcement perspective; officers must not feel as if their guns are being taken away. "Less-than-lethal devices are not alternatives to deadly force. If we create a situation where the officer has at his disposal only less-than-lethal force and the bad guy knows that the officer cannot hurt him, we have a situation where the criminal has a greater incentive to kill because he has nothing to lose. This is a trade-off we never want to create," Boyd said.

New Projects

The future of the NIJ's LTL program holds tremendous promise, with efforts by the Burkhalter panel to identify military technology, facilitate its transfer to law enforcement and help the NIJ sponsor new technologies being developed by the Department of Defense. Even though nobody has seriously proposed inventing the Star Trek phaser, some of the latest ideas come very close:

- Miniaturized video/sound communications systems that would be carried in the helmet of a motorcycle officer or on the uniform of patrol officers. The picture of the officer and the subject's actions would be digitized and relayed to a command or control center. The information could be analyzed immediately for decision-making purposes or later used as legal backup. It would keep the officer on his toes and might act as a deterrent if the subject knew he was being watched.
- An over-and-under weapon that would have a less-than-lethal round in one chamber and a lethal round in the other. The LTL chamber could have several applications: a paintball or sticky foam round containing an electronic tagging device could be shot at a speeding vehicle and later used to track it. A sticky foam round also could partially disable a suspect who touched it because he would be unable to remove his hand. The second barrel would contain a lethal round should the need arise.
- Magnetic tagging devices that could be attached to a vehicle during traffic stops. If the driver of the car left the scene, a chase would be unnecessary because the officer could track the car using the electronic device. If there were no problems, the officer would retrieve the device when he returned to his car.
- An individual officer locator, the technology of which is currently in use by Japanese parents to keep track of their

changed each time they "fix" on their child. The technology is available and adaptable for law enforcement or corrections officers who need to keep track of prisoners in large institutions.

- Robots the size of a spider that can relay images and sound by creeping under closed doorways and hiding in corners.
- Judgmental training using sophisticated computer technology developed by the Department of Defense. One such type of training, SIMNET, has been successfully used by the department in war games.

The DOE labs, in addition to their current NIJ-sponsored LTL projects, are developing other types of technologies that could be transferred to law enforcement. At the Idaho lab, engineers have come up with a helmet that lets officers track one another in large or complex buildings, or in situations with heavy smoke.

At the Oak Ridge lab, scientists have come up with "multilayer shielding," a material that is a lightweight combination of Nomex, Kevlar and Fiberglass, flexible enough to be molded into any kind of configuration. Testing has included lining the fuselage of B-52 bombers and exploding bombs in the interior. The fuselage held, said Baylor. The material can also be molded into walls to create a shoot/don't-shoot type of training course for law enforcement.

Oak Ridge is also working on a machine that can determine if a person has been handling explosives and analyze body fluids for drugs or alcohol. Other projects include developing frangible lead-free bullets for training and an advanced sniper round that would have high stability over a long range.

The Sandia lab is studying the use of aqueous foam, a type of water-based foam that is similar to soapsuds and acts as an obscurant. The person in a room flooded with foam would still be able to breathe but would be unable to find a way out. Aqueous foam primarily has applications in jails and prison environments and would be used to isolate, not restrain, individuals.

One of the more exciting projects is an effort to develop a "smart gun," a weapon that NIJ officials hope will prevent officers' being shot with their own weapons. Doug Weiss, the project engineer at Sandia, said he is currently investigating technologies that will prevent the firearm from being used by anyone other than an authorized user. One possibility is the use of a biometric sensor that can sense unique characteristics of a user's hand. The sensor could be engineered to discriminate between hand sizes, particularly adult or child. The disadvantage to this type of technology is that stress can change how the officer reacts or the way he holds his gun. Other possibilities include using a fingerprint, handprint or sensor strips like those used at toll gates, with the sensor built into the grip. The initial research has been funded by the NIJ, with Congresswoman Pat Shroeder adding her support by requesting in the budget authorization bill an additional $1.5 million in development money.

Shroeder's support, the infusion of additional R&D money and a budding relationship with the Department of Defense is only the beginning of what Boyd would like to see happen with the LTL Program. He wants to use a virtual reality environment to test new weapons concepts. He dreams of setting up a graduate engineering "superbowl" that would have graduate students competing in a national contest to come up with technological solutions to law enforcement's problems.

But Boyd's dreams need funding to come true, and the $6 million allocated to the Science and Technology Division does not go far. Watching every dollar does nothing to dampen his enthusiasm, however. He continually crisscrosses the country, stumping for the LTL program and beseeching law enforcement to play a more active role by helping science come up with new solutions. Even though he knows those Star Trek weapons are light years away, he still believes anything is possible. "If we can imagine it," he said, "we can make it work."

International Association of
Chiefs of Police
515 North Washington Street
Alexandria, VA 22314-2357
Phone: 703-836-6767; 1-800-THE IACP
Fax: 703-836-4543
Cable Address: IACPOLICE
Web address: www.theiacp.org

May 6, 1999

Wendy Howe
Special Assistant to the Director
National Institute of Justice
Office of Science and Technology
810 7th Street, NW
Washington, D.C. 20531

Dear Wendy:

As you requested, I have checked on the amount of remaining funds in our current "Cutting Edge of Technology" grant, your grant number 92-IJ-CX-0003. The remaining amount is $17, 626.51 as of March 31, 1999.

Based on the substantial dollars remaining, and our understanding with you to begin work on various project tasks of the new "Cutting Edge" proposal, specifically support of, and attendance at your upcoming conference in Orlando, it seems best to seek a no-cost extension of the current project from March 31, 1999 to August 30, 1999. This extension should allow us to utilize all remaining funds and initiate work on the next task listed in our proposal, development of a "Policy Liability Avoidance Through Technology Curriculum."

At the end of this extension, this project will conclude and we will begin utilizing funds from the new grant to accomplish all tasks identified in the proposal. This presumes that the extension requested in this letter does not in any way affect progress on the funding of our new project. Your clarification is sought on this matter.

Sincerely,

John R. Firman
Research Coordinator

cc: Jerry Needle
Ellyn Heymann